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ORIGINAL ARTICLE

In-hospital Rehabilitation Therapy Outcomes in Adult Down's Syndrome Patients with Community-acquired Pneumonia: A Nationwide Observational Study

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Objectives: There has been no analysis of the effects of in-hospital rehabilitation on adult patients with Down's Syndrome (DS) after hospitalization for community-acquired pneumonia (CAP). Medical claims data retrospectively collected nationwide were used to examine outcomes at discharge. **Methods**: Hospitalization data were obtained from 440 Japanese hospitals for DS patients with CAP that were discharged between 1 June 2009 and 31 January 2022 (n=2897). After the exclusion of 2478 patients, mainly on the basis of age or type of admission, the records of 419 patients were extracted. The following were used as outcomes: (1) 30-day readmission, (2) 45-day readmission, (3) discharge Barthel Index (BI), (4) BI score gain, and (5) length of hospital stay. The targeted minimum loss-based estimator was used to examine effects of the average daily times of rehabilitation on outcomes at discharge. **Results**: Most patients had no in-hospital rehabilitation (73.5%). Provided that the average daily time of rehabilitation therapy was at least 20 min, BI scores were lower at discharge (coefficient, −15.91; 95% confidence interval, −30.07 to −1.75) and BI gain was lower (coefficient, −12.56; 95% confidence interval, −25.60 to 0.47) when compared with the use of no rehabilitation therapy. **Conclusions**: In-hospital rehabilitation medicine in DS patients with CAP provided by a therapist was not associated with improved activities of daily living at discharge. Future studies are warranted to develop systematic, efficient, and comprehensive rehabilitation medicine for DS patients suffering from CAP.

Key Words: activities of daily living; Barthel Index; length of hospital stay; readmission; rehabilitation medicine

INTRODUCTION

Down's Syndrome (DS) is no longer considered a pediatric disease but rather a condition affecting people throughout their lives. The life expectancy of people with DS has increased dramatically in recent decades—the estimated global life expectancy was 35 years in the 1980s and increased to 55–60 years in the 2010s.[1–3] As a result, a growing number of health issues have emerged in relation to the aging of adults with DS. Recent data from the USA show an increased probability of death from dementia, heart disease, and pneumonia in mature adults with DS aged 30 years and older.[4] A previous study suggested that individuals with DS are highly likely to receive inpatient care for the abovementioned diseases.

One of the leading causes of hospitalization in patients with

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DS is community-acquired pneumonia (CAP).[5] Individuals with DS are more likely to be hospitalized because of CAP than the general population.[5] Previous observational studies mainly targeting the older population reported coexisting dysphasia and physical frailty among patients hospitalized for CAP.[6–8] Adults with DS are more likely to have respiratory issues, immune system deficiency, frailty, disability, intellectual disability, and oral dysfunction, highlighting the importance of multifaceted inpatient care for these patients.[9–13]

Few studies have reported on the effects of rehabilitation therapy on patients with CAP. A systematic review study examining therapy for patients with pneumonia concluded that chest physical therapy was not beneficial in reducing mortality risk or improving the cure rate.[14] The review study also reported that there was limited evidence that chest physical therapy reduced the length of hospital stay. Recent studies examining the effects of physical training induced by physical therapists for hospitalized patients with CAP reported improved hospital discharge outcomes, such as functional capacity, quality of life, and activities of daily living.[15,16] It is likely that adequate in-hospital rehabilitation therapy for DS patients hospitalized for CAP is required to integrate these previous findings and improve outcomes, given that individuals with DS are more prone to poor clinical outcomes.[17] However, few studies have investigated the effects of rehabilitation therapy on patients with DS. Most studies on the care of respiratory tract infections exclude this vulnerable group even though they are at higher risk for these infections.[18]

Recently, a new framework known as the targeted minimum loss-based estimator (TMLE) has allowed researchers to calculate treatment effects using a counterfactual approach instead of traditional methods that focus on associations.[19] Moreover, TMLE does not depend on parametric assumptions, thereby allowing the use of a weighted combination of machine learning algorithms (e.g., generalized linear models, generalized additive models, gradient boosting models, neural networks). This novel framework was used to examine the association between in-hospital rehabilitation therapy and outcomes at discharge in adult DS patients hospitalized for CAP.

MATERIALS AND METHODS

Patient Selection

Data were collected by Medical Data Vision Co., Ltd. and were derived from the Diagnosis Procedure Combination (DPC) database.[20] The DPC system is a patient classification system that is used by acute care hospitals to coordinate payment reimbursement. As part of its function, the DPC system collects clinical information on each patient, including age, sex, primary diagnosis (by ICD-10 codes), consciousness status and comorbidities at admission, rehabilitation during hospitalization, activity status at discharge, complications after admission (by ICD-10 codes), in-hospital mortality, number of hospital beds, length of stay, and hospital charges.

We obtained hospitalization data from 440 hospitals throughout Japan for patients with DS (ICD-10 code Q900) and CAP (ICD-10 codes J09-J18) who were discharged between 1 June 2009 and 31 January 2022 (n=2897). We excluded the following patients: (1) those aged under 15 years (n=2366), (2) those with a hospital readmission within 30 days of the last discharge (n=28), (3) those with a length of hospital stay of less than 3 days (n=37), (4) those with hospital-acquired pneumonia (n=31), and (5) those admitted from another hospital (n=16). Consequently, the data of 419 patients were used in our main analysis (**Fig. 1**). Clinical information such as the severity of pneumonia (A-DROP score) is only entered into the DPC system for patients aged 15 years and older. Therefore, patients younger than 15 years were excluded from the analysis.

Outcomes

The following were used as outcomes: (1) 30-day readmission, (2) 45-day readmission, (3) Barthel Index (BI) score at discharge, (4) the difference in BI scores between admission and discharge (i.e., BI gain), and (5) the length of hospital stay. We used 30-day and 45-day readmissions as the outcomes following previous studies.[21,22] The minimal clinically important difference in BI is reported as 15 points.[23]

Exposures

The exposure variable was defined as the average daily time of in-hospital rehabilitation therapy, which was calculated as the total time of rehabilitation therapy divided by the length of hospital stay. Rehabilitation therapy is covered by the medical insurance system in Japan and is subject to a disease-based payment system. Standards for providing rehabilitation, such as the number of specialists and the area of rehabilitation rooms, are also defined according to the disease. The minimum payment unit is 20 min of rehabilitation, and the unit price is determined according to the disease.[24] We divided patients into three groups according to the rehabilitation time: none, $<$20 min/day, or $\geq$20 min/day.

Patients hospitalized for pneumonia can claim a general

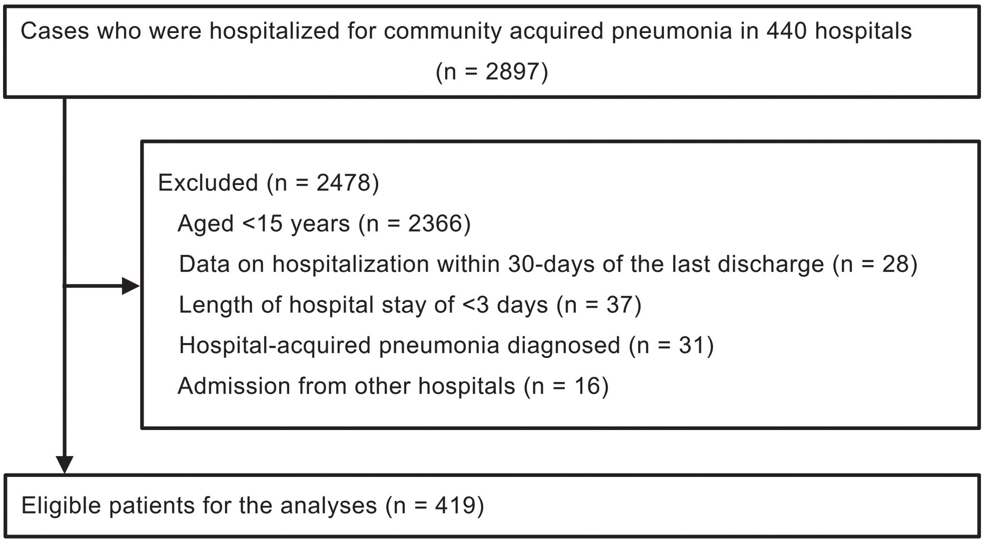

Fig. 1. Flow diagram for patient data collection.

respiratory rehabilitation payment for therapy performed by a therapist under the direction of a physician. In practice, there are cases in which the number of specialists and the area of rehabilitation rooms may not meet the specified standard. Another disease-specific rehabilitation payment (e.g., disuse or musculoskeletal disease rehabilitation payments) may be claimed in those cases without respiratory rehabilitation payment. Whether respiratory rehabilitation was claimed was also used as an exposure variable in this study.

Covariates

We used the following variables as covariates in the analysis: (1) pre-admission data and data at the time of admission and (2) data during hospitalization. Pre-admission data and data at the time of admission included age, sex, Hospital Frailty Risk Score (HFRS; <5, 5–15, or ≥16),[25] the use of supplemental nasogastric feeding, parenteral nutrition, or intravenous infusion at admission, residence before admission (home or nursing facility), body weight status [body mass index (BMI) <18.5 or ≥30.0 kg/m^2],[26] number of hospital beds (<200, 200–499, or ≥500), the A-DROP score (0, 1–2, 3, or 4–5), admission by ambulance, and BI score at admission. Data collected during hospitalization included whether rehabilitation therapy started within 2 days of admission, daily medical resource input within 7 days of hospitalization, whether admitted to the intensive care unit (ICU), length of hospital stay, whether a dysphasia rehabilitation therapy charge was claimed, and whether a respiratory rehabilitation charge was claimed.

According to a previous study, HFRS was calculated based on the ICD-10 codes recorded in the inpatient and outpatient claims during the 12-month look-back period.[27] We classified HFRS into three groups based on the previous study (low [<5], intermediate [5–15], and high [≥16]). The number of hospital beds was classified based on reimbursement and hospital function as small (<200), medium (200–499), or large (≥500).[28] The A-DROP system was proposed by the Japanese Respiratory Society as a modified version of the CURB-65 score (confusion, uremia, respiratory rate, low blood pressure, age 65 years or greater) of the British Thoracic Society.[29] The A-DROP score provides a rating of the clinical severity of CAP on a 6-point scale: 0, mild; 1–2, moderate; 3, severe; 4–5, extremely severe.[29] It is based on the following parameter cutoffs: (1) age (men 70 years, women 75 years); (2) dehydration (blood urea nitrogen 210 mg/L); (3) respiratory failure (arterial oxygen saturation 90% or partial pressure of oxygen in arterial blood 60 mmHg); (4) orientation disturbance; and (5) low blood pressure (systolic blood pressure 90 mmHg). The BI score at the time of admission was added to our model to take into account the possibility of regression to the mean.[30] The medical resource input was the amount of medical treatment performed on a patient, excluding basic hospitalization and rehabilitation charges, and was converted into a piece-rate medical payment. The amount increased as more advanced medical resources were required. The length of hospital stay was used as a covariate only for analyzing BI and readmission as outcomes.

Statistical Analysis

Our statistical analysis considered the temporal nature of the data structure, given that the data was acquired at different times relative to admission: pre-admission data, data collected at the time of admission, data collected during hospitalization, and data collected at discharge. The analysis consisted of three main steps. First, we defined several hypothetical exposure scenarios by dynamically shifting the observed exposure level of each patient: scenario 1, No patients received rehabilitation therapy; scenario 2, All patients received <20 min/day rehabilitation therapy; scenario 3, All patients received ≥20 min/day rehabilitation therapy; scenario 4, What if patients who did not receive any rehabilitation therapy received <20 min/day; scenario 5, What if patients who did not receive any rehabilitation therapy received ≥20 min/day. Then, TMLE was used to obtain expected outcome estimates under each of the aforementioned scenarios. Use of TMLE is a doubly robust method based on the combination of the G-computation and inverse probability of treatment-weighting approaches.[19] Finally, the outcome estimates for the different exposure scenarios were contrasted against scenario 1 or with the originally observed exposure to obtain the odds ratios (ORs) or additive treatment effects and their 95% confidence intervals (CIs).

A secondary analysis was also conducted with exposure to a variable indicating whether a respiratory rehabilitation charge (e.g., disuse syndrome rehabilitation charge, musculoskeletal disorders rehabilitation charge) was claimed. Therefore, this secondary analysis did not include patients who did not receive any rehabilitation therapy during their hospitalization. We aimed to examine the extent to which specialized respiratory rehabilitation provided by physicians and physical therapists (specialists) would differ in outcomes when compared with other rehabilitation medicine.

We also conducted sensitivity analyses in which we excluded patients with severe pneumonia (A-DROP >2) and those with independent activities of daily living (BI=100), and the same analyses were performed. Patients who died during hospitalization (n=15) were treated as censoring events to control collider-stratification bias.[31] We applied the random forest imputation approach to deal with the missing variables, which is recommended for data with mixed continuous and categorical variables.[32] We used the SuperLearner algorithm to obtain more robust specification of G-computation and inverse probability weighting approaches.[33] Specifically, the SuperLearner algorithm is a method to improve the accuracy of a prediction by combining multiple models.[34] Previous studies have suggested the combined use of both parametric and non-parametric models for model specifications to improve the accuracy of predictions in observational data.[35,36] In this study, generalized linear models (for linear relationships), generalized additive models (for non-linear relationships), gradient boosting models (for more complex relationships), and neural networks (for more complex relationships) were used for the candidate algorithms.[34] We used five-fold cross-validation for the predictions. All statistical analyses other than random forest imputation were conducted using R software, version 4.0.5, for Windows. Random forest imputation was performed using Python, version 3.8.3. Ethical approval was obtained from the Ethics Committee of Yamagata University (No. 2022–34). The requirement for informed consent was waived because of the anonymous nature of the data.

RESULTS

The characteristics of the patients in this study are shown in **Table 1**. About 55.0% were men, and the mean age was 40.6 ± 16.1 years in a total of 404 patients. The majority of the patients did not receive any in-hospital rehabilitation therapy (73.5%). **Table 2** represents the cross-table for the exposure and the outcomes. The BI at discharge was greater in the group with no rehabilitation therapy than in other groups with rehabilitation therapy. Another cross-table showing the type of rehabilitation therapy and the outcomes is shown in **Table 3**. Overall, the BI at discharge and BI gain were greater for the group that claimed the respiratory rehabilitation therapy charge.

Tables 4–9 show the results of our TMLE estimations. When the average daily time of rehabilitation therapy was at least 20 min, there was significantly lower risk of 30-day readmission (OR, 0.25; 95% CI, 0.06–0.98) and 45-day readmission (OR, 0.16; 95% CI, 0.04–0.64) when compared with the use of no rehabilitation therapy. Conversely, provided that the average daily time of rehabilitation therapy was at least 20 min, BI scores were lower at discharge (coefficient, −15.91; 95% CI, −30.07 to −1.75) and BI gain was lower (coefficient, −12.56; 95% CI, −25.60 to 0.47) when compared with the use of no rehabilitation therapy, although the latter was not statistically significant. When the average daily time of rehabilitation therapy was less than 20 min, the length of hospital stay was significantly longer when compared with the use of no rehabilitation therapy (coefficient, 5.93; 95% CI, 1.24−10.63). No additive effect of rehabilitation therapy was observed for 30-day readmission, whereas the additive impact of providing an average of at least 20 min/day of rehabilitation therapy was observed for 45-day readmission (OR, 0.39; 95% CI, 0.21–0.73). A curtailment effect of reha-

Table 1. Patient characteristics analyzed in this study (n=404)

Characteristic	n (%)
Men	222 (55.0%)
Age (years)	40.6 (16.1)
Nursing home resident	
Yes	101 (25.0%)
Hospital Frailty Score	
<5	258 (63.9%)
5–15	92 (22.8%)
≥16	54 (13.4%)
Supplemental nasogastric feeding, parenteral nutrition, or intravenous infusion at admission	
Yes	13 (3.2%)
Overweight	
Yes	129 (31.9%)
Underweight	
Yes	82 (19.6%)
Barthel Index at admission	
Dependent (<100)	68 (16.8%)
Admission by ambulance	
Yes	87 (21.5%)
A-DROP	
Mild (0)	146 (36.1%)
Moderate (1,2)	234 (57.9%)
Severe (3)	18 (4.5%)
Extremely severe (4,5)	6 (1.5%)
ICU admission	
Yes	35 (8.7%)
Number of hospital beds	
<200	43 (10.6%)
200–499	231 (57.2%)
≥500	130 (32.2%)
Medical resource input per day within 7 days of hospitalization (JPY)	9884.3 (9657.7)
Rehabilitation medicine started within 2 days of admission	
Yes	51 (12.6%)
Respiratory rehabilitation medicine charge was claimed	
Yes	68 (16.8%)
Dysphasia rehabilitation medicine charge was claimed	
Yes	31 (7.7%)
Average daily units of rehabilitation medicine	
None	297 (73.5%)
<20 min	74 (18.3%)
≥20 min	33 (8.2%)

Data given as number (percentage) or mean [standard deviation (SD)].

bilitation therapy was observed for BI at discharge as well as for BI gain. However, there was no statistical difference in length of hospital stay in the estimation of scenarios 4 and 5.

Table 5 shows the results of our secondary analysis in which exposure was changed to the variable of whether the respiratory rehabilitation charge was claimed. Patients who

Table 2. Cross-table for average daily rehabilitation time and outcomes

Outcome	Average daily time of rehabilitation therapy None n=297	<20 min n=74	≥20 min n=33	P value
30-day readmission				
No	280 (94.3%)	71 (95.9%)	32 (97.0%)	0.71
Yes	17 (5.7%)	3 (4.1%)	1 (3.0%)	
45-day readmission				
No	279 (93.9%)	69 (93.2%)	32 (97.0%)	0.74
Yes	18 (6.1%)	5 (6.8%)	1 (3.0%)	
Barthel Index at discharge	51.5 (39.3)	33.9 (37.2)	29.1 (33.3)	<0.001
Difference in Barthel Index between admission and discharge	4.9 (22.0)	7.4 (23.2)	0.9 (20.5)	0.36
Length of hospital stay (days)	11.0 (14.3)	25.6 (17.6)	14.3 (8.3)	<0.001

Data given as number (percentage) or mean (SD).

Table 3. Cross-table for claim of respiratory rehabilitation charge and outcomes

Outcome	Claim for respiratory rehabilitation charge No (n=39)	Yes (n=68)	P value
30-day readmission			
No	37 (95%)	66 (97%)	0.57
Yes	2 (5%)	2 (3%)	
45-day readmission			
No	36 (92%)	65 (96%)	0.48
Yes	3 (8%)	3 (4%)	
Barthel Index at discharge	19.5 (29.6)	39.9 (37.4)	0.004
Difference in Barthel Index between admission and discharge	0.6 (13.7)	8.2 (26.0)	0.096
Length of hospital stay (days)	21.2 (16.1)	22.6 (16.4)	0.65

Data given as number (percentage) or mean (SD).

claimed the respiratory rehabilitation therapy payment had significantly higher BI at discharge (coefficient, 11.36; 95% CI, 1.06–21.67) and significantly higher BI gain (coefficient, 9.75; 95% CI, 0.78–18.72) compared with patients who underwent other rehabilitation. **Tables 6–9** show the results of our sensitivity analyses in which we excluded patients with severe pneumonia or those with independent daily living at admission. The results also supported our primary analyses.

DISCUSSION

This study examined the outcomes of in-hospital rehabilitation therapy in adult DS patients hospitalized for CAP. We found that over 70% of patients did not receive rehabilitation therapy. Even when rehabilitation therapy was provided, it averaged less than 20 min per day. Patients who received rehabilitation therapy had poorer discharge outcomes for activities of daily living and length of hospital stay than patients who received no rehabilitation therapy. We also found that patients that claimed respiratory rehabilitation therapy charges had better activities of daily living than those that claimed other rehabilitation charges.

We have hypothesized the following reasons for the low rate of rehabilitation therapy in adult DS patients hospitalized for CAP. The Japan Society for Respiratory Care Rehabilitation defined respiratory rehabilitation in a statement published in 2018 as "an individualized, comprehensive intervention to help patients with respiratory-related illnesses to manage their illnesses in a collaborative partnership with their healthcare providers to prevent disease progression or restore and maintain their health as much as possible, and to continue to support them over their disability to become

Table 4. Effects of average rehabilitation time on outcomes

	Odds ratio/difference	95% Confidence interval	P value
30-day readmission			
Scenario 1, none	Ref.		
Scenario 2, <20 min/day	0.30[a]	0.05–1.67	0.169
Scenario 3, ≥20 min/day	0.25[a]	0.06–0.98	0.047
Originally observed data	Ref.		
Scenario 4, none to <20 min/day	0.45[a]	0.13–1.61	0.220
Scenario 5, none to ≥20 min/day	0.48[a]	0.18–1.24	0.129
45-day readmission			
Scenario 1, none	Ref.		
Scenario 2, <20 min/day	0.57[a]	0.12–2.62	0.471
Scenario 3, ≥20 min/day	0.16[a]	0.04–0.64	0.009
Originally observed data	Ref.		
Scenario 4, none to <20 min/day	0.48[a]	0.15–1.51	0.210
Scenario 5, none to ≥20 min/day	0.39[a]	0.21–0.73	0.003
Barthel Index at discharge			
Scenario 1, none	Ref.		
Scenario 2, <20 min/day	−3.69	−19.02 to 11.64	0.637
Scenario 3, ≥20 min/day	−15.91	−30.07 to −1.75	0.028
Originally observed data	Ref.		
Scenario 4, none to <20 min/day	−4.09	−8.92 to 0.73	0.096
Scenario 5, none to ≥20 min/day	−13.82	−24.17 to −3.48	0.009
Difference in Barthel Index between admission and discharge			
Scenario 1, none	Ref.		
Scenario 2, <20 min/day	−1.33	−13.60 to 10.94	0.832
Scenario 3, ≥20 min/day	−12.65	−26.60 to 1.30	0.075
Originally observed data	Ref.		
Scenario 4, none to <20 min/day	−2.92	−6.41 to 0.57	0.101
Scenario 5, none to ≥20 min/day	−12.56	−25.60 to 0.47	0.059
Length of hospital stay			
Scenario 1, none	Ref.		
Scenario 2, <20 min/day	5.93	1.24–10.63	0.013
Scenario 3, ≥20 min/day	1.46	−1.49 to 4.41	0.332
Originally observed data	Ref.		
Scenario 4, none to <20 min/day	3.78	−1.25 to 8.81	0.140
Scenario 5, none to ≥20 min/day	0.27	−1.99 to 2.52	0.815

[a] Odds ratio given.

Scenario 1, No patients received rehabilitation therapy; scenario 2, All patients received <20 min/day rehabilitation therapy; scenario 3, All patients received ≥20 min/day rehabilitation therapy; scenario 4, What if patients who did not receive any rehabilitation therapy received <20 min/day; scenario 5, What if patients who did not receive any rehabilitation therapy received ≥20 min/day.

independent."[37)] In the statement, recommended respiratory rehabilitation therapy consists of improving or maintaining physical functions and activities of daily living, which is also recommended in other guidelines.[38,39)] Those statements mainly focused on patients with chronic obstructive pulmonary disease. Therefore, there is no clear recommendation regarding rehabilitation therapy for patients with CAP. This is one of the reasons that the majority of patients analyzed in this study did not receive rehabilitation therapy, and when they did receive therapy, it was for a short duration.

Table 5. Type of rehabilitation medicine provided effect on outcomes

Whether respiratory rehabilitation was claimed	Odds ratio/difference	95% Confidence interval	P value
30-day readmission			
No	Ref.		
Yes	2.94[a]	0.34–25.29	0.325
45-day readmission			
No	Ref.		
Yes	2.36[a]	0.33–17.12	0.395
Barthel Index at discharge			
No	Ref.		
Yes	11.36	1.06–21.67	0.031
Difference in Barthel Index between admission and discharge			
No	Ref.		
Yes	9.75	0.78–18.72	0.033
Length of hospital stay			
No	Ref.		
Yes	5.25	−3.25 to 13.75	0.226

[a] Odds ratio given.

A previous randomized controlled trial (RCT) reported that respiratory rehabilitation therapy based on 50 min of exercise therapy was efficient in improving physical function in patients with CAP.[15] However, in our study, patients who received rehabilitation therapy had significantly poorer BI scores at discharge and the BI score gain was lower compared with those who did not receive rehabilitation therapy. The following points might explain the discrepancy. First, most patients included in our study received less than 20 min of rehabilitation therapy per day, which was relatively shorter than the program used in the previous RCT.[15] Second, there is a possibility that multifaceted inpatient care for these patients was not provided even though patients with DS are more likely to have respiratory issues, immune system deficiency, frailty, disability, intellectual disability, and oral dysfunction.[9–13] In addition, 39 patients in this study did not receive appropriate respiratory rehabilitation therapy from specialists, which may have affected the results. Those patients who claimed payment for respiratory rehabilitation had greater BI score gains than those who received other rehabilitation payments (**Table 5**). Therefore, a system in which respiratory specialists can provide rehabilitation therapy of sufficient intensity to improve discharge outcomes is considered necessary.

Although most of the outcomes for rehabilitation therapy in this study were poorer than in other studies, 30-day and 45-day readmissions were lower in the rehabilitation therapy group. The results were similar to those of previous studies targeting pneumonia and chronic obstructive pulmonary disease.[40,41] However, our analysis showed that patients who had undergone respiratory rehabilitation therapy spent more time in hospital. In addition to the benefits of educating patients and their families, we consider that a more systematic, efficient, and comprehensive rehabilitation regimen for DS patients hospitalized for CAP will contribute to improved outcomes on each measure.[38,39]

This study has several limitations. First, this study is a retrospective observational study, indicating that the study may be affected by unknown confounders. Therefore, future studies on this topic should include a RCT. Second, we could not identify detailed information on the rehabilitation programs. In particular, some patients in this study were billed for claims other than respiratory rehabilitation charges because rehabilitation programs offered across hospitals are not completely standardized and may differ between hospitals. Therefore, further studies are warranted to explore the detailed reason that patients with pneumonia were not provided with specialized respiratory rehabilitation. Investigation of whether the status of rehabilitation charges differs between patients and the general population is necessary. Third, the generalizability of our study results with other countries may be limited because of differences between medical care systems. Fourth, we did not examine the effect of dysphasia rehabilitation therapy on the outcomes of DS patients but treated them as a covariate and adjusted our model. Therefore, future studies are warranted to examine the effect of

Table 6. Sensitivity analysis that excluded patients with severe pneumonia

	Odds ratio/difference	95% Confidence interval	P value
30-day readmission			
Scenario 1, none	Ref.		
Scenario 2, <20 min/day	0.22[a]	0.04–1.10	0.066
Scenario 3, ≥20 min/day	0.24[a]	0.06–0.97	0.045
Originally observed data	Ref.		
Scenario 4, none to <20 min/day	0.48[a]	0.09–2.52	0.383
Scenario 5, none to ≥20 min/day	0.40[a]	0.14–1.16	0.090
45-day readmission			
Scenario 1, none	Ref.		
Scenario 2, <20 min/day	0.35[a]	0.09–1.42	0.142
Scenario 3, ≥20 min/day	0.30[a]	0.06–1.44	0.132
Originally observed data	Ref.		
Scenario 4, none to <20 min/day	0.43[a]	0.14–1.34	0.145
Scenario 5, none to ≥20 min/day	0.42[a]	0.16–1.10	0.076
Barthel Index at discharge			
Scenario 1, none	Ref.		
Scenario 2, <20 min/day	−6.79	−13.48 to −0.11	0.046
Scenario 3, ≥20 min/day	−21.60	−28.29 to −14.91	<0.001
Originally observed data	Ref.		
Scenario 4, none to <20 min/day	−4.26	−9.18 to 0.66	0.089
Scenario 5, none to ≥20 min/day	−15.31	−24.97 to −5.66	0.002
Difference in Barthel Index between admission and discharge			
Scenario 1, none	Ref.		
Scenario 2, <20 min/day	−7.29	−15.70 to 1.13	0.090
Scenario 3, ≥20 min/day	−18.48	−32.13 to −4.83	0.008
Originally observed data	Ref.		
Scenario 4, none to <20 min/day	−3.19	−7.60 to 1.21	0.155
Scenario 5, none to ≥20 min/day	−15.38	−27.98 to −2.78	0.017
Length of hospital stay			
Scenario 1, none	Ref.		
Scenario 2, <20 min/day	4.71	0.31–9.10	0.036
Scenario 3, ≥20 min/day	0.88	−1.86 to 3.61	0.530
Originally observed data	Ref.		
Scenario 4, none to <20 min/day	4.39	0.53–8.25	0.026
Scenario 5, none to ≥20 min/day	1.25	−1.31 to 3.81	0.339

[a] Odds ratio given.

Scenario 1, No patients received rehabilitation therapy; scenario 2, All patients received <20 min/day rehabilitation therapy; scenario 3, All patients received ≥20 min/day rehabilitation therapy; scenario 4, What if patients who did not receive any rehabilitation therapy received <20 min/day; scenario 5, What if patients who did not receive any rehabilitation therapy received ≥20 min/day.

dysphasia rehabilitation therapy on the outcomes of patients with DS. Fifth, we used the cross-validation approach for model specification in a study with a small sample size. Therefore, our estimates might cause model underfitting. Future studies with large samples are needed.

CONCLUSION

We used medical claims data from across Japan to examine the impact of in-hospital rehabilitation therapy on the outcomes at discharge in DS patients who were hospitalized

Table 7. Sensitivity analysis that excluded patients with independent activities of daily living

	Odds ratio/difference	95% Confidence interval	P value
30-day readmission			
Scenario 1, none	Ref.		
Scenario 2, <20 min/day	0.27[a]	0.06–1.25	0.094
Scenario 3, ≥20 min/day	0.26[a]	0.09–0.76	0.015
Originally observed data	Ref.		
Scenario 4, none to <20 min/day	0.32[a]	0.08–1.32	0.116
Scenario 5, none to ≥20 min/day	0.34[a]	0.16–0.71	0.004
45-day readmission			
Scenario 1, none	Ref.		
Scenario 2, <20 min/day	0.49[a]	0.11–2.16	0.344
Scenario 3, ≥20 min/day	0.26[a]	0.09–0.79	0.017
Originally observed data	Ref.		
Scenario 4, none to <20 min/day	0.53[a]	0.17–1.58	0.254
Scenario 5, none to ≥20 min/day	0.40[a]	0.20–0.80	0.009
Barthel Index at discharge			
Scenario 1, none	Ref.		
Scenario 2, <20 min/day	−5.48	−12.16 to 1.20	0.108
Scenario 3, ≥20 min/day	−12.47	−16.92 to −8.01	<0.001
Originally observed data	Ref.		
Scenario 4, none to <20 min/day	−3.66	−8.34 to 1.02	0.126
Scenario 5, none to ≥20 min/day	−4.65	−8.43 to −0.88	0.016
Difference in Barthel Index between admission and discharge			
Scenario 1, none	Ref.		
Scenario 2, <20 min/day	−5.02	−11.13 to 1.09	0.108
Scenario 3, ≥20 min/day	−7.80	−12.12 to −3.47	<0.001
Originally observed data	Ref.		
Scenario 4, none to <20 min/day	−3.34	−6.71 to 0.03	0.052
Scenario 5, none to ≥20 min/day	−2.41	−7.44 to 2.63	0.349
Length of hospital stay			
Scenario 1, none	Ref.		
Scenario 2, <20 min/day	5.84	0.04–11.29	0.035
Scenario 3, ≥20 min/day	0.64	−3.46 to 4.74	0.759
Originally observed data	Ref.		
Scenario 4, none to <20 min/day	4.22	−0.30 to 8.73	0.067
Scenario 5, none to ≥20 min/day	2.20	−0.36 to 4.76	0.092

[a] Odds ratio given.

Scenario 1, No patients received rehabilitation therapy; scenario 2, All patients received <20 min/day rehabilitation therapy; scenario 3, All patients received ≥20 min/day rehabilitation therapy; scenario 4, What if patients who did not receive any rehabilitation therapy received <20 min/day; scenario 5, What if patients who did not receive any rehabilitation therapy received ≥20 min/day.

for CAP. No benefits were observed for activities of daily living and length of hospital stay. Given that individuals with DS are more prone to poor clinical outcomes, future studies are warranted to develop a systematic, efficient, and comprehensive rehabilitation regimen in terms of type, duration, and intensity for DS patients with CAP.

Table 8. Sensitivity analysis of secondary analysis that excluded patients with severe pneumonia

Whether respiratory rehabilitation was claimed	Odds ratio/difference	95% Confidence interval	P value
30-day readmission			
No	Ref.		
Yes	2.20[a]	0.30–16.00	0.436
45-day readmission			
No	Ref.		
Yes	2.55[a]	0.54–11.97	0.237
Barthel Index at discharge			
No	Ref.		
Yes	9.46	−1.98 to 20.91	0.105
Difference in Barthel Index between admission and discharge			
No	Ref.		
Yes	9.61	1.70–17.52	0.017
Length of hospital stay			
No	Ref.		
Yes	4.28	−3.14 to 11.70	0.258

[a] Odds ratio given.

Table 9. Sensitivity analysis of secondary analysis that excluded patients with independent activities of daily living

Whether respiratory rehabilitation was claimed	Odds ratio/difference	95% Confidence interval	P value
30-day readmission			
No	Ref.		
Yes	3.30[a]	0.44–24.44	0.243
45-day readmission			
No	Ref.		
Yes	2.13[a]	0.27–16.56	0.468
Barthel Index at discharge			
No	Ref.		
Yes	8.66	−6.03 to 23.35	0.248
Difference in Barthel Index between admission and discharge			
No	Ref.		
Yes	6.25	−3.91 to 16.41	0.228
Length of hospital stay			
No	Ref.		
Yes	4.62	−3.69 to 12.94	0.276

[a] Odds ratio given.

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CONFLICTS OF INTEREST

Authors T.I and M.K. each have a son born with Down's Syndrome. The authors declare no conflict of interest.

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