

## Research Article

## Effects of Physical Therapy Intervention in Pneumonia Patients According to the Severity of Illness

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**Abstract**

**Purpose:** The effects of physical therapy on elderly patients admitted to the ICU due to pneumonia were evaluated according to the severity of illness. **Methods:** Intervention by physical therapists was initiated in the super-acute phase on the day after admission. The patients were divided into groups I, II, and III according to the level of severity. The duration of stay in ICU, duration of hospitalization, and ADL before and after admission were evaluated. **Results:** Overall, the duration of stay in the ICU and duration of hospitalization were longer, and changes in total functional independence measure (FIM) score were larger, but ADL at discharge was poorer, as the condition was severer. Concerning the effects of intervention according to severity, significant improvements were observed in the values of motor function, cognitive function, and total FIM score in all groups. **Conclusions:** The effects of physical therapy in elderly pneumonia patients admitted to the ICU were evaluated according to the severity. In group I at the lowest severity level, changes were not large probably because of the low severity of the illness, shortness of the duration of stay in the ICU, and mild progression of disuse syndrome. Improvements were observed in the values of motor function, cognitive function, and total FIM score in all groups, and physical therapy early after the onset of pneumonia was confirmed to be effective.

**Keywords:** Elderly pneumonia patients, early physical therapy, CURB-65, functional independence measure (FIM)

**Introduction**

Since the mortality due to pneumonia in people aged 65 years and over is very high, being 95% or higher, in Japan, [1] it is important to improve the care of pneumonia patients in the acute phase, and early intervention by physical therapists is recommended.

Early resumption of ambulation is known to exert favorable effects on respiratory, circulatory, motor, and psychological aspects of patients, but many pneumonia patients are forced to stay in bed for a long time due to excessive emphasis on rest during treatment and suffer decreases in activities of daily living (ADL).

Physical therapy in the ICU causes very few adverse events and can be performed safely with sufficient risk management [2]. Many studies have been conducted on the effects of exercise therapy early after admission to the ICU and early resumption

of ambulation, [3] leading to increased awareness of the risk of impairment of functions and ADL associated with prolonged stay in the ICU [4]. Early initiation of rehabilitation primarily by physical therapists is an important intervention for preventing disuse syndrome due to pneumonia and securing of ADL after discharge.

We, therefore, initiated physical therapy in elderly pneumonia patients early after admission to the ICU, and evaluated its effects on the duration of stay in the ICU, duration of hospitalization, and ADL at discharge by the severity of illness.

**Methods****Patients**

The subjects were patients admitted to the ICU due to community-acquired pneumonia. The patients who presented with radiographic evidence and clinical symptoms of pneumonia and

fulfilled the criteria of the revised American Thoracic Society score (rATS) [5] for admission of pneumonia patients to the ICU were treated in the ICU.

Early physical therapy was initiated on the day after admission due to pneumonia in 82 patients, and they were divided according to the severity at the time of admission into groups I, II, and III with CURB-65 scores of 3, 4, and 5, respectively [6]. Patients who were bed-ridden before the onset of pneumonia, and those with serious complications such as severe heart failure, were excluded (Figure 1). This study was carried out with approval by the institutional review board of Kan-etsu-chuo-Hospital (approval No.: 201306051) and with sufficient consideration of protection of the subjects' personal information based on the Declaration of Helsinki.

### Intervention methods

Intervention by physical therapy consisted of guidance in respiration practice, assistance in expectoration of sputum, upper limb/lower limb range of motion exercise (ROM ex) initiated on the day of, or the day after, admission, aiming at the earliest possible resumption of ambulation.

In respiration practice, the patients were instructed with assistance to take 10 slow and deep breaths from immediately after admission [7]. Also, the patients practiced self-sputum expectoration by the active cycle of breathing technique with assistance until they became able to do it independently [8].

ROM ex was performed in the shoulder girdle, shoulder, elbow, wrist, and fingers in the upper limb and in the hip, knee, ankle, and toes in the lower limb in all directions and ranges of motion. It was performed from the day of admission even if the patient was unconscious and could not follow instructions. ROM ex was started with passive exercise and advanced to active exer-

cise as the patient became able to follow instructions.

Ambulation was resumed on the day of admission if the temperature was controlled at 38°C or below. It was discontinued if a fever of 38°C or above, orthostatic hypotension, vomiting, or respiratory distress was observed. Ambulation was started from the seated position in a wheelchair and advanced to standing up and walking according to the patient's condition. Intervention was performed for about 40 minutes once a day in all severity groups.

### Evaluation items

The evaluation items were sex, age, BMI, duration of stay in the ICU, duration of hospitalization, and Functional Independence Measure (FIM) [9] scores before admission and at discharge. The severity was evaluated using CURB-65 [6]. The score of CURB-65 is calculated from the data of four tests and age. It ranges from 0 to 5, with 5 indicating the greatest severity.

ADL was evaluated using FIM,9) and the scores before admission and at discharge were examined. The FIM scores before admission and at discharge were evaluated as FIM changes. The FIM scores before admission were based on information obtained by interviewing the patients and their families.

### Statistical Analyses

The background and FIM changes were compared according to severity using the Kruskal-Wallis test, followed by multiple comparisons using Wilcoxon's signed rank sum test with Bonferroni's modification of inequality. The effect of intervention was compared according to severity using Mann-Whitney's U-test.

Statistical analyses were performed using SPSS statistics (version 17.0, IBM, USA) at the 5% level of significance.

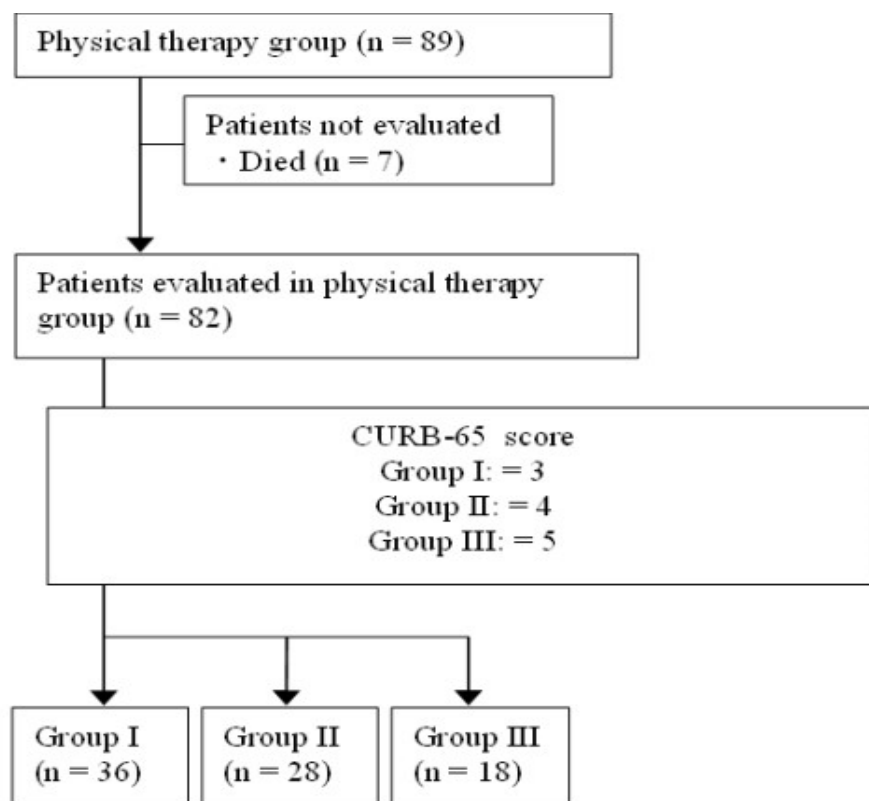


Figure 1. Flow diagram of the patients

## Results

Generally, the duration of stay in the ICU and the duration of hospitalization were longer, and the changes in total FIM score (Table 1) were greater, but ADL at discharge was poorer, as the condition was severer.

Concerning the effects of intervention according to severity, significant improvements were observed in motor function, cognitive function, and total FIM score in groups I, II, and III (Table 2).

**Table 1.** All pneumonia patients

Number of subjects	82
(male/female)	(54/28)
Age (years)	81.44±7.52
BMI	20.25±2.3
Number of patients mechanically ventilated on admission (persons)	16
Duration of stay in the ICU (days)	10.93±3.76
Duration of hospitalization (days)	30.44±15.9
FIM score before admission	82.16±9.47
Motor function	57.61±7.89
Cognitive function	24.55±2.56
FIM score at discharge	66.65±12.45
Motor function	45.91±10.19
Cognitive function	19.54±3.57
FIM change	15.41±6.69
Changes in motor function	11.70±5.46
Changes in cognitive function	5.01±2.25
Mean±SD *; p<0.05, **: p<0.01	
BMI: Body-mass index	
FIM: Functional independence measure	

## Discussion

Physical therapy was performed in elderly pneumonia patients admitted to the ICU, and its effects were evaluated according to the severity of illness. Changes were not large in group I with the lowest severity level. This was probably due to the mildness of the illness, shortness of the duration of stay in the ICU, and low grade of disuse syndrome.

BMI was reported to show the highest accuracy in predicting 1-year mortality, and may be useful for the identification of patients with a poor long-term prognosis, [10] but, in this study, no significant difference was observed in BMI among the groups.

Improvements were observed in motor function, cognitive function, and total FIM score in groups I, II, and III, and early physical therapy after the onset of pneumonia was suggested to be effective.

Concerning motor function, prevention of intensive care acquired weakness (ICUAW) is important. Lack of activity is considered to be a factor of ICUAW and is reported to be related to prolongation of the duration of the use of mechanical ventilation and stay in the ICU and delay of recovery of ADL [11]. In this study, intervention was made by minimizing the inactive period.

As it was reported that the number of steps per day after recovery decreases with the degree of severity [12], the effect of ICUAW may be considerable. Proactive prevention of the loss of muscle mass is likely to contribute to recovery of elderly pneumonia patients, [13] and continuation of passive joint range of motion exercise even if the patient was unconscious and did not respond to instructions is considered to have exerted favorable effects on motor function.

Hopkins et al. reported no relationship between impairment of cognitive function after intensive care and the severity of acute respiratory distress syndrome, or duration of stay in the ICU

**Table 2.** Background and changes in FIM score according to severity

Severity	Grade I	Grade II	Grade III	P-value
Number of patients (persons)	36	28	18	
Age (years)	76.91±6.65	86.5±4.74	82.61±7.48	0.0013
BMI	20.48±2.49	20.19±2.12	19.89±1.89	0.734
Duration of stay in the ICU (days)	9.4±2.8	10.96±4.35	13.88±2.56	0.0013
Duration of hospitalization (days)	22.67±13.98	30.52±15.56	42.33±12.61	0.0067
Changes in FIM score	11.47±5.42	17.35±4.91	20.27±7.10	0.0071
Motor function	8.69±5.27	13.35±3.75	15.11±6.54	0.0025
Cognitive function	4.33±2.34	5.64±2.21	5.38±1.85	0.088
Mean±SD	*: p<0.05, **: p<0.01			
	*On multiple comparison (Wilcoxon's signed rank sum test with Bonferroni's modification of inequality) P values are on the Kruskal-Wallis test.			

**Table 3.** Effects of intervention according to severity

Severity	Grade I		Grade II		Grade III	
	Before intervention	After intervention	Before intervention	After intervention	Before intervention	After intervention
Total FIM score	85.97±9.30	74.28±10.05**	80.46±8.09	63.11±9.74**	77.17±9.14	56.89±11.71**
Motor function	59.97±7.41	51.28±8.42**	56.96±7.09	43.61±8.42**	53.89±8.75	38.78±10.63**
Cognitive function	25.61±2.67	21.67±3.35**	23.50±1.66	17.86±2.81**	23.28±2.05	17.89±2.82**
Mean±SD**: p<0.01						

[14]. In this study, however, the duration of hospitalization and stay in the ICU was longer, and the decline in cognitive function increased with the severity of illness. Shortening of the duration of stay in the ICU by physical therapy intervention may alleviate the decline in cognitive function.

Many critically ill patients admitted to the ICU reportedly show a decline in the cognitive level due to delirium [15]. However, delirium was reduced by physical therapy in patients with acute respiratory impairment and mechanically ventilated patients, [16,17] and intervention with physical therapy is also important for critically ill patients.

It has been reported that a high percentage of elderly patients died or exhibit functional declines from 30-day hospitalization due to pneumonia regardless of the severity of illness [18]. In this study, the mean duration of hospitalization exceeded 30 days in groups II and III. In addition, there is a report that, in pneumonia patients, the severer the illness, the higher the cost of inpatient care [19].

Further evaluation is considered necessary for accelerating the relief of symptoms and shortening of the duration of hospitalization by early intervention with physical therapy.

## Conclusions

Intervention with physical therapy for pneumonia patients in the ICU may be effective regardless of the medical conditions, despite differences in effects according to the severity. Since physical therapy is expected to contribute to the prevention of complications and maintenance/improvement in ADL, further evaluation is necessary.

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## Conflict of Interest

Authors have no conflict of interests to disclose. The data analyzed in this study were obtained in 2017-2019 before SARS-CoV-2. This manuscript is not under consideration for publication elsewhere.

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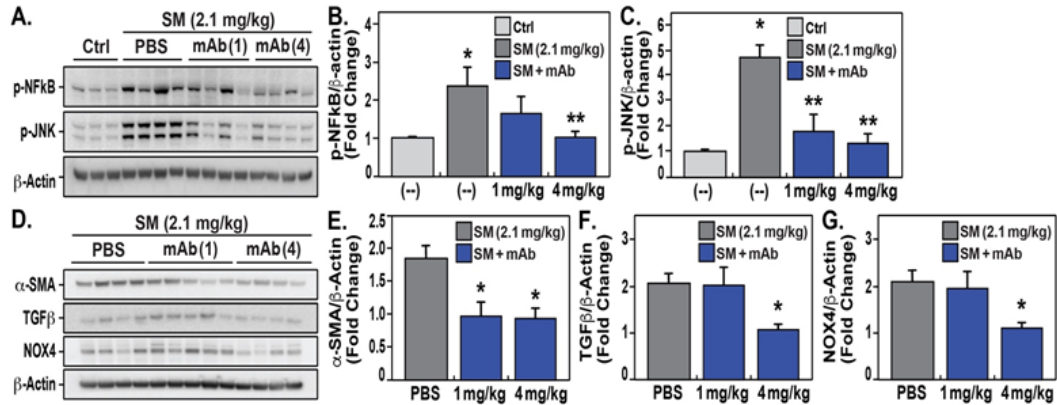
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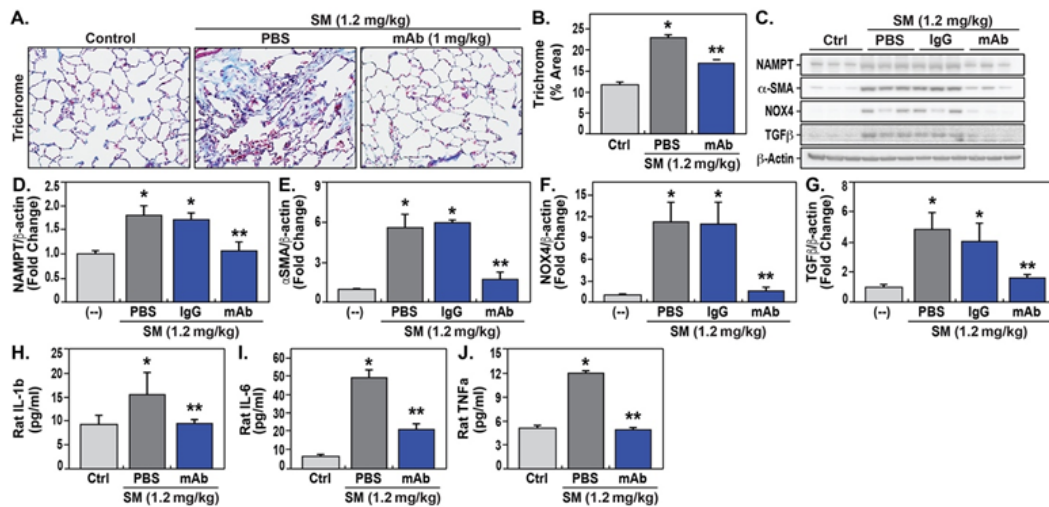
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**Figure 4.** ALT-100 mAb reduces subacute SM inflammatory lung injury and expression of inflammatory proteins at day 14. A/B/C. Expression levels of p-NFkB and p-JNK detected by Western blots in lung homogenates from 2.1mg/kg SM-exposed rats on day 14 show significant increases in each protein with significant reduction in expression levels in ALT-100 mAb-treated rats compared to untreated rats with quantification by densitometry. D/E/F/G. Expression levels of smooth muscle actin (SMA), TGFβ, and NOX4 in lung homogenates are significantly increased in rats exposed to 2.1mg/kg SM on day 14. Each index of lung fibrosis was significantly reduced in rats receiving the ALT-100 mAb. For each protein assessed, ALT-100 mAb at 4mg/kg provided significantly greater protection than 1mg/kg.



**Figure 5.** ALT-100 mAb reduces chronic SM inflammatory lung injury and fibrosis at day 29. A/B. Trichrome blue lung staining and ImageJ analysis of fibrotic lung tissue in the chronic SM model (1.2 mg/kg UC-CADD, 29 days). SM-exposed rats exhibited marked increases in Trichrome expression, consistent with significant lung fibrosis, when compared to controls. ALT-100 mAb-treated SM rats (1 mg/kg, 1x weekly) demonstrated significant reductions in the extent of Trichrome staining at Day 29 (ImageJ quantification). C/D/E/F/G. Western blots and densitometry of 29 day SM-exposed lung tissues show increased NAMPT, SMA, NOX4 and TGFβ immunoreactivity compared to controls, which is reduced by ALT-100 mAb treatment (captured by densitometry). H/I/J. SM exposure increases plasma levels of IL-6, IL-1b, and TNFα at 29 days, with ALT-100 mAb-treated rats (1mg/kg, 1x weekly) showing reduced levels.







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