



# Relationship Between Start of Feeding and Functional Outcome in Aspiration Pneumonia: A Retrospective Cohort Study

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Received: August 2, 2022 / Accepted: September 26, 2022 / Published online: October 13, 2022  
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## ABSTRACT

**Introduction:** Aspiration pneumonia is the predominant form of pneumonia in the elderly. Low oral intake levels and malnutrition have been reported to be associated with increased mortality and loss of function in aspiration pneumonia. However, the relationship between start of feeding and readmission, which is associated with malnutrition and low oral intake levels, has not been reported. The purpose of this study was to clarify the relationship between start of feeding and functional prognosis in aspiration pneumonia.

**Methods:** Patients' basic information, comorbidities, severity of pneumonia, swallowing function, time from admission to the start of feeding, geriatric nutritional risk index (GNRI), readmission, and Barthel index (BI) were evaluated in 160 patients. The patients were divided into two groups—a readmission group and a non-readmission group—and statistical verification was performed.

**Results:** The readmission group was 62 cases (38.8%). Univariate analysis showed that the time from admission to the start of feeding was significantly longer in the readmission group ( $p < 0.001$ ). Age was significantly higher and nutrition parameters were lower in the readmission group ( $p = 0.001, 0.006$ ). Furthermore, according to logistic regression analysis, readmission was associated with age (odds ratio, 1.063;  $p = 0.007$ ; 95% confidence interval (CI) 1.017–1.111) and time from admission to the start of feeding (odds ratio 1.080;  $p < 0.001$ ; 95% CI 1.025–1.137).

**Conclusion:** The time from admission to the start of feeding was significantly longer in the readmitted patients. A comprehensive intervention with multidisciplinary collaboration should be performed from the early stage of hospitalization.

**Trial Registration:** This study is registered in the UMIN-Clinical Trials Registry (UMIN-CTR). UMIN-CTR meets the criteria of the International Committee of Medical Journal Editors (ICMJE). (Registration number: 000047141).

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## PLAIN LANGUAGE SUMMARY

Aspiration pneumonia is the predominant form of pneumonia in the elderly. Low oral intake levels and malnutrition have been reported to

be associated with increased mortality and loss of function in aspiration pneumonia. However, the relationship between start of feeding and readmission, which is associated with malnutrition and low oral intake levels, has not been reported. The purpose of this study was to clarify the relationship between start of feeding and functional prognosis in aspiration pneumonia. Patients' basic information, comorbidities, severity of pneumonia, swallowing function, time from admission to the start of feeding, geriatric nutritional risk index (GNRI), readmission, and Barthel index (BI) were evaluated in 160 patients. The patients were divided into two groups: a readmission group and a non-readmission group. The readmission group was 62 cases (38.8%). Univariate analysis showed that the time from admission to the start of feeding was significantly longer in the readmission group. Age was significantly higher and nutrition parameters were lower in the readmission group. According to logistic regression analysis, readmission was associated with age and time from admission to the start of feeding. The time from admission to the start of feeding was significantly longer in the readmitted patients. A comprehensive intervention with multidisciplinary collaboration should be performed from the early stage of hospitalization. It is necessary to carry out indirect swallowing training from the time of hospitalization, nursing care such as feeding assistance, oral care, and functional training; to periodically evaluate intention; to identify problems by conference; and to decide on a treatment plan.

**Keywords:** Aspiration pneumonia; Readmission; Start of feeding; Nutritional parameters

## Key Summary Points

### *Why carry out this study?*

Low oral intake levels and malnutrition have been reported to be associated with increased loss of function in aspiration pneumonia.

The relationship between the start of feeding and functional prognosis has not been reported.

The purpose of this study was to clarify the relationship between the start of feeding and functional prognosis in aspiration pneumonia.

### *What was learned from this study?*

38.8% of patients hospitalized for aspiration pneumonia were readmitted.

In the readmitted patients, the time from admission to the start of feeding was observed to be significantly delayed.

A comprehensive intervention with multidisciplinary collaboration and early dietary initiation training should be performed from the early stage of hospitalization in order to prevent readmission.

## INTRODUCTION

Aspiration pneumonia is a significant health problem affecting the elderly, with more than 70% of pneumonia cases in this population said to be aspiration pneumonia cases [1]. The mortality rate increases gradually from age 65 and increases precipitously for those aged 85 and older [2]. Important risk factors for aspiration pneumonia include dysphagia caused by cerebrovascular disease, cognitive decline, sarcopenia, and use of multiple antipsychotic agents [3, 4], as well as poor oral hygiene and gastroesophageal reflux [5]. Acute care and

convalescent rehabilitation hospitals provide comprehensive treatment for aspiration pneumonia, as well as multidisciplinary treatment that includes feeding and swallowing rehabilitation, nutritional management, and patient education. However, following hospital discharge, patients do not receive adequate feeding and swallowing rehabilitation or nutritional management opportunities at home [6]. This leads to the recurrence of aspiration pneumonia and repeat hospitalizations, often resulting in a life-threatening condition. Therefore, a seamless approach to dysphagia, which causes aspiration pneumonia, is needed.

There have been reports on the effectiveness of early rehabilitation in aspiration pneumonia and of comprehensive care that includes dysphagia rehabilitation [7, 8], but there have been no reports examining the factors that may affect the readmission of patients with aspiration pneumonia. For this reason, we retrospectively investigated various functions and activities of patients who were hospitalized for aspiration pneumonia. In addition, we investigated causes that may lead to readmission and factors that may affect disease progression in order to identify factors that may help prevent aspiration pneumonia relapse.

The authors have no conflicts of interest in regard to the content of this article.

## METHODS

### Subjects

Of the 178 patients aged 20 years or older who were admitted to our hospital for aspiration pneumonia and underwent rehabilitation between October 1, 2014 and January 31, 2022, 160 patients were included in the study (the 6 patients with missing data and 12 patients with cognitive impairment were not included) (Fig. 1). This study was approved by the Ethics Committee of Nihon University Hospital (approval number 20220103). All subjects provided informed consent to participate in the study. However, due to Japanese ethical guidelines, we outlined our research in the open system, the University Hospital Medical Information

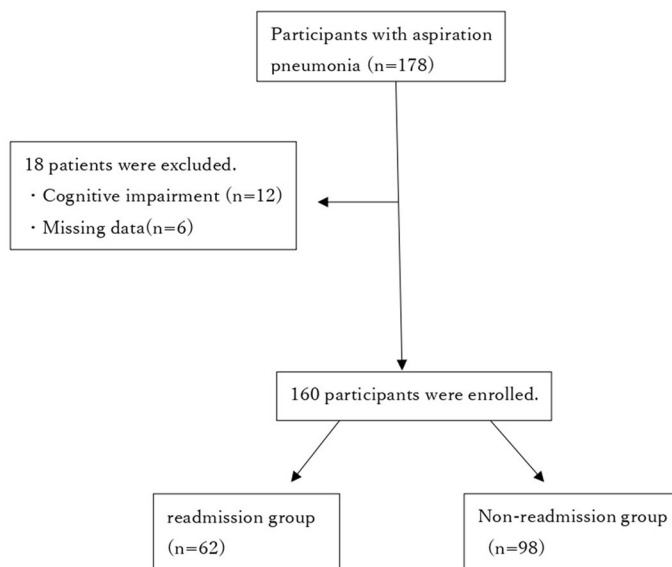
Network, and guaranteed the protection of personal information.

### Methods

The subjects' medical records were analyzed retrospectively by age, gender, body mass index (BMI), nursing care level, history of respiratory disease, comorbid conditions, pneumonia severity (A-DROP), swallowing function (functional oral intake scale, FOIS), time from admission to the start of feeding, serum albumin levels, geriatric nutritional risk index (GNRI), readmission status, number of readmissions, outcome, and activities of daily living (ADL) at admission and discharge.

The A-DROP scoring system classifies severity of pneumonia based on physical examination and age. The system assesses the following variables: (1) age ( $\geq 70$  years for males and  $\geq 75$  years for females), (2) blood urea nitrogen (BUN)  $\geq 21$  mg/dL or dehydration, (3)  $\text{SpO}_2 \leq 90\%$ , (4) confusion, and (5) systolic blood pressure  $\leq 90$  mmHg. Severity was classified into four stages (mild, moderate, severe, and very severe) based on the number of applicable variables [9].

The level of food consumption was assessed using the FOIS. The FOIS is one indicator reported by Cray et al. that is used to assess nutrient intake levels [10]. The scale is expressed as seven standardized categories ranging from tube dependent to oral intake, and its reproducibility and validity have been verified. ADL was assessed using the Barthel index (BI) [11]. The BI is an ordinal scale that quantifies performance in activities of daily living and evaluates 10 variables on a scale of 2 to 4; these include feeding, transfer (bed to wheelchair and back), grooming, toilet use, bathing, mobility (on level surfaces), stairs, dressing, bowels, and bladder. A higher score indicates a greater ability to perform basic activities of daily living. The Charlson comorbidity index (CCI) was used as a measure of comorbidity. The CCI is a weighted index of multiple comorbid conditions and includes diabetes with chronic complications, heart failure, kidney disease, liver disease, chronic lung disease, dementia, hemiplegia or



**Fig. 1** Flow chart of patient selection

paraplegia, malignant tumors, and AIDS/HIV. A weighting (0, 1, 2, 3, 4, 5 or more) is assigned to each variable, with a higher number indicating a greater number of comorbid conditions [12]. GNRI was calculated using the formula proposed by Bouillanne et al.:  $14.89 \times \text{serum albumin (g/dL)} + \{41.7 \times (\text{current body weight/ideal body weight})\}$  [13].

### Statistical Analysis

Subjects were divided into two groups (a hospital readmission group and a non-readmission group), and survey variables were compared between the two groups. The primary outcome was the time from admission to the start of feeding, and the secondary outcome was FOIS score at discharge. Statistical analysis was performed using the Mann–Whitney *U* test or an unpaired *t* test, and categorical variables were analyzed using the chi-square test. Multiple regression analysis was performed using the time from admission to the start of feeding as a dependent variable and the variables that showed significant difference in the univariate analysis as independent variables. Furthermore, a logistic regression analysis was performed with hospital readmission status as a dependent variable, while the variables that showed a

significant difference in the univariate analysis were designated as independent variables. Statistical analysis was performed with IBM SPSS Statistics version 25 (IBM-SPSS, Inc.) software, with the level of significance set at less than 5%. The sample size was calculated based on the readmission outcome. The readmission rate was 17.25% in the elderly patients. The sample size was estimated as 155 subjects with a confidence level of 90% and an error of 5%. From the results mentioned above, our study verified 160 cases.

## RESULTS

The readmission group was 62 cases (38.8%). The subjects' characteristics are shown in Table 1. The univariate analysis showed significant differences between the two groups in age ( $p = 0.001$ ), BMI ( $p = 0.021$ ), time from admission to the start of feeding ( $p < 0.001$ ), GNRI at admission ( $p = 0.006$ ), and FOIS score at discharge and FOIS change ( $p = 0.002, 0.029$ ).

Upon checking for correlations of the time from admission to the start of feeding with all the other variables, a positive correlation with FOIS change ( $p < 0.01$ ) and a negative correlation with GNRI ( $p < 0.01$ ) were confirmed (Table 2).

**Table 1** Clinical characteristics of the study groups at baseline

	<b>Overall (<i>n</i> = 160)</b>	<b>Readmission group (<i>n</i> = 62)</b>	<b>Non-readmission group (<i>n</i> = 98)</b>	<b><i>p</i> value</b>
Mean age ± SD, y	82.78 ± 9.84	85.87 ± 6.89	80.83 ± 10.91	0.001 <sup>a</sup>
Sex, female, <i>N</i> (%)	61 (38.1)	42 (40.4)	19 (33.9)	0.528 <sup>b</sup>
BMI ± SD (kg/m <sup>2</sup> )	21.69 ± 5.27	20.54 ± 4.46	22.42 ± 5.63	0.021 <sup>a</sup>
CCI, <i>N</i> (%)				
0	20 (12.5)	10 (9.6)	10 (17.9)	0.424 <sup>b</sup>
1	90 (56.2)	62 (59.6)	28 (50.0)	
2	43 (26.9)	27 (26.0)	16 (28.6)	
3	7 (4.4)	5 (4.8)	2 (3.6)	
> 4	0 (0.0)	0 (0.0)	0 (0.0)	
Severity of pneumonia				
A-drop, <i>N</i> (%)				
Mild	24 (15.1)	13 (12.5)	11 (20.0)	0.167 <sup>b</sup>
Moderate	55 (34.6)	32 (30.8)	23 (41.8)	
Severe	65 (40.9)	48 (46.2)	17 (30.9)	
Very severe	15 (9.4)	11 (10.6)	4 (7.3)	
Nutrition status				
GNRI on admission, [IQR]	88.95 [77.69, 94.60]	83.88 [79.90, 91.87]	90.27 [76.07, 96.68]	0.006 <sup>c</sup>
Number of drugs on admission, [IQR]	6 [4, 8]	6 [5, 8]	6 [4, 8]	0.106 <sup>c</sup>
ADL score				
BI on admission [IQR]	30 [17.5, 40]	30 [17.5, 40]	30 [17.5, 41.25]	0.713 <sup>c</sup>
BI at discharge [IQR]	35 [20, 42.5]	30 [20, 40]	35 [20, 45]	0.517 <sup>c</sup>
BI change [IQR]	0 [− 10, 20]	0 [− 10, 16.25]	0 [− 11.25, 20]	0.116 <sup>c</sup>
Assessment of the level of food consumption				
FOIS score at the start of feeding [IQR]	4 [2, 5]	5 [3, 5.25]	3 [0, 4]	0.652 <sup>c</sup>
FOIS score at discharge [IQR]	4 [0, 4]	4 [2.75, 5]	3 [0, 4]	0.002 <sup>c</sup>
FOIS change [IQR]	0 [− 2, 1]	− 1 [− 2, 1]	0 [− 2, 1]	0.029 <sup>c</sup>
From admission to the start of feeding ± SD (days)	5.06 ± 13.16	6.87 ± 18.08	3.91 ± 8.76	< 0.001 <sup>a</sup>

**Table 1** continued

	Overall ( <i>n</i> = 160)	Readmission group ( <i>n</i> = 62)	Non-readmission group ( <i>n</i> = 98)	<i>p</i> value
Rehabilitation staff intervention, <i>n</i> (%)				
Physical therapist	160 (100)	62 (100)	98 (100)	–
Occupational therapist	5	2	3	0.953 <sup>b</sup>
Speech-language pathologist	12	3	9	0.309 <sup>b</sup>
Period from admission to rehabilitation ± SD (days)	4.21 ± 1.24	5.21 ± 2.46	3.98 ± 1.24	0.297 <sup>a</sup>
Length of stay ± SD (days)	26.01 ± 25.39	26.92 ± 28.54	25.59 ± 17.07	0.841 <sup>a</sup>

SD standard deviation; BMI body mass index; CCI Charlson comorbidity index; IQR interquartile range; GNRI geriatric nutritional risk index; ADL activities of daily living; BI Barthel index; FOIS functional oral intake scale

<sup>a</sup>Student's *t* test

<sup>b</sup> $\chi^2$  test

<sup>c</sup>Mann–Whitney *U* test

**Table 2** Spearman's rank correlation coefficients among the factors

	Age	CCI	GNRI	BI change	FOIS change	From admission to the start of feeding
Age	–	– 0.103	– 0.163*	< 0.001	0.0277	0.126
CCI	–	–	0.0322	– 0.0919	– 0.105	– 0.038
GNRI	–	–	–	– 0.23**	– 0.279**	– 0.299**
BI change	–	–	–	–	0.193*	0.133
FOIS change	–	–	–	–	–	0.365**
From admission to the start of feeding	–	–	–	–	–	–

CCI Charlson comorbidity index; GNRI Global Leadership Initiative on Malnutrition; BI Barthel index, FOIS food intake level scale

\**p* < 0.05, \*\**p* < 0.01

Multiple regression analysis revealed that the variable which was significantly associated with the time from admission to the start of feeding was readmission ( $\beta = 0.319$ ;  $p < 0.001$ ; 95% confidence interval (CI) 3.876–11.467) (Table 3). Logistic regression analysis showed that the variables affecting readmission were age (odds ratio 1.063;  $p = 0.007$ ; 95% CI 1.017–1.111) and the time from admission to

the start of feeding (odds ratio 1.080;  $p = 0.004$ ; 95% CI 1.025–1.137) (Table 4).

## DISCUSSION

In the study, it was demonstrated that 38.8% of the patients admitted with aspiration pneumonia were patients who were being readmitted. Also, in those readmitted patients, the time

**Table 3** Multiple linear regression analysis of the time from admission to the start of feeding

	Unstandardized		Standardized $\beta$	<i>p</i> value	95% CI	
	<i>B</i>	SE			Lower	Upper
Age	− 0.077	0.096	− 0.065	0.423	− 0.267	0.113
CCI	− 0.014	1.251	− 0.011	0.991	− 2.485	2.457
GNRI	− 0.008	0.064	− 0.010	0.901	− 0.135	0.119
Readmission	7.671	1.921	0.319	< 0.001	3.876	11.467

**Table 4** Logistic regression analysis for readmission

Variable	Odds ratio	95% CI		<i>p</i> value
		Lower	Upper	
Age	1.063	1.017	1.111	0.007
GNRI	0.973	0.947	1.000	0.052
CCI	1.047	0.633	1.732	0.858
From admission to the start of feeding	1.080	1.025	1.137	0.004

from admission to the start of feeding was observed to be significantly delayed.

Mounayar reported that the readmission rate for community-acquired pneumonia was 17.5%, which was lower than our result [14]. One reason for this may be the higher readmission rate at our hospital, which is an acute care facility. Patients in primary care and whose conditions are difficult to manage or who are at a high risk of developing serious illness visit the hospital for regular treatment as outpatients. This circumstance is considered to be related to the increase in readmission rates. Also, in this study, the readmission group was characterized by a significantly older age ( $p = 0.001$ ) and low GNRI ( $p = 0.006$ ). These results suggest that in elderly and malnourished patients, it is necessary to pay attention to the risk of readmission due to aspiration pneumonia and to perform active pulmonary rehabilitation and enhancement of swallowing function.

The readmission group had significantly higher FOIS at discharge and FOIS change ( $p = 0.002, 0.029$ ). The reason for this was

considered to be that these patients had a higher oral intake level than their actual swallowing function at discharge. Therefore, it was considered possible that the patients had sub-clinical aspiration leading to pneumonia. Regarding FOIS in aspiration pneumonia, there have been several reports on the relationship between survival and oral intake level, and it has been stated that mortality is high when oral intake level is low [15–17]. On the other hand, the relationship between readmission and the level of food consumption in aspiration pneumonia has not been reported. This study showed that the selection of an appropriate feeding style at discharge is necessary to prevent aspiration after discharge.

Nutritional indicators and readmission were significantly lower in the readmission group ( $p = 0.006$ ). Malnutrition has been associated with high readmission and mortality [18–20]. In our study, as in previous reports, undernutrition was associated with a significantly higher risk of repeated hospitalization. Moreover, in the readmission group, the time from admission to the start of feeding was significantly longer, suggesting that nutritional management may not have been adequate during hospitalization in the readmission group. The longer the period between admission and the start of feeding, the higher the risk of undernutrition. Furthermore, if the patient is discharged from the hospital without appropriate nutrition management, the risk of repeated hospitalization due to recurrence of pneumonia resulting from a lack of appropriate nutritional management and feeding methods at home is higher.

There was no significant difference between the two groups in terms of length of stay ( $p = 0.841$ ). Heggstad et al. reported an association

between length of stay and readmission in the elderly, with a higher rate of readmission when length of stay was shorter [21]. In our study, age (odds ratio 1.055; 95% CI 1.001–1.112) and history of respiratory disease (odds ratio 2.815; 95% CI 1.001–1.112) had more influence on readmission than length of stay did.

Secondly, the time from admission to the start of feeding was significantly longer in readmitted patients ( $p < 0.001$ ). On the other hand, FOIS scores at the start of feeding and at discharge were significantly higher in the readmission group. Since FOIS is an assessment of dietary and nutritional status, there is the possibility that patients at high risk of aspiration were not provided with the appropriate food and methods of nutrient intake, and sub-clinical aspiration may have occurred in such patients whose dysphagia was not considered during feeding. This suggested a need for early and appropriate assessment of swallowing function as well as the determination of when to start feeding patients with the appropriate foods and what methods of nutritional intake to use. In our study, the reason for the low number of speech-language pathologist (SLP) interventions (12 cases) may be that the Japanese reimbursement system does not cover the cost of SLP intervention when the main disease is pneumonia. In order to start feeding early, it is necessary to provide appropriate feeding through the intervention of the support team, including the SLP, from an early stage. Further, patients should be given comprehensive training in-hospital in how to swallow, with multidisciplinary collaboration; they should be educated in regard to eating patterns and methods to prevent re-aspiration; and appropriate feeding for each patient should be determined by the time of discharge from hospital. Further, if the meal is started late, a deterioration of the nutritional state is predicted, and functional training for the purpose of endurance strengthening may cause further deterioration of the nutritional state. Therefore, it is not possible to conduct training with a high load. As a result, it was considered that respiratory function and swallowing function could not be strengthened and the risk of readmission might be increased.

Maeda et al. reported the effectiveness of early oral feeding in patients with aspiration pneumonia [22]. In addition, early enteral feeding within 24 to 48 h after hospitalization is associated with decreased tube permeability as well as less activation and release of inflammatory cytokines compared to initiation after 72 h of hospitalization. As such, early enteral feeding has been shown to significantly reduce infectious complications and has a tendency to shorten hospital stay [23]. The results of our study also underline the importance of early oral feeding and demonstrate its potential effectiveness in preventing readmission. However, there are few reports on early oral feeding and dysphagia rehabilitation in patients with aspiration pneumonia. Therefore, further verification and accumulation of knowledge are required to generalize our findings.

This study has some limitations. First, we could not perform a detailed assessment of swallowing function. Further studies should be performed to carefully assess swallowing function and its relationship with diet. It is expected that the risk of readmission to the hospital can be reduced by conducting an appropriate eating function assessment and training to improve swallowing function and nutritional status from an early stage.

Second, evaluations of physical function (such as checking for sarcopenia) and detailed evaluations of cognitive function were insufficient. Additional study of specific interventions for the purpose of equipping patients with self-management skills to prevent hospital readmission for aspiration pneumonia, and study of the effectiveness of such interventions, is needed.

## CONCLUSION

We investigated the factors that may lead to readmission of patients with aspiration pneumonia. Age and history of respiratory disease were identified. The results also showed that the time from admission to the start of feeding was significantly longer in the readmitted patients.

A comprehensive intervention with multidisciplinary collaboration and early dietary



initiation training should be performed from the early stage of hospitalization in order to prevent readmission. More specifically, it is necessary to carry out indirect swallowing training by SLP intervention from the time of hospitalization, nursing care such as feeding assistance, oral care by a dental professional, and functional training by physical and occupational therapists; to periodically evaluate intention; to identify problems by conference; and to decide on a treatment plan.

## ACKNOWLEDGMENTS

The authors would like to thank all the patients and staff in the Nihon University Hospital and Nihon University School of Medicine.

**Funding.** This study was supported in part by JSPS KAKENHI grant number 21K11250. No funding or sponsorship was received for the publication of this article. The authors funded the journal's Rapid Service Fee.

**Authorship.** All named authors meet the International Committee of Medical Journal Editors (ICMJE) criteria for authorship for this article and have given their approval for this version to be published.

**Author Contributions.** Takako Nagai, Hiroshi Uei, and Kazuyoshi Nakanishi contributed equally to the writing of this manuscript.

**Disclosures.** Takako Nagai, Hiroshi Uei, and Kazuyoshi Nakanishi have nothing to disclose.

**Compliance with Ethics Guidelines.** The study protocol was reviewed and approved by the Committee on Ethics and the Institutional Review Board of Nihon University Hospital, and was approved by the Ethics Committee of Nihon University Hospital (approval number 20220103). This study was performed in accordance with the Helsinki Declaration of 1964, and its later amendments. This study was retrospective, the requirement for informed consent was waived. All subjects provided informed

consent to participate and consent to publish in the study.

**Data Availability.** The datasets generated during and analyzed during the current study are available from the corresponding author on reasonable request.

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