JAMDA xxx (2019) 1–6

JAMDA

journal homepage: www.jamda.com

Original Study

The Global Leadership Initiative on Malnutrition–Defined Malnutrition Predicts Prognosis in Persons With Stroke-Related Dysphagia

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Keywords:
Dysphagia
global leadership initiative on malnutrition
swallowing rehabilitation
IDDSI
IDDSI-FDS

A B S T R A C T

Objective: This study aimed to clarify the association between malnutrition and improvement of swallowing ability during rehabilitation of stroke patients.
Design: This was a retrospective cohort study.
Setting and participants: One hundred eighty-eight older adults with oropharyngeal dysphagia after stroke who were admitted to a rehabilitation hospital.
Methods: The International Dysphagia Diet Standardization Initiative Functional Diet Scale (IDDSI-FDS) was used to assess swallowing ability. The Global Leadership Initiative on Malnutrition (GLIM) definition was used to diagnose malnutrition. The primary outcome was IDDSI-FDS score at discharge.
Results: The mean age of the patients was 78.9 ± 7.7 years, and 36.7% were women. A total of 122 (64.8%) patients were diagnosed with malnutrition. Compared with those without malnutrition, malnourished patients had more severe dysphagia on admission. After adjusting for confounders, malnutrition was an independent contributor to the IDDSI-FDS scores at discharge (standardized coefficient: −0.165, $P = .011$).
Conclusion and implications: In patients with oropharyngeal dysphagia after stroke, malnutrition at admission inversely affected their swallowing ability at discharge. Dysphagia rehabilitation, including early nutritional intervention, may be effective in the recovery of swallowing ability.

Oropharyngeal dysphagia is highly prevalent in individuals with stroke, neurodegenerative disease, dementia, and older adults.[1] In particular, after stroke, the incidence is reported to be 11% to 50%.[2] It is associated with aspiration pneumonia, choking, and malnutrition.[1,3,4] An article described that oropharyngeal dysphagia is estimated to affect up to 8% of the global population.[5] More recently, oropharyngeal dysphagia is considered to be one of the geriatric syndromes.[6] Sarcopenia and muscle function are known determinants of malnutrition in older adults[7] and have been considered to be possible etiologies for oropharyngeal dysphagia in geriatric patients.[8–10] Furthermore, in patients with oropharyngeal dysphagia who had a stroke, those presenting with low skeletal muscle mass were reported to experience more severe dysphagia,[11] suggesting a possible association between sarcopenia and dysphagia after stroke.

Texture-modified diets (TMDs) and thick liquids are usually provided to patients with oropharyngeal dysphagia.[3] However, TMD has a lower energy and protein content compared with normal diets.[12] Older adult patients on TMD have been found to have a high prevalence of malnutrition and reduced skeletal muscle mass.[12,13] Furthermore, excessive use of TMD in patients with oropharyngeal dysphagia is associated with a lower health-related quality of life.[14] Additionally, long-term TMD consumption may adversely affect not only nutritional status and muscle mass but also the quality of life in oropharyngeal dysphagia patients. Therefore, for patients with oropharyngeal dysphagia in the clinical and rehabilitative settings,

This research received a grant from the Japan Society for the Promotion of Science (Grant no.: 18K11142).

The authors declared no conflicts of interest.

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https://doi.org/10.1016/j.jamda.2019.07.008
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effective rehabilitation training to improve swallowing ability is particularly important.

Several previous studies have reported on the relationship between nutritional status and functional improvement in patients with stroke.[15–18] Additionally, the risk of malnutrition at admission has been found to be a predictor of failure to withdraw from tube feeding, indicating severe dysphagia after stroke.[18] Malnutrition in patients with stroke has been found to be a risk factor for mortality and extended hospital stays.[19,20] Therefore, the early identification of malnutrition in patients with stroke and the provision of nutritional interventions may improve the swallowing ability. However, only a few studies have investigated the association between malnutrition and improvement of swallowing ability in patients with oropharyngeal dysphagia after stroke.[18,21] The present study aimed to clarify the association between malnutrition at admission and improvement in swallowing ability during rehabilitation training in patients with oropharyngeal dysphagia after stroke.

Methods

Participants

This retrospective cohort study was conducted in patients aged ≥65 years who were admitted to the rehabilitation wards of Hamamatsu City Rehabilitation Hospital between March 2016 and May 2018, following stroke. This hospital has 225 beds and provides medical and rehabilitative care for individuals with post-acute conditions necessitating rehabilitation in a city with a population of approximately 800,000, of which 26.1% are aged ≥65 years. Patients who were discharged within 30 days because of a low likelihood of changes in swallowing ability, and those who were transferred to acute-care hospitals for treatment of other new diseases after hospitalization, were excluded. In this study, an International Dysphagia Diet Standardization Initiative Functional Diet Scale (IDDSI-FDS) score of <5 indicated dysphagia risk.[22] Therefore, patients with an IDDSI-FDS scores of ≥5, which did not indicate dysphagia, were excluded. Finally, patients aged ≥65 years who developed oropharyngeal dysphagia after acute stroke and completed a rehabilitation program were studied. This study was approved by the ethics committee of the Hamamatsu City Rehabilitation Hospital (ID: 18-23). Because this study was retrospective in nature, we could not obtain written informed consent; therefore, instead of exempting written informed consent, we guaranteed the participants the right to withdraw from the study using an opt-out procedure by notifications through websites and bulletin boards of the hospital.

Data Collection

The data were obtained retrospectively from medical records by 2 reviewers. The collected variables were age, sex, current type and history of stroke, comorbidities, oral condition, height, body weight, body mass index (BMI), Mini Nutritional Assessment–Short From,[23] activities of daily living, nutritional intake, and length of hospital stay. Muscle mass was evaluated using the skeletal muscle mass index (SMI). Height, body weight, and activities of daily living were measured and assessed within 3 days after admission. Comorbidity was evaluated using the Charlson Comorbidity Index (CCI).[24] The CCI, which consists of 19 comorbid conditions including diabetes, congestive heart failure, and renal disease, is scored from 1 to 6. A higher CCI score indicates several comorbidities associated with mortality. The oral condition was evaluated using the Oral Health Assessment Tool (OHAT),[25] and was assessed by trained nurses. The OHAT is an oral condition assessment tool consisting of 8 oral health domains, namely, lips, tongue, gums and tissues, saliva, natural teeth, dentures, oral cleanliness, and dental pain, and is scored from 0 to 16. A higher OHAT score indicates a poor oral condition.[25] BMI was calculated using the formula: body weight (kg)/[height (m)]^2. The Mini Nutritional Assessment-Short Form is a valid nutritional screening scale, comprising 6 domains with values ranging from 0 to 14 points.[23] Activities of daily living were evaluated using the Functional Independence Measure (FIM),[26] and were assessed by physical or occupational therapists. The FIM consists of motor domains (motor FIM) and cognitive domains (cognitive FIM) and is scored from 18 to 126. A lower FIM score indicates higher levels of inactivity.[27] Nutritional intake was measured by the nurses using the visual estimation method, and calculations were performed by dietitians, based on the dietary intake record. The nutritional intake for 7 days from admission, and for 7 days until discharge, was obtained separately. The nutritional intake per day was calculated by measuring the mean intake for 7 days divided by the weight (in kilograms). Muscle mass was evaluated from SMI. Estimated SMI was calculated based on the appendicular skeletal muscle mass (ASM) using a validated equation.[28]

$$\mathrm{ASM[kg]} = 0.193 \times \text{body weight} + 0.107 \times \text{height} - 4 : 157 \times \text{sex}(\text{men} = 1, \text{women} = 2) - 0.037 \times \text{age} - 2.631.$$

$$\mathrm{SMI}\left[\mathrm{kg}/\mathrm{m}^2\right] = \mathrm{ASM[kg]}/(\mathrm{height[m]})^2.$$

Global Leadership Initiative on Malnutrition Definition of Malnutrition

Malnutrition was assessed using the criteria of the Global Leadership Initiative on Malnutrition (GLIM) definition,[7] which is based on phenotypic criteria including change in body weight, low BMI, and reduced muscle mass, as well as etiologic criteria including reduced food intake or assimilation, and disease burden. The GLIM definition includes 2 steps: First, a validated nutritional risk screening tool is used to identify individuals at risk of malnutrition. Second, for people at risk of malnutrition, malnutrition is defined by at least the detection of 1 phenotypic and 1 etiologic criterion. In this study, the risk of malnutrition was evaluated by a dietician using the Mini Nutritional Assessment–Short Form as an initial screening tool. Phenotypic criteria included 3 items, namely, change in body weight (>5% weight loss within past 6 months, or >10% weight loss beyond 6 months), low BMI (<18.5 if < 70 years, or <20 if > 70 years), and reduced muscle mass (SMI <6.70 in men, SMI <4.75 in women).[29] Etiologic criteria include 2 items, namely, reduced food intake/assimilation problems (≤50% of energy requirements for >1 week, or any reduction for >2 weeks), owing to any chronic gastrointestinal condition (dysphagia and nausea, among others) that adversely impacted food assimilation or absorption, and disease burden (eg, cancer or chronic diseases).

Swallowing Ability Measurements

Swallowing ability was assessed using the IDDSI-FDS (Figure 1).[22] The IDDSI-FDS is a new scale that assesses swallowing ability, and focuses on food textures and thickness of fluids consumed by patients on a daily basis. The scale was developed based on the IDDSI framework.[5,30] The IDDSI framework has 8 stages, including liquid thickness and food texture. IDDSI levels of the food and liquids provided at Hamamatsu City Rehabilitation Hospital were tested according to the methods provided by the IDDSI (official website: www.iddsi.org). The IDDSI-FDS is validated, and the probability of having an IDDSI-FDS score of <5 is significantly higher in individuals with dysphagia.[22] Therefore, in this study, patients with an IDDSI-FDS score of ≥5 were not considered to have dysphagia.

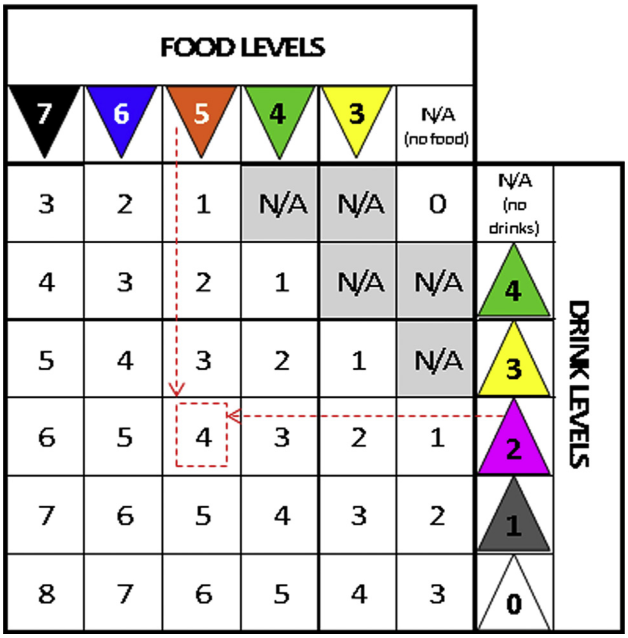

Fig. 1. Scoring chart for the IDDSI Functional Diet Scale. To determine the IDDSI-FDS score for a patient, a clinician must find the intersecting cell for the column showing the patient's food texture recommendation, and the row showing the patient's drink consistency recommendation. For example, if a patient has a recommendation for level 5 (minced and moist food texture) foods and level 2 (mildly thick drinks) drinks, the intersecting cell shows an IDDSI Functional Diet Scale score of 4, as indicated by the dashed line, arrows, and square. N/A, not applicable. (Source: Steele CM, Namasivayam-MacDonald AM, Guida BT, et al. Creation and initial validation of the International Dysphagia Diet Standardisation Initiative Functional Diet Scale. Arch Phys Med Rehabil 2018; 99:934–944, based on CC BY license permission [http://creativecommons.org/licenses/by/4.0/]).

Main Outcome Measurements

The primary outcome was the IDDSI-FDS score at discharge. The IDDSI-FDS scores at admission and discharge were assessed by a registered dietitian. The IDDSI-FDS consists of 6 levels for food (ranging from no food to the normal texture of food) and drink (no drink to thin drinks), respectively, and is scored from 0 to 8.[22] The IDDSI-FDS score is 0 points if the patient is only tube fed or is receiving parenteral nutrition, and 8 points when the food level is normal and the drink level is thin. The secondary outcome was the improvement rate (IDDSI-FDS score $\geq$5 at discharge).

Sample Size Calculation

The sample size was calculated using the Power and Sample Size Calculation software ver. 3.0 (Department of Biostatistics, Vanderbilt University, Nashville, TN) program. Our unpublished data obtained prior to the study period, for patients aged $\geq$65 years with oropharyngeal dysphagia after stroke, revealed that the mean and standard deviation of the IDDSI-FDS score at discharge were 5.2 and 2.4, respectively. In view of these results, this study required 182 or more participants. We calculated the sample size that could detect the difference in 1 IDDSI-FDS score unit at discharge between groups, with 80% power and a 5% α error, assuming a 1:1 ratio on the number of participants between groups.

Statistical Analysis

All statistical analyses were performed using the SPSS 21.0 software (IBM Japan, Tokyo, Japan) package. Categorical variables were expressed as the number of patients (percentage), and quantitative variables, including parametric and nonparametric values evaluated by the histogram, were expressed as mean $\pm$ standard deviation and median (interquartile range), respectively. Comparisons between groups were made using the χ^2 test and Mann-Whitney *U* test for categorical variables and quantitative variables, respectively. Analysis of covariance was performed to determine the factors independently related to the IDDSI-FDS at discharge, using the forced entry method. Variables related to swallowing ability, such as age, sex, length of hospital stay, type and history of stroke, CCI, OHAT, total FIM score, and IDDSI-FDS score at admission, were used as covariates in the analysis of covariance. Furthermore, a multivariate logistic regression analysis was performed to determine the factors independently related to the improvement of dysphagia at discharge, using the forced

Table 1
Patients' Baseline Characteristics

	Overall (n = 188)	Intact (n = 66)	Malnutrition (n = 122)	*P* Value
Age, years	78.9 ± 7.7	77.2 ± 7.6	79.9 ± 7.6	.026
Sex, n (%)				.92
Male	120 (63.8)	43 (65.2)	77 (63.1)	
Female	68 (36.2)	23 (34.8)	45 (36.9)	
Types of stroke, n (%)				.71
Cerebral infarction	115 (61.2)	40 (60.6)	75 (61.5)	
Intracranial hemorrhage	58 (30.9)	22 (33.3)	36 (29.5)	
Subarachnoid hemorrhage	15 (7.9)	4 (6.1)	11 (9.0)	
History of stroke, n (%)				.08
Yes	22 (11.7)	4 (9.2)	18 (14.8)	
No	166 (88.3)	62 (90.8)	104 (85.2)	
CCI, points, median (IQR)	2 (1–2)	2 (1–2)	2 (2–2)	.83
OHAT, points, median (IQR)	2 (1–4)	2 (0.3–4)	2 (1–4)	.34
BMI	20.4 ± 3.0	22.3 ± 2.0	19.4 ± 3.0	<.001
MNA-SF, points, median (IQR)	5 (4–7)	7 (5–9)	5 (3–6)	<.001
SMI				
Male	6.84 ± 0.56	7.18 ± 0.38	6.64 ± 0.55	<.001
Female	4.84 ± 0.70	5.27 ± 0.35	4.61 ± 0.74	<.001
FIM at admission, points, median (IQR)	43 (26–65)	53 (37.8–74)	35 (24–59.8)	.001
Motor FIM domain, points, median (IQR)	25.5 (14–46)	35 (20–50)	19 (13–37.3)	<.001
Cognitive FIM domain, points, median (IQR)	15 (10.8–24)	18 (14–24)	14 (9–21.8)	.009
IDDSI-FDS at admission, points, median (IQR)	2 (0–3)	3 (2–3)	2 (0–3)	.007
Mean energy intake during the 7 d of admission, kcal/kg/d	26.0 ± 8.4	23.6 ± 7.0	27.4 ± 9.0	.004
Mean protein intake during the 7 d of admission, g/kg/d	1.1 ± 0.3	1.0 ± 0.3	1.2 ± 0.4	<.001

IQR, interquartile range; MNA-SF, Mini Nutritional Assessment–Short Form.

Table 2
Comparison Between Variables at Discharge

	Intact (n = 66)	Malnutrition at Admission (n = 122)	*P* Value
IDDSI-FDS at discharge, points	7 (4.3–8)	4.5 (3–7)	<.001
Improvement in swallowing ability (IDDSI-FDS $\geq$ 5), n (%)	49 (74.2)	61 (50.0)	.001
LOS, d, median (IQR)	97 (64.5–119.8)	95 (77.3–125.8)	.63
FIM, points, median (IQR)	87.5 (57.3–102.8)	53 (35–88.5)	<.001
Motor FIM domain, points, median (IQR)	65.5 (40–75.8)	36.5 (20–63)	<.001
Cognitive FIM domain, points, median (IQR)	23 (17–28)	17 (12–26)	<.001
Mean energy intake during 7 d before discharge, kcal/kg/d	26.7 ± 5.7	30.4 ± 9.2	.001
Mean protein intake during 7 d before discharge, g/kg/d	1.2 ± 0.2	1.3 ± 0.4	<.001

IQR, interquartile range; LOS, length of hospital stay.

entry method. A *P* value of <.05 was considered statistically significant.

Results

During the study period, 412 patients with stroke aged ≥65 years were enrolled. Among them, 31, 27, and 166 patients, who were transferred to an acute hospital due to exacerbation of clinical conditions, and who were nondysphagic, respectively, were discharged within 30 days. Finally, 188 older adults with oropharyngeal dysphagia following stroke were enrolled in this study. Table 1 shows the patients' baseline characteristics and the comparison between the intact and malnourished groups. Based on the GLIM definition, 66 and 122 patients were assigned to the intact group and the malnutrition group, respectively. Approximately 65% of older patients with oropharyngeal dysphagia following stroke were found to have GLIM-defined malnutrition. The mean age of the patients was 78.9 ± 7.7 years, and 36.7% were women. The IDDSI-FDS and FIM scores at admission in the malnutrition group were significantly lower than that in the intact group ($P = .007$ and $P < .001$, respectively).

Table 2 shows the comparisons of variables at discharge. The IDDSI-FDS scores at discharge were significantly higher in the intact group than in the malnutrition group ($P < .001$). Patients who experienced improvements in dysphagia (IDDSI-FDS score ≥5) were significantly more prevalent in the intact group than in the malnutrition group ($P = .002$). The total FIM scores were significantly higher in the intact group than in the malnutrition group ($P < .001$).

Table 3 shows the results of the analysis of covariance for the IDDSI-FDS score at discharge. GLIM-defined malnutrition was found to be an independent contributor to the IDDSI-FDS scores at discharge after adjusting for variables (beta −0.739, 95% confidence interval: −1.516 to −0.203, standardized coefficient: −0.165, $P = .011$).

Table 4 shows the results of the logistic regression analysis for improvement of dysphagia. Malnutrition at admission (adjusted odds ratio: 0.442, 95% confidence interval: 0.202, 0.971; $P = .042$) was independently associated with improvement of dysphagia (IDDSI-FDS score ≥ 5) at discharge.

Table 3
ANCOVA for the IDDSI-FDS Score at Discharge

	Beta	95% Confidence Interval	Standardized Coefficient	*P* Value
IDDSI-FDS at admission	0.481	0.249, 0.712	0.283	<.001
Sex, female	0.431	−0.218, 0.712	0.084	.20
Age	−0.053	−0.097, −0.009	−0.164	.018
LOS	0.007	−0.002, 0.017	0.102	.13
History of stroke	−0.477	−1.417, 0.463	−0.062	.32
Type of stroke	0.077	−0.429, 0.582	0.020	.77
CCI	−0.016	−0.261, 0.230	−0.008	.90
OHAT	−0.076	−0.206, 0.055	−0.070	.26
Total FIM at admission	0.033	0.019, 0.048	0.328	<.001
GLIM-defined Malnutrition	−0.739	−1.516, −0.203	−0.165	.011

ANCOVA, analysis of covariance; LOS, length of hospital stay.

Discussion

The present study included patients who underwent rehabilitation for dysphagia after stroke. The study was conducted primarily to determine whether malnutrition at admission is an adverse factor for the improvement of swallowing ability. Data from 188 older adults with oropharyngeal dysphagia after stroke in a rehabilitation hospital were analyzed. Based on the results of this study, 2 important conclusions can be made. First, malnutrition in oropharyngeal dysphagia patients after stroke was inversely associated with the swallowing ability at discharge, and the benefits of swallowing rehabilitation were poor in those with malnutrition. Second, patients who were malnourished at admission revealed severe dysphagia.

The malnutrition of patients suffering from dysphagia after stroke was inversely associated with the swallowing ability at discharge, and benefits of swallowing rehabilitation were poor. Nishioka et al[18] reported that the risk of malnutrition at admission in tube-fed patients after stroke was a predictor of failure of withdrawal from tube feeding. Our results indicate the existence of an inverse relationship between malnutrition and swallowing rehabilitation benefits. Similarly, in the current study, swallowing ability at discharge was significantly poorer in patients with malnutrition diagnosed based on the GLIM criteria. The association did not change after adjusting for the baseline factors. We speculated that the reduced muscle mass could have been a related cause. Malnutrition is characterized by weight loss, low BMI, and reduced muscle mass,[7] and is the cause of loss of muscle.[31] In fact, in this study, patients with malnutrition had significantly lower muscle mass at admission. It has been reported that muscle loss is a risk factor for the onset of dysphagia in patients without dysphagia.[32] In addition, Sporns et al[11] reported that reduced muscle mass in patients with dysphagia after stroke was related to the severity of dysphagia. Therefore, reduced muscle mass in patients with oropharyngeal dysphagia may lead to the deterioration of swallowing ability and may impair the effectiveness of swallowing rehabilitation. In

Table 4
Logistic Regression Analysis for Improvement of Dysphagia (IDDSI-FDS Score ≥5 at Discharge)

	Adjusted Odds Ratio	95% Confidence Interval	*P* Value
IDDSI-FDS at admission	1.345	1.033, 1.751	.032
Sex, female	1.960	0.926, 4.149	.08
Age	0.940	0.896, 0.986	.012
CCI	0.931	0.705, 1.228	.61
OHAT	0.939	0.806, 1.094	.42
Total FIM at admission	1.033	1.014, 1.052	<.001
GLIM-defined malnutrition	0.442	0.202, 0.971	.042

addition, malnutrition and sarcopenia, characterized by reduced muscle mass and muscle weakness, have been reported to increase the incidence of pneumonia, other infections, and gastrointestinal bleeding.[33,34] Therefore, in this study, these events may have inhibited the general and swallowing rehabilitation in malnutrition patients.

In this study, patients who had malnutrition at admission demonstrated more severe dysphagia than those without malnutrition. Carrión et al[35] reported that dysphagia in the acute phase is a risk factor for malnutrition. The study participants were post-acute patients, and it was speculated that their severe dysphagia during the stay in hospital may have partly been responsible for the malnutrition. Conversely, potential malnutrition, which is related to reduced muscle mass, may result in severe dysphagia. Wakabayashi et al[36] found reduced muscle mass and malnutrition to be associated with severe dysphagia.

In recent years, the new concept of sarcopenic dysphagia has been proposed.[37] It is defined as dysphagia caused by sarcopenia in both the whole body and swallowing-related muscles, and excludes cases presenting with diseases obviously related to dysphagia, such as stroke. However, oropharyngeal dysphagia after stroke leads to malnutrition owing to the relatively low nutritional intake, and may cause secondary sarcopenia. Therefore, oropharyngeal dysphagia after stroke, deteriorating nutritional status, and sarcopenia are considered to be closely related. The results of this study possibly suggest that sarcopenia-related dysphagia is largely a component of oropharyngeal dysphagia after stroke, and that sarcopenic dysphagia may have influenced the results.

This study has some limitations. First, it had a retrospective design. Therefore, the influence of the background (eg, nature of rehabilitation program) and confounding factors among participants cannot be completely eliminated. However, oral conditions and functional status, which could affect improvements in swallowing ability, were adjusted during multivariate analysis. Second, this study did not directly evaluate swallowing function. Instead, the IDDSI-FDS, which is a validated scale for assessing swallowing ability,[22] and is well correlated with the functional oral intake scale,[22,38] was used. Finally, SMI was calculated from the estimation formula. However, SMI calculated using the estimation formula shows high correlation with that of dual-energy x-ray absorptiometry,[28] and its validity has been verified.[29]

Conclusion and Implications

GLIM-defined malnutrition during admission for rehabilitation among patients with oropharyngeal dysphagia after stroke inversely affects the severity and improvement in swallowing ability at discharge. For patients with post-stroke oropharyngeal dysphagia, early identification of malnutrition on admission and provision of both rehabilitation training and nutritional interventions may be desirable. Further studies are needed to confirm the impact of the identification of malnutrition and nutritional interventions in malnourished patients with oropharyngeal dysphagia.

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