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# Re-expansion pulmonary edema: Evaluation of risk factors in 173 episodes of spontaneous pneumothorax

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ABSTRACT

*Background:* The precise incidence and clinical features of re-expansion pulmonary edema (RPE) are unclear, and they vary among reports. In this study, we assessed the incidence, risk factors, and outcomes of patients with RPE over a 3-yr period in a general hospital, with the goal of proposing a primary intervention for pneumothorax.

*Methods:* We retrospectively reviewed records of inpatients with spontaneous pneumothorax treated by tube thoracostomy between October 2007 and December 2010.

*Results:* A total of 173 episodes of spontaneous pneumothorax occurred in 156 patients. The incidence of RPE was 27/173 (15.6%). Symptom duration and pneumothorax size were significant risk factors for RPE, and the occurrence of RPE was independent of primary treatment of spontaneous pneumothorax. Among the patients with RPE, 18 (67%) were symptomatic. Five patients (18.5%) were treated with temporary oxygen, however, 21 patients (78%) did not need any treatment. All patients survived and none required mechanical ventilation. The occurrence of RPE did not influence the clinical outcome.

*Conclusions:* The risk of developing RPE increases with an increased duration or size of pneumothorax. Our results suggest that the methods of primary intervention, including prompt suction, do not affect the onset of RPE. Close observation is always required regardless of the intervention because of the potentially fatal complications.

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## 1. Introduction

Re-expansion pulmonary edema (RPE) is a complication of tube thoracostomy for pneumothorax and pleural effusion. The incidence of RPE varies from 0.9% to 29.8% in patients treated for spontaneous pneumothorax [1,2]. Clinical features of RPE range from asymptomatic to critical [1–3], and the mortality rate in patients with severe symptoms has been reported to be as high as 20% [3]. Although most patients with RPE recover without any treatment, diuretics, corticosteroids, and mechanical ventilation may be useful. Ideally, RPE should be avoided, but it occasionally occurs even with careful treatment of pneumothorax with a water seal or without manual aspiration. Therefore, this study was

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conducted to investigate the incidence, risk factors, initial treatment, and effect on clinical outcomes of RPE, and to propose strategies for proper management of spontaneous pneumothorax with regard to avoidance of RPE.

## 2. Materials and methods

### 2.1. Evaluation items

The clinical records of consecutive inpatients treated for spontaneous pneumothorax using thoracostomy from October 2007 to December 2010 at Komaki Municipal Hospital were retrospectively reviewed. RPE was defined as a new infiltration on chest radiography after chest tube insertion, regardless of symptoms. Patients with obvious atelectasis or a local infiltrate were excluded. The patients were categorized into groups with or without RPE. Age, sex, smoking history, history of pneumothorax, Brinkman Index (defined as the daily number of cigarettes × years of smoking), pneumothorax size, symptom duration before hospitalization, and methods of primary intervention (manual aspiration, continuous suction, chest tube size) were compared between the 2 groups. A chest tube size over 18 Fr was classified as large bore and under 12 Fr as small bore. Pneumothorax size was estimated using Kircher's formula [4], which is widely used in Japan (Fig. 1). Using these clinical factors, risk factors for RPE were identified. Symptoms and treatment were examined in patients with RPE by evaluation of clinical outcomes including duration of chest tube insertion, hospital stay, requirement for surgical intervention, and 1-yr recurrence rate.

### 2.2. Statistical analysis

All analyses were performed using Stat View 5.0 (SAS Institute Inc, Cary, NC, USA). $P<0.05$ was taken to indicate a significant difference. Data are shown as means ± standard deviation. The continuous variables were analyzed using Mann–Whitney $U$ test. The categorized variables were analyzed using $\chi^2$ test or Fisher's exact probability test as appropriate. To determine risk factors for RPE, variables with $P<0.1$ in univariate analysis were used in multiple logistic regression.

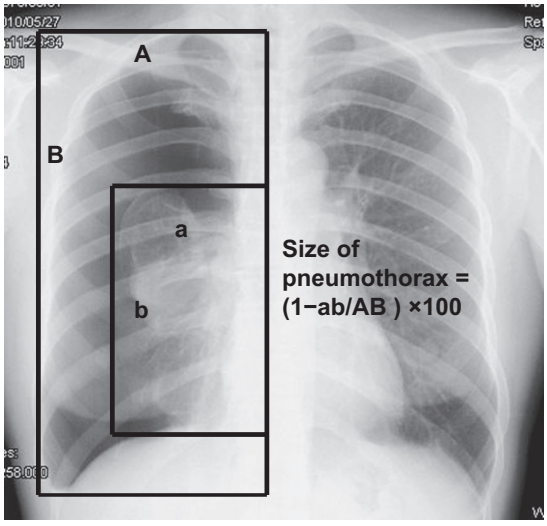


**Fig. 1 – Chest radiograph showing the use of Kircher's formula to calculate the size of a pneumothorax. The reference points for determining the area of the collapsed lung are the extreme superior (a), lateral (b), and inferior borders of the lung and the center of the mediastinum.**

## 3. Results

### 3.1. Patient characteristics

A total of 173 episodes of spontaneous pneumothorax were investigated in 156 patients (Table 1). The mean age of the patients was 47.6 (range 16 to 91) years, 65.2% had a smoking history, and the mean Brinkman Index was 455. The episode of spontaneous pneumothorax was the first such episode in 69.9% of the patients. The mean duration of symptoms before hospitalization was 5.3 days. RPE was diagnosed in 27 of the 173 cases, an incidence of 15.6%.

### 3.2. Comparison of patients with and without RPE

Comparisons of clinical factors between patients with and without RPE are shown in Table 2. Symptom duration and pneumothorax size differed significantly between these groups. Patients with smoking history and those aged 40 to 69 years, compared to other age groups, had a higher incidence of RPE. The method of primary treatment for spontaneous pneumothorax, including manual aspiration, prompt suction, and chest tube size, did not have a significant effect on the occurrence of RPE. Variables with $P<0.1$ in univariate analysis were selected for multiple logistic regression. Symptom duration and pneumothorax size emerged as significant independent risk factors for RPE in multivariate analysis (Table 3).

### 3.3. Clinical presentation and outcomes

As shown in Table 4, cough and dyspnea were common symptoms among patients with RPE, whereas 9/27 (33%) of the patients with RPE were asymptomatic. Supportive care was provided for 30% of patients, but none required mechanical ventilation and all survived. All 5 patients who needed oxygen therapy received it only on the first day. The

**Table 1 – Patient characteristics[a]**

| Item | Number |
|---|---|
| Age (years) | 47.6 ± 23.6 |
| Male/Female (*n*) | 148/25 |
| Smoking history (yes/no) (*n*) | 107/57 |
| First/recurrent episode (*n*) | 121/52 |
| Brinkman Index[b] | 455 ± 569 |
| Symptom duration (days) | 5.3 ± 11.4 |

Smoking history, Brinkman Index, and symptom duration were evaluated in 164 (94%), 149 (86%), and 170 (98%) patients, respectively, on arrival at the hospital.

[a] Data are presented as a number (*n*) or mean ± SD.

[b] The Brinkman Index is defined as the daily number of cigarettes × years of smoking.

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