

Association between the amount of rehabilitation and the outcomes in patients with aspiration pneumonia

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The appropriate amount of rehabilitation for aspiration pneumonia remains unknown. We conducted a historical cohort study to investigate the association between the amount of rehabilitation provided and the outcome of patients with aspiration pneumonia. A total of 4148 patients with aspiration pneumonia recruited from a database created by JMDC were categorized into three groups based on daily rehabilitation units: none or <1 unit (low-volume group), 1–2 units (medium-volume group), and more than 2 units (high-volume group). The main outcome measures were death in the hospital, discharge home, and length of hospital stay. The results showed that the middle-volume and high-volume groups had significantly fewer in-hospital deaths [middle-volume group, odds ratio (OR) 0.62; 95% confidence interval (CI), 0.46–0.83; high-volume group, OR 0.66; 95% CI, 0.45–0.97], more patients were discharged home (middle-volume group, OR 1.29; 95% CI, 1.03–1.62; high-volume group, OR 2.00; 95% CI, 1.48–2.71), and shorter hospital stay (middle-volume group, coefficient –3.30;

95% CI, –6.42 to –0.19; high-volume group, coefficient –4.54; 95% CI, –8.69 to –0.40) compared with the low-volume group. In conclusion, higher rehabilitation units per day provided to patients with aspiration pneumonia were associated with fewer deaths, more home discharges, and shorter hospital stays. *International Journal of Rehabilitation Research* XXX: XXXX–XXXX Copyright © 2023 Wolters Kluwer Health, Inc. All rights reserved.

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Introduction

Aspiration pneumonia is common in the older population, with a high mortality rate and increasing prevalence [1]. More than 60% of older patients hospitalized for community-acquired pneumonia have aspiration pneumonia, and almost all patients with nursing and health-care-associated pneumonia have aspiration pneumonia [2]. Patients with aspiration pneumonia require longer hospitalization than those with normal pneumonia [3]. Moreover, many patients who are cured of pneumonia cannot be discharged home and end up in long-term care facilities [4].

In clinical practice, rehabilitation, which includes mobilization training and respiratory exercise, is generally provided for patients with aspiration pneumonia. Previous studies have shown that early initiation of rehabilitation after hospitalization in patients with aspiration pneumonia is associated with an increase in oral intake, a decrease in discharge to long-term care facilities, and recovery of activities of daily living (ADL) [5,6].

Despite reports of the effectiveness of rehabilitation for aspiration pneumonia, how much rehabilitation should be provided is unclear. Increased rehabilitation has been reported to improve the physical function and ADL of

patients with pelvic fractures and stroke [7–9]. Moreover, increased rehabilitation for patients with pneumonia during hospitalization reduced death and rehospitalization within 30 days of discharge [10]; however, no previous studies have focused on aspiration pneumonia, and patient characteristics are reported to differ between pneumonia in patients with general and aspiration pneumonia [3]. We hypothesized that there would be an association between the amount of rehabilitation provided and clinical outcomes in patients with aspiration pneumonia. This study aimed to determine whether the amount of rehabilitation provided per day to patients hospitalized with aspiration pneumonia was associated with outcomes including death, discharge home, and length of hospital stay.

Materials and methods

We conducted this historical cohort study using a national inpatient database. This study used a hospital-based database created by JMDC [11]. The JMDC database is an epidemiological database that has been accumulating medical information claims and diagnosis procedure combination (DPC) survey data from contracted hospitals since 2014. As of August 2020, it contained information on approximately 12 million patients. The

DPC database is a national inpatient administrative claims and discharge database. JMDC contains a medical claims database of 400 hospitals. The database contains encrypted personal identifiers, patient attributes such as year of birth, sex, medication history, and types of services in addition to data on diagnosis, treatments performed, medications dispensed, tests performed, and types of medical facilities used. Diagnoses were defined according to the International Classification of Diseases, 10th edition (ICD-10).

We collected information on patients admitted with a diagnosis of aspiration pneumonia (ICD-10 code: J690) and rehabilitation provided within 3 days of admission using the DPC survey data of JMDC (April 2014–August 2020). To exclude patients with physical conditions that precluded rehabilitation, we included patients whose rehabilitation was initiated early after hospitalization. Patients with missing data on Age, Dehydration, Respiratory Failure, Orientation Disturbance, Blood Pressure (A-DROP) and severity of pneumonia were excluded.

Regarding rehabilitation, we included all types and intensities by physical and occupational therapists and others. In Japan, rehabilitation cost is reimbursed by the national health insurance system as one unit of rehabilitation for 20 min [8]. Therefore, the number of rehabilitation units and rehabilitation dates were available in the administrative claims database. Generally, rehabilitation for patients with aspiration pneumonia includes mobilization training, muscle strength and endurance training, sputum elimination assistance, and breathing guidance [12]. These rehabilitation programs are associated with hospital-acquired physical debilitation and decreased risk of in-hospital mortality. The indications for rehabilitation in patients with aspiration pneumonia were dependent on the preference of the attending physicians.

We calculated the number of rehabilitation units provided per day based on the total number of rehabilitation units during the hospital stay divided by the length of hospital stay. Patients were classified into three groups: low-volume group (<1 rehabilitation unit per day), middle-volume group (1–2 rehabilitation units per day), and high-volume group (≥ 2 rehabilitation units per day). In this study, we selected in-hospital death, home discharge, and length of hospital stay as outcomes.

The following covariates related to rehabilitation were used: sex, age, Barthel index on admission, BMI, vasopressor use on admission (within 3 days), admission from home, Charlson comorbidity index (CCI), A-DROP score, number of beds, and year of admission. These data were obtained from hospitalization insurance claims data. Barthel index is a scale used to evaluate ADL and is expressed on a scale of 0–100, with a higher score indicating more independent ADL [13]. The CCI is a weighted index of comorbidity that combines the number and

severity of the condition [14]. The CCI is highly reliable, and higher scores indicate higher mortality [15]. The A-DROP scoring system was a modified version of the British Thoracic Society's CURB-65 criteria, consisting of age (male ≥ 70 years, female ≥ 75 years), dehydration (blood urea nitrogen ≥ 21 mg/ml), respiratory failure (pulse oxygenation, SpO₂ $\leq 90\%$), disturbance of consciousness, and hypotension (SBP ≤ 90 mmHg). Each category scored 1 point if applicable, with a maximum of 5 points [16]. The higher the score, the more severe the pneumonia, and a score of ≥ 3 indicates severe pneumonia.

The characteristics and outcomes of patients in each group were compared. Categorical data are presented as absolute values and percentages, whereas continuous data are presented as mean (SD). The χ^2 test and one-way analysis of variance were used to compare the groups. Multiple logistic regression and multiple regression analyses were used to adjust for covariates and determine the association between the number of rehabilitation units provided per day and outcomes. Significance was set at $P < 0.05$. All statistical analyses were performed using the IBM SPSS Statistics version 25.0 (IBM Corp., Armonk, New York, USA).

Results

During the study period, 32,645 patients were hospitalized for aspiration pneumonia and received rehabilitation (Fig. 1). Among them, those in whom rehabilitation was not initiated within 3 days of admission ($n = 14140$) and patients with missing A-DROP scores ($n = 14357$) were excluded. Finally, 4148 patients were identified for the study.

Tables 1–2 show the characteristics of the patients. In total, 2850 (68.7%) were in the low-volume group, 850 (20.5%) in the middle-volume group, and 448 (10.8%) in the high-volume group. In total, 58.6% of the patients were men with a mean age of 83.5 years, 51.7% of the patients were admitted from home, the mean Barthel index on admission was 16, 54.1% of the patients had a BMI of ≤ 18.5 , and 28.5% were severely ill with an A-DROP score of ≥ 3 points. Residence before admission, admission year, and the number of beds were significantly different between the groups.

Table 3 shows the results of the comparison of outcomes between the groups. The higher the amount of rehabilitation provided, the fewer the in-hospital deaths, the more home discharges, and the shorter the hospital stay.

Table 4 shows the results of the multiple logistic and multiple regression analyses. In-hospital death was significantly lower in the middle-volume group [odds ratio (OR), 0.63; 95% confidence interval (CI), 0.46–0.83] and high-volume group (OR, 0.66; 95% CI, 0.45–0.97) than in the low-volume group. The number of home discharges was significantly higher in the middle-volume group (OR, 1.30; 95% CI, 1.03–1.62) and high-volume group (OR,

2.01; 95% CI, 1.48–2.71) than in the low-volume group. The length of hospital stay was significantly shorter in the middle-volume (regression coefficient, –3.31; 95% CI, –6.42 to –0.19) and high-volume group (regression coefficient –4.55; 95% CI, –8.69 to –0.40) than in the low-volume group.

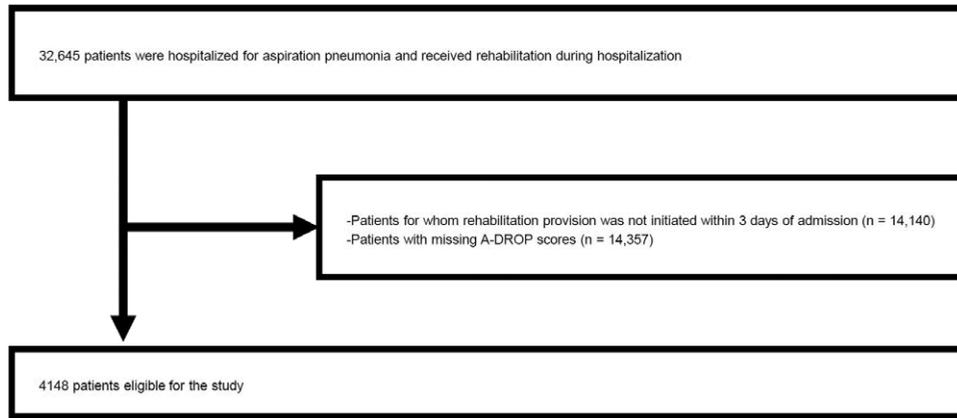
Discussion

In this study, we investigated the association between the number of rehabilitation units provided per day and in-hospital death, home discharge, and length of hospital stay in patients hospitalized for aspiration pneumonia using a nationwide database of hospitalized patients. We found that the higher the rehabilitation units provided per day, the fewer the in-hospital deaths, the more home discharges, and the shorter the hospital stay. The strength of this study related to its

use of a nationwide inpatient database and focus on the recovery of patients with aspiration pneumonia in a real-world setting.

Several studies have reported the effects of the rehabilitation amount provided on patient prognosis. Patients who received 60 min of rehabilitation per day after surgery for pelvic fractures had better ambulation and shorter hospital stay than those who received 30 min of rehabilitation per day [7,8]. An association was reported between the number of rehabilitation units per day and the number of patients with stroke who had improved ADL [9]. For patients with pneumonia, early rehabilitation after hospitalization was reported to improve prognosis [17]. Freburger *et al.* also reported that the higher the amount of rehabilitation provided to patients with pneumonia during hospitalization, the fewer deaths and rehospitalizations within 30 days of discharge [10]. In the present

Fig. 1



Flowchart of patient selection. A-DROP, Age, Dehydration, Respiration, Orientation, Pressure.

Table 1 Patient characteristics

	Total	Low-volume group	Middle-volume group	High-volume group	P value
Number of patients, n (%)	4148 (100)	2850 (68.7)	850 (20.5)	448 (10.8)	
Male, n (%)	2430 (58.6)	1652 (58.0)	514 (60.5)	264 (58.9)	0.423
Age, mean (SD), years	83.5 (8.7)	83.5 (8.8)	83.6 (8.6)	83.3 (8.2)	0.878
Barthel Index on admission, mean (SD)	16.0 (28.7)	16.3 (28.4)	14.8 (28.5)	16.2 (31.0)	0.447
BMI, kg/m ² n (%)					0.290
<18.5	2044 (54.1)	1429 (54.9)	413 (53.4)	202 (50.5)	
18.5–24.9	1502 (39.8)	1029 (39.6)	305 (39.4)	168 (42.0)	
25–29.9	199 (5.3)	122 (4.7)	50 (6.5)	27 (6.8)	
≥30	30 (0.8)	21 (0.8)	6 (0.8)	3 (0.8)	
Vasopressor use on admission, n (%)	114 (2.7)	78 (2.7)	27 (3.2)	9 (2.0)	0.472
Admission from home, n (%)	2145 (51.7)	1436 (50.4)	472 (55.5)	237 (52.9)	0.027
Charlson comorbidity index, n (%)					0.073
0	1359 (32.8)	919 (32.2)	307 (36.1)	133 (29.7)	
1	1367 (33.0)	933 (32.7)	281 (33.1)	153 (34.2)	
2	1422 (34.3)	998 (35.0)	262 (30.8)	162 (36.2)	
A-DROP, n (%)					0.193
0	126 (3.0)	89 (3.1)	26 (3.1)	11 (2.5)	
1	1478 (35.6)	1056 (37.1)	268 (31.5)	154 (34.3)	
2	1363 (32.9)	911 (32.0)	296 (34.8)	156 (34.8)	
3	796 (19.2)	523 (18.4)	181 (21.3)	92 (20.5)	
4	320 (7.7)	227 (8.0)	64 (7.5)	29 (6.5)	
5	65 (1.6)	44 (1.5)	15 (1.8)	6 (1.3)	

A-DROP, Age, Dehydration, Respiration, Orientation, Pressure.

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study, patients had an average age of 67 years, an average hospital stay of 9 days, and several sessions of rehabilitation. Our study differs from the study by Freburger *et al.* because we examined the effect of rehabilitation amount in older patients with aspiration pneumonia who have longer hospital stays.

A large rehabilitation volume provided to patients with aspiration pneumonia may prevent pneumonia recurrence, as the prolonged time away from bedtime enables patients to be alert and conscious during the day [18,19]. These factors may have contributed to the reduction in in-hospital deaths.

Rehabilitation of patients with aspiration pneumonia has been reported to promote oral intake [20]. Patients who received higher rehabilitation volume may have better oral intake levels and are more likely to be discharged home. Patients with unstable oral intake require more time to adjust to the destination and schedule of discharge [21]. Therefore, increased rehabilitation volume may have improved oral intake levels, contributing to earlier discharge and shorter hospital stays.

A study reported that rehabilitation and mobilization of patients with pneumonia can be performed without increasing adverse events [17]. Moreover, patients with severe pneumonia can be safely mobilized if appropriate protocols are followed [22]. Thus, increasing the rehabilitation volume for patients with aspiration pneumonia is feasible and likely to be a therapeutic alternative.

Limitations

This study has several limitations. First, this was a historical cohort study without randomization. There could

be unmeasured confounders, such as patients' physical function before admission. Second, it is unclear how the amount of rehabilitation provided to patients was determined. A study reported a large regional disparity in the number of therapists in Japan, and many areas have a shortage of therapists [23]. Therefore, the number of rehabilitation staff and prioritization of treatment at each facility could have influenced the intensity of rehabilitation. Third, we were unable to obtain detailed information on the content of the rehabilitation programs provided to each patient and which therapists provided the rehabilitation services.

Conclusion

This historical cohort study using a national database showed that the number of rehabilitation units per day provided to patients hospitalized with aspiration pneumonia was associated with in-hospital death, home discharge, and length of hospital stay. Further studies, including randomized controlled trials, are needed to confirm the effect of the rehabilitation amount provided to patients hospitalized with aspiration pneumonia.

Acknowledgements

The Ethics Committee of Mie University determined that no ethical review was required for studies using this database because this database is generally available and widely used in research. Because the JMDC provided de-identified and unlinked data, there was no need for informed consent. The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Conflicts of interest

There are no conflicts of interest.

Table 2 Number of beds and admission year

	Total	Low-volume group	Middle-volume group	High-volume group	P value
Number of beds, n (%)					<0.001
20–99	143 (3.4)	138 (4.8)	5 (0.6)	0 (0.0)	
100–199	1811 (43.7)	1389 (48.7)	356 (41.9)	66 (14.7)	
200–299	538 (13.0)	267 (9.4)	157 (18.5)	114 (25.4)	
300–499	1160 (28.0)	683 (24.0)	229 (26.9)	248 (55.4)	
≥500	496 (12.0)	373 (13.1)	103 (12.1)	20 (4.5)	
Admission year, n (%)					<0.001
2014	168 (4.1)	97 (3.4)	55 (6.5)	16 (3.6)	
2015	452 (10.9)	290 (10.2)	108 (12.7)	54 (12.1)	
2016	631 (15.2)	434 (15.2)	132 (15.5)	65 (14.5)	
2017	722 (17.4)	459 (16.1)	166 (19.5)	97 (21.7)	
2018	934 (22.5)	699 (24.5)	149 (17.5)	86 (19.2)	
2019	916 (22.1)	647 (22.7)	171 (20.1)	98 (21.9)	
2020	325 (7.8)	224 (7.9)	69 (8.1)	32 (7.1)	

Table 3 Comparisons of outcomes between the groups

	Total	Low-volume group	Middle-volume group	High-volume group	P value
Death in-hospital, n (%)	568 (13.7)	424 (15.0)	95 (11.2)	45 (10.0)	0.001
Home discharge, n (%)	1419 (34.2)	916 (32.2)	318 (37.5)	185 (41.9)	<0.001
Length of hospital stay, mean (SD), days	31.6 (35.5)	32.9 (39.1)	30.4 (27.8)	25.8 (20.8)	<0.001

Table 4 Results of the logistic regression analysis for in-hospital death and home discharge and multiple regression analysis for the length of hospital stay

Outcome	In-hospital death			Home discharge			Length of hospital stay		
	OR	95% CI	P value	OR	95% CI	P value	Regression coefficient	95% CI	P value
Rehabilitation volume	Reference			Reference			Reference		
Low-volume group	0.62	0.46–0.83	0.001	1.29	1.03–1.62	0.025	–3.30	–6.42 to –0.19	0.037
Middle-volume group				2.00	1.48–2.71	<0.001	–4.54	–8.69 to –0.40	0.031
High-volume group	0.66	0.45–0.97	0.035						

Adjusted for age, sex, Barthel index on admission, vasopressor use on admission, admission from home, Charlson comorbidity index (CCI), Age, Dehydration, Respiration, Orientation, Pressure (A-DROP), number of beds, and admission year. CI, confidence interval, OR, odds ratio.

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