Current situation of management of spontaneous pneumothorax in Japan: A cross-sectional cohort study

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Abstract

Background: Limited epidemiological information is available on spontaneous pneumothorax. To address this gap, the Japan Society for Pneumothorax and Cystic Lung Disease (JSPCLD) conducted a nationwide retrospective survey to investigate the current epidemiology of spontaneous pneumothorax in Japan.

Methods: In this study, we conducted a retrospective cross-sectional cohort study to demonstrate the clinical features of spontaneous pneumothorax in one year from April 2019 to March 2020, compare patient characteristics and treatment outcomes between primary (PSP) and secondary spontaneous pneumothorax (SSP), and investigate the risk factors associated with in-hospital mortality among patients with SSP.

Results: A total of 1784 patients from 28 institutions were enrolled in the study, with PSP observed in 956 cases (53.6%) and SSP in 817 cases (45.8%). The age distribution showed a biphasic peak caused by the different peaks between PSP and SSP. In-hospital mortality occurred in 42 cases (2.4%) among all patients, with 0 cases (0%) in PSP and 42 cases (5.1%) in SSP. Multivariable analyses revealed that interstitial pneumonia as an underlying disease (odds ratio: 2.3300, 95% confidence interval: 1.0600 to 5.1100, p=0.0354), performance status≧3 (odds ratio: 6.8600, 95% confidence interval: 3.0400 to 15.4000, p<0.0001), and lower value of serum albumin on admission (odds ratio: 0.3260, 95% confidence interval: 0.1860 to 0.5710, p<0.0001) were significantly associated with in-hospital mortality among patients with SSP.

Conclusions: SSP patients with poor baseline conditions are at a higher risk for in-hospital mortality. It is crucial to provide close and meticulous management for SSP patients with compromised conditions.

248 words

Keywords: current situation, management, spontaneous pneumothorax, in-hospital mortality, Japan

1. Introduction

Pneumothorax is a common condition encountered by pulmonologists and general thoracic surgeons. It occurs when air or gas from a pulmonary fistula accumulates in the pleural cavity, leading to lung collapse and impaired respiratory function in affected patients (1,2). Pneumothorax is typically classified into two types: spontaneous and traumatic. The spontaneous type can be further categorized as primary spontaneous pneumothorax (PSP), which occurs without underlying lung disease, and secondary spontaneous pneumothorax (SSP), which occurs in the presence of underlying lung disease. Patient characteristics, initial management, and treatment outcomes differ between PSP and SSP (1,2).

Patients with PSP often experience mild symptoms, as subpleural blebs and bullae in an otherwise healthy lung contribute to the lung collapse (3,4). In contrast, patients with SSP frequently exhibit severe symptoms even with minimal lung collapse due to compromised pulmonary function resulting from underlying lung disease. SSP is usually associated with higher morbidity and mortality compared to PSP. The British Thoracic Society (BTS) guidelines recommend outpatient follow-up for asymptomatic patients with PSP, while emphasizing that all patients with SSP should be admitted to the hospital for a minimum of 24 hours (5). Regarding surgical intervention, the guidelines suggest discussing cases of

SSP with persistent air leak with a thoracic surgeon within 48 hours, while noting limited effectiveness of thoracoscopic salvage operation after failed chest drainage for PSP. Despite the differences in clinical features between PSP and SSP, there have been only a few large-scale nationwide studies describing these characteristics (6-10). Consequently, the epidemiological information on spontaneous pneumothorax remains limited. To address this knowledge gap, the Japan Society for Pneumothorax and Cystic Lung Disease (JSPCLD) conducted a nationwide retrospective survey to investigate the epidemiology of spontaneous pneumothorax in Japan. The specific objectives of this study were to compare patient characteristics and treatment outcomes between PSP and SSP, as well as to identify risk factors associated with in-hospital mortality among patients with SSP.

2. Patients and methods

2.1. Design, setting, and data collection

The study was approved by institutional ethics board of Japanese Red Cross Maebashi Hospital (*approval no. 2021–19, date: 21, June, 2021*). For the retrospective observational study, the requirement for written informed consent was waived owing to the use of anonymized retrospective data. Additionally, this study adhered to an opt-out consent model, which allowed participants to withdraw their consent and delete their information from the registry at any point.

We conducted a retrospective cohort study to examine the clinical features of spontaneous pneumothorax, compare patient characteristics and treatment outcomes between PSP and SSP, and investigate the risk factors associated with in-hospital mortality among patients with SSP.

Between April 1, 2019, and March 31, 2020, we extracted data on hospitalized cases with the code number "040200" indicating "pneumothorax" from the Diagnosis Procedure Combination (DPC) database. The DPC is a nationwide administrative hospital discharge data in Japan, and it has been widely utilized for large clinical trials in Japan (11,12). This patient classification system is linked to a flat-rate payment system for inpatients in acute care hospitals and was initially developed in Japan in 2002 (13). Cases of traumatic, iatrogenic, or neonatal pneumothorax were excluded from the extracted data. We included patients with spontaneous pneumothorax who were originally admitted for other diseases, and their total hospitalization time encompassed the treatment period for both conditions. It is important to note that the date of admission could fall within the specified time frame, but the treatment duration could extend beyond April 1, 2020.

Following the extraction of eligible cases using the DPC data, clinicians at each institution completed a case report form, providing information on the clinical features, which was then sent to the central coordinating office.

2.2. Study variables

The following variables were collected using a case report form: mode of onset (first, recurrence, unknown), type of pneumothorax (primary, secondary, unknown), underlying pulmonary disease in SSP (chronic obstructive pulmonary disease, interstitial pneumonia, combined pulmonary fibrosis and emphysema, pulmonary malignancy, pulmonary infection, catamenial, others), home oxygen therapy (+, -), comorbidities except for pulmonary disease (impaired liver function; Child-Turcotte classification≥B, hemodialysis, ischemic heart disease, malignancy treated within 5 years, cerebrovascular disease, diabetes mellitus, anemia; hemoglobin value ≤ 8g/dL, autoimmune disorder, arrhythmia, hypertension, others), administration of steroid on admission (+, -), affected side (left, right, bilateral), age (years), gender (female, male), performance status (0, 1, 2, 3, 4, unknown), body mass index (BMI), smoking index (pack-years), serum C-reactive protein (CRP) on admission (g/dL), serum albumin on admission (g/dL), degree of lung collapse (mild, moderate, severe, unknown), thoracography (+, -), chest tube drainage (+, -), pleurodesis (+, -), administrative agents used in pleurodesis (OK-432, Minocycline, autoblood, talc, glucose solution, others), trans-airway procedure (+, -), surgical intervention (+, -), surgical approach (thoracoscopy, thoracotomy, unknown), treatment in the intensive care unit (+, -, unknown), total hospitalization time (days), and discharge outcome (home, transferred to another hospital, death).

Underlying pulmonary disease was decided by each institution based on the radiographic findings and the medical record.

The degree of lung collapse was defined as follows：

1. Mild: Air space was seen only in the apex of the lung on chest X-ray.
2. Moderate: The lung was collapsed to a degree between mild and severe on chest X-ray.
3. Severe: The lung was completely collapsed on chest X-ray.

Performance status was determined according to the criteria published by the Eastern Cooperative Oncology Group (14).

2.3. Statistical analysis

Initially, the characteristics, treatments, and outcomes of all enrolled patients with spontaneous pneumothorax were summarized. In addition, the age distribution of the enrolled spontaneous pneumothorax patients was evaluated. Subsequently, all patients were classified into two groups: PSP and SSP. We compared the clinical features between the two groups using univariate analyses. Moreover, the underlying pulmonary diseases in patients with SSP were listed. Next, patients with SSP were classified into two groups: those receiving surgical intervention and those not receiving surgical intervention. We compared the clinical features between the two groups using univariate analyses. Finally, we used multivariate analysis to identify the factors associated with in-hospital mortality.

We analyzed continuous variables using the Mann-Whitney U test and categorical variables using Fisher's exact test. Multivariate analyses were performed using a logistic regression model. Results were considered significant at $p < 0.05$. Calculations and statistical tests were performed using the EZR graphical user interface (Saitama Medical Centre, Jichi Medical University, Saitama, Japan).

3. Results

3.1. Study population

The JSPCLD invited 63 institutions in Japan to participate in this retrospective multi-institutional study, and 28 institutions (44.4%) agreed to participate. The 28 institutions provided completed case report forms for 1784 patients who were diagnosed with "pneumothorax" during hospitalization between April 1st, 2019 and March 31st, 2020. Ultimately, data from the 1784 patients were analyzed. Figure 1 illustrates the patient enrollment process.

3.2. Characteristics, treatments, and outcomes of patients with spontaneous pneumothorax

Table 1 presents the characteristics, treatments, and outcomes of all enrolled patients with spontaneous pneumothorax during the study period (n=1784). Among them, 956 cases (53.6%) were PSP and 817 cases (45.8%) were SSP. The male-to-female ratio was approximately 4:1. Surgical intervention was performed for 1149 cases (66.5%), and 96.8% of these cases received a thoracoscopic approach. In-hospital mortality occurred in 42 cases (2.4%) among all patients.

3.3. Age distribution of spontaneous pneumothorax

Figure 2 shows the age distribution of the enrolled all 1784 spontaneous pneumothorax patients. The gray bars represent the number of PSP patients, showing a monophasic trend with a peak observed between the ages of 20 and 29 years. The orange bars represent the number of SSP patients, also exhibiting a monophasic trend with a peak observed between the ages of 70 and 79 years. The dotted line represents the overall trend of all spontaneous pneumothorax cases, including both PSP and SSP. It shows a biphasic pattern, resulting from the different peak ages between PSP and SSP.

3.4. Comparison of characteristics, treatments, and outcomes between patients with PSP (n=956) and SSP (n=817)

Since the subtype of pneumothorax was unknown in 11 cases, a total of 1773 cases were analyzed. Table 2 presents a comparison of the characteristics, treatments, and outcomes between patients with PSP (n=956) and SSP (n=817). Significant differences were observed between the two groups in most of the variables. SSP patients generally had more compromised backgrounds compared to PSP patients. Surgical intervention was more frequently performed in PSP, whereas pleurodesis was more commonly performed in

SSP (PSP: 79.1%, SSP: 52.5%, p<0.0001). Furthermore, a higher proportion of SSP patients underwent thoracotomy approach compared to PSP (PSP: 1.2%, SSP: 5.6%, p<0.0001). The length of hospital stay was significantly longer in SSP (PSP: 8 days, SSP: 13 days, p<0.0001). In-hospital mortality occurred in 0 cases (0%) in PSP and 42 cases (5.1%) in SSP (p<0.0001).

3.5. Underlying pulmonary disease

Supplementary table 1 lists the underlying pulmonary diseases in patients with SSP (n=817). The highest proportion of patients had COPD (53.6%), followed by interstitial pneumonia (15.5%) and lung cancer (11.8%).

3.6. Comparison of clinical features between SSP patients with (n=429) and without surgical intervention (n=388)

The characteristics, treatments, and outcomes of SSP patients with (n=429) and without surgical intervention (n=388) were compared in Supplementary table 2. The proportion of underlying lung diseases, including interstitial pneumonia (surgical group: 10%, non-surgical group: 21.6%, p<0.0001), and pulmonary infection (surgical group: 4.9%, non-surgical group: 16.5%, p<0.0001), was significantly higher in the non-surgical group. Additionally, the non-surgical group had a significantly higher proportion of patients with coexisting impaired liver function (surgical group: 0.2%, non-surgical group: 2.3%, p=0.0083), ischemic heart disease (surgical group: 6.5%, non-surgical group: 11.3%, p=0.0185), malignancy (surgical group: 11.2%, non-surgical group: 16.2%, p=0.0407), cerebrovascular disease (surgical group: 6.1%, non-surgical group: 15.5%, p<0.0001), arrhythmia (surgical group: 6.3%, non-surgical group: 10.6%, p=0.0310), and hypertension (surgical group: 23.5%, non-surgical group: 36.9%, p<0.0001). Furthermore, the non-surgical group had lower BMI (surgical group: 19.8, non-surgical group: 19, p=0.0001), higher CRP on admission (surgical group: 0.3 g/dl, non-surgical group: 0.8 g/dl, p<0.0001), and lower serum albumin on admission (surgical group: 4 g/dl, non-surgical group: 3.7 g/dl, p<0.0001). In-hospital mortality was 8.2% in the non-surgical group compared to 2.3% in the surgical group (p<0.0001).

3.7. Risk factor associated with in-hospital mortality among the patients with SSP

Supplementary table 3 demonstrates univariable and multivariable analyses to identify factors associated with in-hospital mortality in patients with SSP. In the multivariable analyses, interstitial pneumonia as an underlying disease (odds ratio: 2.3300, 95% confidence interval: 1.0600 to 5.1100, p=0.0354), performance status≥3 (odds ratio: 6.8600, 95% confidence interval: 3.0400 to 15.4000, p<0.0001), and lower serum albumin levels on admission (odds ratio: 0.3260, 95% confidence interval: 0.1860 to 0.5710, p<0.0001) were significantly associated with in-hospital mortality among patients with SSP.

4. Discussion

In the present study, we investigated the epidemiology of spontaneous pneumothorax in Japan, the differences in clinical features between PSP and SSP, and the risk factors associated with in-hospital mortality among SSP patients. In Japan, almost 80% of all spontaneous pneumothorax were male, which is consistent with other previous nationwide reports (Korean report: 81.5%, French report: 76.6%, and previous Japanese report: 82.4%)6)7)10). The ratio between PSP and SSP was described only in the French report, in which SSP occupied only 15% of all patients with spontaneous pneumothorax, while it was 45.8% in our study6). As the registered cases were extracted from DPC, cases in which pneumothorax occurred as a secondary condition to other diseases were also included, which might be the cause of the difference. In our study, 66.5% of the patients underwent surgical intervention, 96.8% of which were thoracoscopic procedures. In contrast, only 24% of the patients underwent surgery in the French report, which collected data between 2008 and 2011 (6). We speculate that the difference might be due to the variation in those study periods. Compared to the last decade, most surgical interventions for patients with spontaneous pneumothorax are now performed using thoracoscopic approaches due to technological advancements and improved technical skills (15,16).

Regarding the comparison of clinical features between patients with PSP and SSP, most of the variables were significantly different between PSP and SSP, indicating that the clinical conditions were markedly distinct between the two conditions. Specifically, patient backgrounds were more compromised and clinical outcomes were worse in SSP than in PSP. This might explain why the rate of patients with SSP receiving surgical intervention was lower than that of PSP, and the rate of patients with SSP receiving pleurodesis was higher. Moreover, the rate of patients with PSP receiving surgical intervention differed considerably from the French epidemiological report of 2015 (6). While 79.1% of PSP received surgical intervention in this study, only 23% of PSP did so in the French report. In European countries, observation is often preferred for PSP, as recommended by BTS guidelines (5). In contrast, surgical intervention is more commonly selected for PSP in Japan based on the excellent intra- and postoperative outcomes for PSP after the emergence of less invasive thoracoscopic approaches (17-19).

Among patients with SSP, the most frequent underlying pulmonary disease was COPD, which is consistent with many previous publications (6,7,20,21). The second most frequent underlying pulmonary disease was interstitial pneumonia, which is consistent with previous Japanese studies but differs from results in other countries. For example, Kim et al. reported that the second most frequent underlying pulmonary disease was pneumonia, and asthma ranked third in a Korean nationwide study (7). In their report, only 0.7% of patients with spontaneous pneumothorax had interstitial pneumonia as an underlying pulmonary disease. Wang et al. demonstrated that the second most frequent underlying pulmonary disease was lung malignancy among SSP patients, while interstitial pneumonia ranked third in a United States nationwide study (22). The discrepancy between these previous reports and ours indicates that the frequency of underlying pulmonary disease varies, and this may depend on cultural, social, and other factors in each country.

In the BTS guideline, patients with a persistent air leak should consult a thoracic surgeon to plan surgical intervention (5). However, in our cross-sectional nationwide study, surgical intervention was performed only for 52.6% of all SSP patients. SSP patients without surgical intervention were older, received more home oxygen therapy, had lower albumin values, higher CRP values, and lower BMI. This indicates that conservative treatment tended to be selected for compromised SSP patients. This tendency was consistent with Wang's previous report (22). Although they described that same-admission pneumothorax recurrence prophylaxis including surgical intervention was associated with lower odds of in-hospital mortality, the prophylaxis was performed for only 33.73% of all SSP patients. Patients without prophylaxis were older and more compromised than those who received it. Moreover, the group without surgical intervention in our study included significantly more patients with interstitial pneumonia than the group that received surgical intervention. Previous reports revealed that perioperative outcomes in patients with interstitial pneumonia as an underlying disease were worse than those with other diseases, which might lead to avoiding surgical intervention in more patients with interstitial pneumonia (21).

In this Japanese epidemiological study, the in-hospital mortality of patients with SSP was 5.1%. Although the treatment for SSP is considered challenging due to underlying pulmonary disease or patient compromised condition, there have been only a few studies describing the in-hospital mortality rate (20,21). Onuki et al. identified that emergency transportation was significantly associated with in-hospital mortality (odds ratio: 16.37, p value<0.001) in a single-center retrospective study, and they concluded that patients with SSP receiving emergency transportation should be carefully managed (20). Ichinose et al. reported a hospital mortality rate of 3% in patients with SSP; however, their study included only patients undergoing surgical intervention, which was different from our study (21). Furthermore, the hospital mortality rate in patients with interstitial pneumonia as an underlying disease was 15%, which was much higher than that in patients with COPD. Our study also revealed that interstitial pneumonia as an underlying disease was significantly associated with in-hospital mortality in multivariable analysis. Moreover, we found that a lower performance status and serum albumin on admission might serve as indicators for in-hospital mortality among SSP patients.

Although it is well known that the treatment of patients with SSP can be difficult, there have been no nationwide studies that have addressed the rate of in-hospital mortality. Additionally, in this study, cases were extracted from the DPC data, which allowed for the inclusion of cases in which pneumothorax occurred while other diseases were primarily treated on admission. This selection method allowed for a non-biased representation of enrolled patients. Furthermore, the study period was limited to a year, which minimized bias. As a result, this study provides valuable insights into the current state of pneumothorax in Japan.

The current study has several limitations. First, the study design was retrospective in nature, although multiple institutions participated. Second, the database did not include outpatient data because all the data were extracted from the DPC, which might have affected the clinical features of PSP and SSP. Third, the present study did not include all spontaneous pneumothorax data in our country, although many institutions joined. This is because invitations to participate in the study were not sent to facilities that did not have a JSPLCD council member on staff, which may have introduced selection bias. Fourth, the severity of COPD or interstitial pneumonia, the dose of steroids administered, and the details of the lung infection were not assessed, although these may affect prognosis. Fifth, the type of background disease was defined by each participating institution. For example, the odds ratio in CPFE was better than that in interstitial pneumonia, although the prognosis of CPFE was considered worse than that of interstitial pneumonia, indicating that the number of CPFE might be underestimated.

5. Conclusion

The present study provides valuable insights into the characteristics, management, and outcomes of pneumothorax patients in Japan, with a particular focus on in-hospital mortality in patients with SSP, which was found to be 5.1%. Multivariable analyses revealed that interstitial pneumonia as an underlying disease, performance status of 3 or higher, and lower serum albumin levels on admission were significantly associated with in-hospital mortality among patients with SSP. These findings suggest that SSP patients with poor baseline conditions are at a higher risk for in-hospital mortality, and that the above three variables are important prognostic indicators.

Conflicts of Interest

The authors have no conflicts of interest.

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Author contributions

Hitoshi Igai: Conceptualization, formal analysis, investigation, and writing of the original draft. **Noryoshi Sawabata:** Conceptualization, writing, review, and editing. **Toshiro Obuchi:** Writing, review, and editing. **Noriyuki Matsutani:** Writing, review, and editing. **Kenji Tsuboshima:** Writing, review, and editing. **Shouichi Okamoto:** Writing, review, and editing. **Akihiro Hayashi:** Project administration

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Figure legends

Figure 1: The patient enrollment process in this retrospective study.

Figure 2: Age distribution of the patients with spontaneous pneumothorax in Japan.

Table 1: Clinical features of patients with spontaneous pneumothorax.

Variables	Cases (n=1784)
Mode of onset	
first/recurrence/unknown	1031 (57.8)/748 (41.9)/5 (0.3)
Type of pneumothorax	
primary/secondary/unknown	956 (53.6)/817 (45.8)/11 (0.6)
Home oxygen therapy	
+/-	91 (5.1)/1693 (94.9)
Comorbidities except for pulmonary disease	
+/-/unknown	660 (37)/1120 (62.8)/4 (0.2)
Details of comorbidities except for pulmonary disease	
Impaired liver function （Child-Turcotte classification≧B）	13 (0)
Hemodialysis	9 (0.5)
Ischemic heart disease	80 (4.5)
Malignancy（treated within 5 years）	122 (6.8)
Cerebrovascular disease	94 (5.2)
Diabetes mellitus	116 (6.5)
Anemia（Hb≦8g/dl）	11 (0.6)
Autoimmune disorder	41 (2.3)
Arrhythmia	77(4.3)
Hypertension	281 (15.8)
Others	368 (20.6)
Administration of steroid on admission	
+/-	91 (5.1)/1693 (94.9)
Affected side	
left/right/bilateral	822 (46.1)/921 (51.6)/41 (2.3)
Age, median (IQR), years	40 (22-70)
Gender	
Female/Male	351 (19.7)/1433 (80.3)

Performance Status	
0/1/2	1188 (66.6)/321 (18)/134 (7.5)
/3/4/unknown	/77 (4.3)/41 (2.3)/23 (1.3)
BMI, median (IQR),	19.2(17.4-21.2)
Smoking index, median (IQR), pack x year	0 (0-30)
Serum CRP on admission, median (IQR), g/dl	0.1 (0-0.7)
Serum albumin on admission, median (IQR), g/dl	4.3 (3.8-4.7)
Degree of the collapsed lung	
mild/moderate/severe/unknown	394 (22.1)/900 (50.1)/446 (25)/44 (2.5)
Thoracography	
+/-	77 (4.3)/1707 (95.7)
Chest tube drainage	
+/-	1369 (76.7)/415 (23.3)
Pleurodesis	
+/-	167 (9.4)/1617 (90.1)
Administrative agents in the pleurodesis	
OK-432	64 (3.6)
Minocycline	46 (2.6)
Autoblood	42 (2.4)
Talc	14(0.8)
Glucose solution	108 (6.1)
Others	18 (1)
Trans-airway procedure	
+/-	23 (1.3)/1761 (98.7)
Surgical intervention	
+/-	1187 (66.5)/597 (33.5)

Surgical approach	
thoracoscopy/thoracotomy/unknown	1149 (64.4)/33 (1.9)/5 (0.3)
Treatment in intensive care unit	
+/-/unknown	175 (9.8)/1606 (90)/3 (0.2)
Total hospitalization, median (IQR), days	9 (6-15)
Outcome at discharge	
home/transferred to other hospital/death	1651 (92.5)/91 (5.1)/42 (2.4)

Hb: hemoglobin, IQR: interquartile range, BMI: body mass index, CRP: c-reactive protein

Table 2: Clinical features between patients with PSP (n=956) and SSP (n=817).

Variables	PSP (n=956)	SSP (n=817)	p-value
Mode of onset			0.5220
first/recurrence/ unknown	540 (56.5)/413(43.2)/ 3 (0.3)	483 (59.1)/332(40.6)/ 2 (0.2)	
Home oxygen therapy			**<0.0001**
+/-	0 (0)/956 (100)	91 (11.1)/726 (88.9)	
Comorbidities except for pulmonary disease			**<0.0001**
+/-/ unknown	112 (11.7)/841 (88)/ 3 (0.3)	542 (66.3)/274 (33.5)/ 1 (0.1)	
Details of comorbidities except for pulmonary disease			
Impaired liver function（Child-Turcotte classification≧B）	3 (0.3)	10 (1.2)	**0.0463**
Hemodialysis	2 (0.2)	7 (0.9)	0.0897
Ischemic heart disease	7 (0.7)	72 (8.8)	**<0.0001**
Malignancy（treated within 5 years）	10 (1)	111 (13.6)	**<0.0001**
Cerebrovascular disease	6 (0.6)	86 (10.5)	**<0.0001**
Diabetes mellitus	11 (1.2)	105 (12.9)	**<0.0001**
Anemia（Hb≦8g/dl）	2 (0.2)	9 (1.1)	**0.0289**
Autoimmune disorder	5 (0.5)	36 (4.4)	**<0.0001**
Arrhythmia	9 (0.9)	68 (8.3)	**<0.0001**
Hypertension	34 (3.6)	244 (29.9)	**<0.0001**
Others	89 (9.3)	274 (33.5)	**<0.0001**
Administration of steroid on admission			**<0.0001**
+/-	6 (0.6)/950 (99.4)	85 (10.4)/732 (89.6)	
Affected side			**<0.0001**
left/right/ bilateral	502 (52.5)/440(46)/ 14 (1.5)	316 (38.7)/475(58.1)/ 26 (3.2)	
Age, median (IQR), years	23 (12-94)	70 (13-96)	**<0.0001**
Gender			**<0.0001**
Female/Male	133 (13.9)/823 (86.1)	210 (25.7)/607 (74.3)	

Performance Status			
0	825 (86.3)	358 (43.8)	**<0.0001**
1	108 (11.3)	211 (25.8)	**<0.0001**
2	16 (1.7)	116 (14.2)	**<0.0001**
3	2 (0.2)	73 (8.9)	**<0.0001**
4	2 (0.2)	39 (4.8)	**<0.0001**
unknown	3 (0.3)	20 (2.4)	**<0.0001**
BMI, median (IQR),	19 (11.9-32.6)	19.5 (10-33.9)	**0.0178**
Smoking index, median (IQR), pack x year	0 (0-150)	30.5 (0-175)	**<0.0001**
Serum CRP on admission, median (IQR), g/dl	0.1 (0-35.1)	0.44 (0-29.9)	**<0.0001**
Serum albumin on admission, median (IQR), g/dl	4.6 (2-7.3)	3.9 (1.6-5.2)	**<0.0001**
Degree of the collapsed lung			0.1140
mild/moderate /severe/unknown	230 (24.1)/458 (47.9) /244 (25.5)/24 (2.5)	163 (20)/434 (53.1) /200 (24.5)/20 (2.4)	
Thoracography			**<0.0001**
+/-	12 (1.3)/944 (98.7)	65 (8)/752 (92)	
Chest tube drainage			**<0.0001**
+/-	688 (72)/268 (28)	671 (82.1)/146 (17.9)	
Pleurodesis			**<0.0001**
+/-	27 (2.8)/929 (97.2)	139 (17)/678 (83)	
Administrative agents in the pleurodesis			
OK-432	12 (1.3)	51 (6.2)	**<0.0001**
Minocycline	5 (0.5)	41 (5)	**<0.0001**
Autoblood	3 (0.3)	39 (4.8)	**<0.0001**
Talk	0 (0)	14 (1.7)	**<0.0001**
Glucose solution	57 (6)	50 (6.1)	0.9200
Others	1 (0.1)	17 (2.1)	**<0.0001**
Trans-airway procedure			**<0.0001**
+/-	0 (0)/956 (100)	23 (2.8)/794 (97.2)	
Surgical intervention			**<0.0001**
+/-	756 (79.1)/200 (20.9)	429 (52.5)/388 (47.5)	

Surgical approach			**<0.0001**
thoracoscopy/thoracotomy/ unknown	747 (98.8)/9 (1.2)/ 0 (0)	400 (93.2)/24 (5.6)/ 5 (1.2)	
Treatment in intensive care unit			**0.0002**
+/-/ unknown	73 (7.6)/883 (92.4)/ 0 (0)	102 (12.5)/712 (87.1)/ 3 (0.4)	
Total hospitalization, median (IQR), days	8 (0-63)	13 (0-234)	**<0.0001**
Outcome at discharge			**<0.0001**
home/transferred to other hospital/death	951 (99.5)/5 (0.5)/ 0 (0)	690 (84.5)/85 (10.4)/ 42 (5.1)	

Hb: hemoglobin, IQR: interquartile range, BMI: body mass index, CRP: c-reactive protein

PSP: primary spontaneous pneumothorax, SSP: secondary spontaneous pneumothorax

Eleven cases with unknown subtype of pneumothorax were excluded.