# Respiratory healthcare resource allocation in rural hospitals in Hunan, China: a cross-sectional study

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# Abstract

Background Rural hospitals in China provide respiratory health service for about 600 million people, but the current situation of respiratory healthcare resource allocation in rural hospitals has never been reported.Methods In the present study, we designed a survey questionnaire, and collected information from 48 rural hospitals in Hunan Province, focusing on their respiratory medicine specialty, basic facilities and equipment, clinical staffing and available medical techniques.Results The results showed that 58.3% of rural hospitals established an independent department of respiratory medicine, 50% provided specialized outpatient service, and 12.5% had an independent respiratory intensive care unit. Among these hospitals, 72.9% were equipped with pulmonary function test laboratories, 54.2% had bronchoscopy rooms, 64.6% had non-invasive ventilators, 43.8% had invasive ventilators, while less than 15% had set up sleep laboratories and atomization therapeutic rooms. The overall physician-to-bed ratio and nurse-to-bed ratio were 1:11.1 and 1:13.6, respectively. Mechanical ventilation, diagnostic bronchoscopy, therapeutic bronchoscopy, thoracoscopy, percutaneous lung biopsy, transbronchial needle aspiration and bronchial artery embolism were applicable in 66.7%, 47.9%, 6.3%, 18.8%, 20.8%, 8.3% and 8.3% of rural hospitals, respectively. Rural hospitals without an independent department of respiratory medicine showed significant disadvantages in facilities and equipment, clinical staffing and medical techniques over the other hospitals.Conclusions Respiratory healthcare system in rural areas of China are facing great challenges, including a serious shortage of basic facilities and equipment, necessary medical techniques and high-quality workforce. Besides, disparity of respiratory healthcare resources has been increasing among rural hospitals. More financial and political support from the government are needed to improve the access to and the quality of respiratory health service for rural residents.


# Background

Respiratory diseases are leading causes of death and disability worldwide. In the updated report on the top 10 common causes of death published by World Health Organization in 2017, 4 kinds of respiratory diseases were listed, including chronic obstructive pulmonary disease (COPD), lower respiratory tract infections, lung cancer and tuberculosis [1]. It has been well recognized that prevention, control and cure of respiratory diseases and promotion of respiratory health service must be a top priority in the health sector.

China has the biggest population on the planet. Respiratory diseases are serious public health problems and cause a heavy financial burden in China, at least partly attributing to severe air pollution and uncontrolled tobacco use [2, 3]. Rural health service is the key component of the whole respiratory healthcare system. In rural society of China, which is economically underdeveloped and occupies about 45% of the whole population, difficult access to comprehensive respiratory health service remains a serious problem to be solved. Even though rural healthcare system in China has been significantly improved since the enforcement of health reform in recent decades, there is still a large gap between rural and urban areas in terms of the access to and the quality of respiratory health service.

Therefore, there is an urgent need to assess the respiratory healthcare resource allocation in rural China and analyze the present problems, as well as the reasons. In this study, we investigated the current respiratory healthcare resources in 48 rural hospitals in Hunan province through a cross-sectional survey.

# Methods

### Study design and setting

In the present study, a cross-sectional survey was performed among 48 rural hospitals located in 13 cities and 44 counties in Hunan Province, China (all the hospitals involved are listed in the additional File). Hunan Province is located in middle China, which consists of 13 cities and 1 autonomous prefecture. The total area of Hunan is 210,000 square kilometers and the total population is 69 million. In the year of 2018, Hunan's gross domestic product per capita is ranked 16th among all the 31 provinces in mainland China, which represents the average level of the whole country.

### Data collection and processing

We designed a survey questionnaire of respiratory healthcare resources in rural hospitals, which focused on the establishment and development of respiratory medicine specialty (RMS), the availability of facilities and equipment, the access to medical techniques, clinical staffing and the prevalence of respiratory diseases. This survey questionnaire was approved, distributed and collected by the Medical Policy and Management Office of Health Commission in Hunan Province, China. Thus, data authenticity was guaranteed in this study. Finally, data were extracted and analyzed by two analysts independently.

### Content of questionnaire

The survey questionnaire included 5 aspects of inquiry content which were listed as follows: (1) Establishment and basic setup of the department of respiratory medicine; (2) Medical facilities and equipment including pulmonary function test (PFT) laboratories, bronchoscopy rooms, sleep laboratories, atomization therapeutic rooms, non-invasive and invasive ventilators; (3) Total number of clinical staffs and their clinical training experiences; (4) Medical techniques including mechanical ventilation, diagnostic bronchoscopy, therapeautic bronchoscopy, thoracoscopy, percutaneous lung biopsy, transbronchial needle aspiration (TBNA) and bronchial artery embolization; (5) Total number of patients with respiratory diseases who were admitted to these rural hospitals in the year of 2018.

### Statistical analysis

The chi-square statistic was used to assess the differences of respiratory healthcare resource allocation between rural hospitals which had established an independent department of respiratory medicine and those hospitals which had not. A $P$ value $< 0.05$ was considered to be statistically significant. The software package SPSS Statistics Version 19.0 (IBM Corp., Armonk, New York, USA) was used for all of the analyses.

### Ethics approval

The study was reviewed and approved by the Ethical Committee of Central South University Xiangya Hospital (2019030466).

## Results

### Prevalence of respiratory diseases in rural hospitals

Total patient number for each kind of respiratory diseases in 48 rural hospitals was summarized in Figure 1. In the year of 2018, the top 5 common respiratory diseases included COPD (*N*=31, 487), community-acquired pneumonia (*N*=19, 229), chronic respiratory failure (*N*=5, 965), bronchial asthma (*N*=5, 515) and pulmonary tuberculosis (*N*=5, 012). These data indicated the heavy burden of respiratory health service for rural hospitals.

### Department setup of respiratory medicine specialty (RMS) in rural hospitals

Even though rural hospitals are responsible for providing respiratory health service to a large population, the development of RMS in rural hospitals is limited and inequal due to the lack of financial support. As shown in Table 1, among 48 rural hospitals in Hunan, 58.3% (28/48) of them established an independent department of respiratory medicine, while other hospitals had a department of general internal medicine. Only half of these hospitals could provide respiratory specialized outpatient services. Only 12.5% (6/48) of them established an independent respiratory intensive care unit (RICU). The average available bed number for respiratory health service in each rural hospital was 58.

### Available respiratory healthcare facilities and equipment in rural hospitals

As shown in Table 2, 35 out of 48 rural hospitals had PFT laboratories, and 26 hospitals had bronchoscopy rooms. 64.6% (31/48) of these rural hospitals had non-invasive ventilators, while 43.8% (21/48) had invasive ventilators. Sleep laboratories were set up in only 6 hospitals and atomization rooms in 7 hospitals. Among 48 rural hospitals, only 2 hospitals had all these basic medical facilities and equipment, indicating that a comprehensive scope of respiratory health service was not available in most rural hospitals.

To further assess the disparity of respiratory healthcare resources among rural hospitals, we compared the differences in medical facilities and equipment between hospitals with an independent RMS and those without. Our data showed that rural hospitals which established an independent department of respiratory medicine had better facilities and equipment than those without an independent department, and statistically significant differences could be seen between two groups in terms of bronchoscopy room ($P$=0.005) and sleep laboratory ($P$=0.027).

### Respiratory healthcare staffs in rural hospitals

Table 3 presents the respiratory healthcare staff composition in rural hospitals. The overall physician-to-bed ratio (PBR) was 1:11.1, and the nurse-to-bed ratio (NBR) was 1:13.6. In rural hospitals with an independent department of respiratory medicine, PBR was 1:10.3 and NBR was 1:11.9. While in rural hospitals without an independent department of respiratory medicine, PBR was 1:12.5 and NBR was 1:17.0. The proportion of respiratory physicians and nurses who received subspecialty clinical training was also low in rural hospitals. Only 56.3% of rural hospitals had physicians who finished clinical training in intensive care units of grade IIIA hospitals (the first-class hospitals in urban areas of China), 54.2% had physicians who finished specialized ventilator training, 37.5% had physicians who finished respiratory therapy training, and 29.2% had physicians who finished PFT training. Besides, only 35.4% of rural hospitals had nurses who received ventilator training or respiratory therapy training. Not surprisingly, rural hospitals without independent RMS showed lower proportion of clinical staffs with clinical training. Significant differences were observed between two groups in physicians with ventilator training ($P$=0.024) and PFT training ($P$=0.014). These data revealed the shortage of clinical staffs, especially the shortage of physicians and nurses with subspecialty training experience, in rural hospitals.

### Applicable respiratory medical techniques in rural hospitals

Respiratory medical techniques in 48 rural hospitals were summarized in Table 4. Mechanical ventilation was applicable in 32 rural hospitals. Diagnostic bronchoscopy was applicable in 47.9% of rural hospitals, while therapeutic bronchoscopy was applicable in only 6.3% of rural hospitals. Thoracoscopy was doable in 9 out of 48 hospitals. Percutaneous lung biopsy and TBNA were applicable in 20.8% and 8.3% of rural hospitals, respectively. By the end of 2018, only 4 out of 48 hospitals were able to carry out bronchial artery embolism in patients with hemoptysis. Rural hospitals with an independent department of respiratory medicine had statistically significant advantages over those without in the access to mechanical ventilation ($P$=0.038), diagnostic bronchoscopy ($P$=0.001) and thoracoscopy ($P$=0.039).

## Discussion

China has a population of more than 1.4 billion, and rural population takes up more than 40% of the whole country based on the statistics in 2016 [4]. Rural hospitals are a critical component of health system across the whole country due to their significant contributions to overall community well-being. In the present study, we found that, while rural hospitals were bearing a heavy burden of respiratory health service, their healthcare resources were significantly underdeveloped in terms of basic facilities and equipment, clinical staffing and medical techniques. This imbalance was extremely serious in those rural hospitals which had not established an independent RMS.

Since the enforcement of health reform in 2009, Chinese government has achieved great accomplishments, including the expansion of social health insurance, the reform of public hospitals, and the strengthening of primary care [5]. However, respiratory healthcare in rural areas of China are still facing challenges. Healthcare resource allocation imbalance is the key problem. Unlike America and Europe, hospitals in China are organized according to government administration and strictly hierarchized

based on their scales, available armamentarium and techniques [4]. Generally, rural hospitals, which are small-scale, have less facilities and equipment, and lower-quality healthcare staffs, could not meet the basic needs of all local people. But meanwhile, more financial support from the government is flowing to high-grade hospitals in urban areas instead of rural ones. Therefore, urban-to-rural disparity of resource allocation has been increasing, resulting in a vicious circle. Most rural residents do not have easy access to comprehensive and high-quality respiratory health service. These patients may substitute local primary care providers for specialists or they may decide to postpone or forego healthcare from a respiratory specialist due to the heavy financial burdens and long travel time, which at least partially contributes to the low patient satisfaction in rural hospitals [6].

In this study, 48 rural hospitals provided respiratory health services across the continuum of care from primary care to long-term care for a total population of about 40 million in rural China. Our data showed that 42.7% of these hospitals did not establish an independent department of respiratory medicine due to the lack of financial support and medical resources. Under such a condition, meeting the needs of patients for specialty care remains challenging. Physicians and nurses in these hospitals must deal with a wide variety of general diseases every day, instead of concentrating on respiratory diseases. While they get comprehensive knowledge and skills of general internal medicine, they lose the opportunity to be trained as an outstanding respiratory specialist, which is obviously not good to provide high-quality subspecialty health service. Moreover, a considerable proportion of rural hospitals do not have basic facilities and equipment, including PFT laboratories, atomization room, bronchoscopes and ventilators, which strongly suggests that some common respiratory diseases, such as COPD and lung cancer, cannot be accurately diagnosed and treated until patients go to higher-grade hospitals in urban areas. Besides, less than 15% of rural hospitals have set up sleep laboratories, indicating that sleep disorders is a weak point of respiratory health system in rural hospitals.

Based on our data, the overall PBR in rural hospitals is 1:11.1, and the overall NBR is 1:13.6, which is significantly lower compared with most hospitals in urban areas of China and other developed countries [7-9]. Heavy workload directly causes fatigue, which is associated with increased medical errors [10, 11]. It has been reported that up to 98, 000 patients die each year in hospitals as a result of preventable medical errors, in which excess clinical workload is a main cause [12]. Consistently, a higher PBR or NBR is associated with a better clinical outcomes in patients with pneumonia and malignancies [7, 9, 13]. On the other hand, the fact that a low proportion of respiratory healthcare staffs in rural hospitals have received professional clinical training is also worrying. Most physicians and nurses have not undertaken any formal training on respiratory intensive care, respiratory therapy or PFT. As a result, these clinical procedures may not be correctly performed. It has been reported that an internship in a PFT laboratory significantly improved the technical and diagnostic skills of respiratory trainees [14]. Thus, in order to improve the knowledge and skills of rural healthcare workers, more opportunities must be provided to those who are willing to participate clinical training on respiratory medicine. Furthermore, application of respiratory medical techniques are also very limited in rural hospitals based on our data. Common diagnostic tools, including percutaneous lung biopsy, TBNA and thoracoscopy are not applicable in more than 79% of rural hospitals. Without a comprehensive diagnostic system for respiratory diseases, it is

extremely difficult to promote health service quality and patient satisfaction. A simple and convincing example is that, without PFT, there is no way for standardized diagnosis, treatment and long-term management for COPD and bronchial asthma, two of the most common respiratory diseases in rural hospitals.

A lack of specialist physicians has been a long-term problem in rural hospitals. Cultivation of more specialists is important to reduce the urban-to-rural disparity in high-quality health service. Currently, Chinese government is implementing the "Health China" strategy, with the aim of providing all-round health services through more medical reform. In a response to the nation's call to integrate healthcare resources, with the joint effort of a group of leading Chinese and American pulmonary specialists, the formal subspecialty training program in the combined fields of pulmonary and critical care medicine (PCCM) throughout China was designed in 2014 [15]. Subsequently, the Chinese Thoracic Society proposed collaborating with the American College of Chest Physicians to establish PCCM fellowship training program in China [16]. So far, the Chinese Thoracic Society keeps enhancing and expanding PCCM training in urban and rural China, hopefully which will contribute to providing more specialists for rural hospitals. However, it is still too far to conclude on the beneficial effects of PCCM training program on rural hospitals due to the following issues. Firstly, the engagement of respiratory physicians from rural hospitals needs to be promoted. Till now, more than 300 fellows have enrolled and been trained with common curricula, educational activities, and assessment measures. But the proportion of trainees from rural hospitals is less than 10% overall. Furthermore, almost all the PCCM fellows from rural hospitals chose to work in higher-level hospitals after finishing the training program, which could lead to a brain drain in rural hospitals instead. Additionally, the final assessment examination for Chinese PCCM training fellows has been held in English so far, which is a big challenge for physicians from rural hospitals and directly reduce their enthusiasm to participate in this program. Thus, there is an urgent need to better adjust this training program to Chinese healthcare system instead of completely copying the American pattern.

# Conclusions

In summary, our data provides a view of current situation of respiratory healthcare resource allocation in rural China. Respiratory healthcare system in rural areas of China are facing great challenges, including a serious shortage of basic facilities and equipment, necessary medical techniques and high-quality clinical staffs. The

results of this study may motivate policymakers to adopt suitable approaches to improve the respiratory healthcare resources in rural areas.

# Abbreviations

COPD: chronic obstructive pulmonary disease; NBR: nurse-to-bed ratio; PBR: physician-to-bed ratio; PCCM: pulmonary and critical care medicine; PFT, pulmonary function test; RICU: respiratory intensive

care unit; RMS: respiratory medicine specialty; TBNA: transbronchial needle aspiration.

# Declarations


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### Authors' contributions

HCP designed the study. JJ, HRX, YHM, LSZ, LYY, LYL and QF contributed to acquisition of data and data analysis. JJ wrote the draft of the paper. HCP revised and edited the paper. All authors contributed to writing or reviewing the paper. All authors read and approved the final manuscript.

### Competing interests

The authors declare that they have no competing interests.

### Availability of data and materials

The datasets used and analyzed during the current study are available from the corresponding author on reasonable request.

### Ethics approval and consent to participate

Ethical review and approval were provided by the Ethical Committee of Central South University Xiangya Hospital. Informed consent was obtained from all rural hospitals included in this study.

### Consent for publication

Not applicable.

### Authors' information

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# Tables

**Table 1.** Department setup of respiratory medicine specialty in rural hospitals

| Department setup | Rural hospitals<br>*N*=48 (%) |
|---|---|
| Independent department of respiratory medicine | |
| Yes | 28 (58.3) |
| No | 20 (41.7) |
| Specialized outpatient service | |
| Yes | 24 (50) |
| No | 24 (50) |
| Independent RICU | |
| Yes | 6 (12.5) |
| No | 42 (87.5) |
| Average bed number for respiratory healthcare | 58 |

*RICU, respiratory intensive care unit.

**Table 2.** Respiratory healthcare facilities and equipment in rural hospitals.

| Facilities and equipment | Total *N*=48 (%) | Hospitals with independent RMS *N*=28 (%) | Hospitals without independent RMS *N*=20 (%) | *P* value |
|---|---|---|---|---|
| PFT laboratory | | | | |
| Yes | 35 (72.9) | 23 (82.1) | 12 (60.0) | |
| No | 13 (27.1) | 5 (17.9) | 8 (40.0) | 0.089 |
| Bronchoscopy room | | | | |
| Yes | 26 (54.2) | 20 (71.4) | 6 (30.0) | |
| No | 22 (45.8) | 8 (28.6) | 14 (70.0) | 0.005* |
| Sleep laboratory | | | | |
| Yes | 6 (12.5) | 6 (21.4) | 0 (0.0) | |
| No | 42 (87.5) | 22 (78.6) | 20 (100.0) | 0.027* |
| Atomization room | | | | |
| Yes | 7 (14.6) | 6 (21.4) | 1 (5.0) | |
| No | 41 (85.4) | 22 (78.6) | 19 (95.0) | 0.112 |
| Non-invasive ventilator | 31 (64.6) | 20 (71.4) | 11 (55.0) | |
| Yes | 17 (35.4) | 8 (28.6) | 9 (45.0) | 0.241 |
| No | | | | |
| Invasive ventilator | 21 (43.8) | 17 (60.7) | 10 (50.0) | |
| Yes | 27 (56.2) | 11 (39.3) | 10 (50.0) | 0.461 |

| | |
|---|---|
| No | |

RMS, respiratory medicine specialty; PFT, pulmonary function test; *$P < 0.05$ indicates statistical significance between rural hospitals with independent RMS and those without.

**Table 3.** Respiratory healthcare staffs in rural hospitals.

| Clinical staff composition | Total *N*=48 (%) | Hospitals with independent RMS *N*=28 (%) | Hospitals without independent RMS *N*=20 (%) | *P* value |
|---|---|---|---|---|
| Physician-to-bed ratio | 1:11.1 | 1:10.3 | 1:12.5 | - |
| Nurse-to-bed ratio | 1:13.6 | 1:11.9 | 1:17.0 | - |
| Specialist physicians | | | | |
| Yes | 46 (95.8) | 28 (100.0) | 18 (90.0) | |
| No | 2 (4.2) | 0 (0.0) | 2 (10.0) | 0.087 |
| Physicians | | | | |
| with ICU training | 27 (56.3) | 18 (64.3) | 9 (45.0) | 0.184 |
| with ventilator training | 26 (54.2) | 19 (67.9) | 7 (35.0) | 0.024* |
| with RT training | 18 (37.5) | 13 (46.4) | 5 (25.0) | 0.131 |
| with PFT training | | 12 (42.9) | 2 (10.0) | 0.014* |
| Specialist nurses | | | | |
| Yes | 14 (29.2) | 23 (82.1) | 11 (55.0) | |
| No | | 5 (17.9) | 9 (45.0) | 0.041* |
| Nurses | | | | |
| with ventilator training | 34 (70.8) | 12 (42.9) | 5 (25.0) | 0.202 |
| with RT training | 14 (29.2) | 13 (46.4) | 4 (20.0) | 0.059 |

| | |
|---|---|
| | 17 (35.4) |
| | 17 (35.4) |

RMS, respiratory medicine specialty; ICU, intensive care unit; RT, respiratory therapy; PFT, pulmonary function test; *$P < 0.05$ indicates statistical significance between rural hospitals with independent RMS and those without.

**Table 4.** Applicable respiratory medical techniques in rural hospitals.

| Techniques | Total *N*=48 (%) | Hospitals with independent RMS *N*=28 (%) | Hospitals without independent RMS *N*=20 (%) | *P* value |
|---|---|---|---|---|
| Mechanical ventilation | | | | |
| Yes | 32 (66.7) | 22 (78.6) | 10 (50.0) | |
| No | 16 (33.3) | 6 (21.4) | 10 (50.0) | 0.038* |
| Diagnostic bronchoscopy | | | | |
| Yes | 23 (47.9) | 19 (67.9) | 4 (20.0) | |
| No | | 9 (32.1) | 16 (80.0) | 0.001* |
| TBNA | | | | |
| Yes | 25 (52.1) | 4 (14.3) | 0 (0.0) | |
| No | | 24 (85.7) | 20 (100.0) | 0.077 |
| Therapeutic bronchoscopy | 4 (8.3) | 3 (10.7) | 0 (0.0) | |
| Yes | 44 (91.7) | 25 (89.3) | 20 (100.0) | 0.131 |
| No | | | | |
| Thoracoscopy | | | | |
| Yes | 3 (6.3) | 8 (28.6) | 1 (5.0) | |
| No | 45 (93.7) | 20 (71.4) | 19 (95.0) | 0.039* |
| Percutaneous lung biopsy | | | | |
| Yes | 9 (18.8) | 8 (28.6) | 2 (10.0) | |
| | | 20 (71.4) | 18 (90.0) | 0.118 |

| | | | | |
|---|---|---|---|---|
| No | 39 (81.2) | | | |
| Bronchial artery embolization | | 3 (10.7) | 1 (5.0) | |
| | | 25 (89.3) | 19 (95.0) | 0.480 |
| Yes | 10 (20.8) | | | |
| No | 38 (79.2) | | | |
| | | 4 (8.3) | | |
| | 44 (91.7) | | | |

RMS, respiratory medicine specialty; TBNA, transbronchial needle aspiration; *$P < 0.05$ indicates statistical significance between rural hospitals with independent RMS and those without.

# Figures

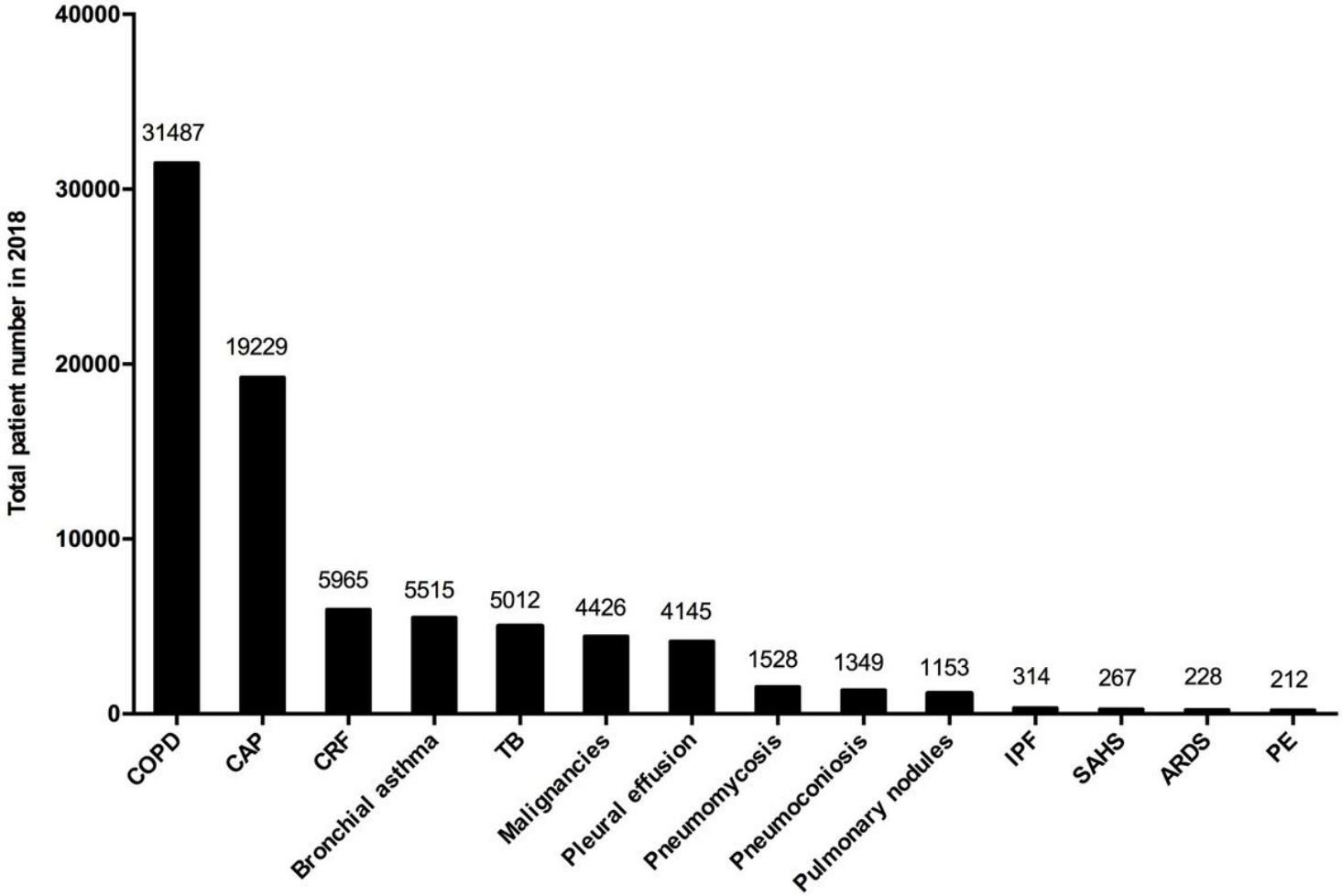


**Figure 1**

Total numbers of patients with respiratory diseases who were admitted to 48 rural hospitals in 2018. *COPD, chronic obstructive pulmonary disease; CAP, community-acquired pneumonia; CRF, chronic respiratory failure; TB, tuberculosis; IPF, interstitial pulmonary fibrosis; SAHS, sleep apnea-hypopnea syndrome; ARDS, acute respiratory distress syndrome; PE, pulmonary embolism.

# Supplementary Files

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