Initial National Institute of Health Stroke Scale to Early Predict the Improvement of Swallowing in Patients with Acute Ischemic Stroke

Wen-Chih Lin, MD,* Chih-Yuan Huang, MD, PhD,† Lin-Fu Lee, PT,*
Yun-Wen Chen, PhD,‡ Chung-Han Ho, PhD,§,|| and Yuan-Ting Sun, MD, PhD¶,#

Objectives: To study the applicability of National Institutes of Health Stroke Scale (NIHSS) in early predicting the prognosis of poststroke dysphagia in an acute ward. *Methods:* This is an observational retrospective cohort study including adult patients with ischemic stroke. Patients with various factors affecting swallowing were excluded to obtain a representative sample of 165 patients. The main outcome measure was the improvements of oral intake function. *Results:* The scores of facial palsy (NIHSS item 4) (odds ratio [OR]: 0.484, 95% confidence interval [CI]: 0.279-0.838, P = .0096] and language/aphasia (NIHSS item 9) (OR: 0.562, 95% CI: 0.321-0.982, P = .0430) demonstrated significantly negative effects on the early improvement of dysphagia. Moreover, the improved patients had a 4.14-fold (95% CI: 2.53-11.23, P = .005) increased odds of returning home compared with nonimproved patients. *Conclusions:* Our findings provide evidence that early improvement of poststroke dysphagia was significantly associated with a favorable discharge destination and NIHSS items of facial palsy and language/aphasia can be used at the onset of stroke to identify dysphagic patients at risk of achieving limited improvement. These findings provide valuable prognostic indicators for clinicians to make a precise outcome prediction at very early stage.

Key Words: Stroke—prediction—prognosis—stroke scales—dysphagia

Introduction

Dysphagia is a common poststroke morbidity, affecting 37%-78% of patients with stroke.[1] In the acute stage, initial dysphagia results in negative outcomes such as prolonged hospital stays,[2] aspiration pneumonia,[3,4] and mortality.[5] In the chronic stage, persistent dysphagia[6,7] affects the long-term functional outcome of patients with stroke.[8,9] Thus, it is generally agreed that early detection of

Abbreviations: NIHSS, National Institutes of Health Stroke Scale; ST, speech therapy; OR, odds ratio; CI, confidence interval; FOIS, functional oral intake scale; PEG, percutaneous endoscopic gastrostomy; NGT, nasogastric tube; DWI, diffuse weighted imaging; DM, diabetes mellitus; HTN, hypertension; Af, atrial fibrillation; COPD, chronic obstructive pulmonary disease; PAOD, peripheral arterial occlusive disease; CAD, coronary artery disease; UTI, urinary tract infection; MRI, magnetic resonance imaging; AUC, area under the curve; ROC, receiver operating characteristic; IQR, interquartile range.

From the *Department of Physical Medicine and Rehabilitation, Chi Mei Medical Centre, Chiali branch, Tainan, Taiwan; †Department of Surgery, National Cheng Kung University Hospital, College of Medicine, National Cheng Kung University, Tainan, Taiwan; ‡Department of Pharmacology, College of Medicine, National Cheng Kung University, Tainan, Taiwan; §Department of Hospital and Health Care Administration, Chia Nan University of Pharmacy and Science, Tainan, Taiwan; ||Department of Medical Research, Chi Mei Medical Centre, Tainan, Taiwan; ¶Department of Neurology, National Cheng Kung University Hospital, College of Medicine, National Cheng Kung University, Tainan, Taiwan; and #Advanced Optoelectronic Technology Centre, National Cheng Kung University, Tainan, Taiwan.

Received April 23, 2019; revision received June 16, 2019; accepted July 13, 2019.

Financial Disclosure: This study was funded by Chi Mei Medical Center, Chiali branch (JCHHCR10202) and National Cheng Kung University Hospital (NCKUH10703048).

Address correspondence to Yuan-Ting Sun, MD, PhD, Department of Neurology, College of Medicine, National Cheng Kung University, 1 University Road, Tainan, Taiwan. E-mail: ytsun@mail.ncku.edu.tw.

1052-3057/$ - see front matter

https://doi.org/10.1016/j.jstrokecerebrovasdis.2019.07.013

dysphagia is crucial for the reduction of overall health care expenditure and mortality.[3,5,10-12]

Factors associated with persistent poststroke dysphagia in late-subacute and chronic stages have been documented.[9,10] However, studies focusing on early predicting improvements of swallowing function in patients with poststroke dysphagia during the acute stage are relatively limited. As the length of hospital stays in the acute stroke ward are currently brief, early outcome prediction for poststroke dysphagia is imperative for the timely development of individualized treatment strategies. For this purpose, a broadly applicable assessment at admission for stroke patients and a semiquantitative method for grading improvements in swallowing are required.

Expanding upon the detection of poststroke dysphagia, this study focused specifically on improving swallowing. Apart from major improvements such as weaning from percutaneous endoscopic gastrostomy (PEG) or nasogastric tubes (NGTs),[13-15] minor improvements in swallowing, which need a more precise and sensitive grading scale to identify, can also be of clinical significance.[16,17] However, it has not been addressed in most reports.

In addition to the structural and neurological problems of the digestive tract, other stroke-related factors such as cognition function, affect swallowing function.[18] From a practical perspective, the most crucial concern of swallowing is the extent to which a patient can eat and drink orally. Although videofluoroscopy is a standard method for the diagnosis of dysphagia, its shortcomings, such as invasiveness, radiation exposure, and reliance on patients' comprehension and awareness, limit its application in patients with stroke.[19] Thus, this study adopted the Functional Oral Intake Scale (FOIS), a clinical assessment instrument with high reliability and validity,[20] to evaluate patients' swallowing function after stroke. The FOIS is a widely used, precise and practical semiquantitative tool for assessing swallowing function in various dysphagic populations.[16,21,22] Applying this scale enable us to study the clinical significance of any minor improvements in swallowing, not merely the major ones such as weaning from PEG or NGTs.

Among multiple factors associated with the presence of dysphagia at onset or in the chronic stage, neurological status has been the most commonly mentioned.[23-27] The NIHSS is a systematic, semiquantitative assessment tool for stroke-related neurologic deficits. A high NIHSS score or a broadly poor neurological status is correlated with a higher incidence of dysphagia.[13,23,24,27] However, the possibility of using this scale to predict the treatment outcomes of dysphagia is unaddressed. Since there is no specific item assessing dysphagia in the NIHSS, this study attempted to investigate the applicability of broadly used NIHSS in predicting the prognosis of post stroke dysphagia. The clinical significance of early improvement in swallowing function after stroke was also studied.

Methods

Participants

This retrospective study was approved as a medical record review by the Institutional Ethics Board (IRB serial No.: 107-2-J02). Owing to the retrospective nature of the study, the IRB waived the requirement for informed patient consent. Data were obtained from adult patients with stroke aged over 20 years who were referred for speech therapy (ST) between March 2012 and April 2013. To obtain a representative group of patients with ischemic stroke, patients with hemorrhagic stroke or no evidence of recent stroke on diffuse weighted imaging (DWI) were excluded. Then, those who had the following factors that affect swallowing function were also excluded to restrict this analysis to postischemic stroke dysphagia: previous ST in their lifetime, scheduled operations during hospital stay (eg, craniectomy), cancer-related difficulty in swallowing, presence of other neuromuscular disorders, in-hospital stroke while the patient was hospitalized due to other diseases, and intubation.

Demographic Data Collection

Demographic variables and NIHSS scores on admission and at discharge were obtained by a well-trained medical team. Demographic variables included age, sex, first or recurrent stroke, hemorrhage or infarction, time from onset to admission, receipt or nonreceipt of thrombolysis treatment, medical history of diabetes mellitus, hypertension, atrial fibrillation, chronic obstructive pulmonary disease, peripheral arterial occlusive disease, coronary artery disease, in-hospital pneumonia, and urinary tract infection (UTI).

Image Interpretation

A qualified neurologist and a neuroradiologist independently viewed all magnetic resonance imaging (MRI) scans and were blind to clinical presentation and dysphagia status. They documented the acute and chronic brain lesions for all patients. The acute lesion was determined by DWI.

Assessments of Swallowing Function

Dysphagia assessments were conducted by qualified speech therapists using the FOIS, first at consultation on admission and last before discharge. The timing of discharge was dependent on improvements in stroke-related complications and neurological status. The speech therapist assessed the aspiration risk of each patient from an oral diet of various consistencies according to the patient's motor functions of lips, tongue, and soft palate; ability to manipulate foods; sensitivity of swallowing reflex; laryngeal lifting when swallowing; remnant sensation in the pharynx; and cough or change in vocal quality after

swallowing; and the results of a video fluoroscopic swallowing exam. The therapist then recommended a suitable feeding status, determined the FOIS score, and assessed whether the patient had dysphagia. Dysphagia was identified as an FOIS score of 1-6.

Standard Speech Therapy for Stroke Patients

Standard ST interventions were performed between the first (admission) and last (discharge) assessments. Treatments included methods that have been reported as the standard therapy for survivors of stroke with dysphagia, such as neuromuscular electrical stimulation, oral function training, laryngeal muscle function training, swallowing reflex facilitation training, swallowing compensation skill training, safe swallowing skill training, food consistency modification, and posture modification,[5] which can be covered by the National Health Insurance. The applications of treatment strategies such as direct swallowing exercise (eg, effortful swallowing, supraglottic swallow technique), compensation technique, (eg, upright position with chin tuck or tilt), environmental modification, appropriate dietary modification and safe swallowing advice were directed by the findings of clinical swallowing examinations. A treatment session lasts at least 30 minutes. The intervention frequencies depend on the general conditions of patients in the ward. Improvement in dysphagia was defined as a positive value of: discharge FOIS—admission FOIS. ST interval (days) was defined as the length of hospital stay (days) divided by bedside visits from a speech therapist.

Statistical Analysis

Statistical analyses were performed using SPSS version 24.0 (IBM Corporation, Armonk, NY). Demographic data between groups were compared using a Mann-Whitney U test for continuous variables after normality test or Pearson's chi-square test for categorical variables. Significance was set at $P < .05$. To identify the associated NIHSS items of early swallowing improvements, multivariable logistic regression analysis was used to estimate the odds ratios (ORs) with 95% confidence intervals (95% CIs) for controlling the potential confounding factors. Factors that may affect the outcomes of dysphagia and the efficacy of ST interventions, such as age, sex, old lesions on the MRI, comorbidities, in-hospital pneumonia, admission FOIS, ST intervals, and days of hospital stay, were included as covariates based on clinical experiences and previous studies.[15,25,28] The dependent variable was swallowing improvements (improvements = 1; nonimprovement = 0), and the total NIHSS or subitems were predictor variables with the aforementioned confounding factors. For the assessment of accuracy, the area under the curve of the receiver operating characteristic curve was presented for each item.

Results

From March 2012 to April 2013, 366 patients with stroke received ST referrals. Study participants were further restricted to patients with acute ischemic stroke by viewing their DWI (n = 314). A subset of these participants was deemed ineligible for the analysis of stroke-related dysphagia for the following reasons: normal swallowing (FOIS = 7), a history of previous ST intervention, presence of other factors affecting swallowing function such as operations scheduled during hospital stay (eg, craniectomy), cancer-related swallowing difficulty, other neuromuscular disorders, in-hospital stroke while the patient was hospitalized due to other diseases, and intubation (n = 119). Others were excluded due to missing admission NIHSS score (n = 1) or inability to receive standard ST because of deteriorating neurological status (n = 29). Finally, 165 subjects were included in the study; 72 experienced no change in swallowing impairment at discharge and 93 had improved swallowing function at discharge (Fig 1). The early recovery rate under standard treatments was 56.4%. The characteristics of the entire cohort, (the improved swallowing and nonimproved swallowing subgroups) are described in Table 1. The median admission FOIS in both the improved and nonimproved groups was 5 (interquartile range [IQR] 2-6). The median admission NIHSS scores for the improved and nonimproved groups were 6 (IQR 3-11) and 5 (IQR 3-9), respectively. The median discharge modified Rankin scale was 3 for both groups (IQR 2-4). The latency of first FOIS assessment was similar between groups (Table 1).

A comparison of the scores of each NIHSS item and the total score between the improved and nonimproved groups revealed that the nonimproved patients exhibited a lower score in facial palsy (NIHSS item 4) (mean[IQR] of improved and nonimproved group, 1[0-1] and 1[0-1]; mean ± SD of improved and nonimproved group, 0.58 ± 0.61 and 0.82 ± 0.72; $P = 0.034$ by Mann-Whitney test). No significant difference in other items and the admission and discharge NIHSS total scores was observed between the groups (Table 2).

After adjusting for variables of sex, age, old lesions on MRI, comorbidities, in-hospital pneumonia, admission FOIS, ST intervals, and days of hospital stay, logistic regression analyses were conducted for each NIHSS item, as depicted in Figure 2. The scores of facial palsy (item 4; OR = 0.484, 95% CI = 0.279-0.838, $P = .0096$) and language/aphasia (item 9; OR = 0.562, 95% CI = 0.321-0.982, $P = .043$) showed significantly negative effects on the early improvement in dysphagia. A 1 point increase in the scores of the items assessing facial palsy and aphasia resulted in an approximate 50% reduction in the chances of early improvement in dysphagia under standard ST. The corresponding area under the curve values for facial palsy (items 4) and language/aphasia (item 9) were 0.731 and 0.714, respectively.

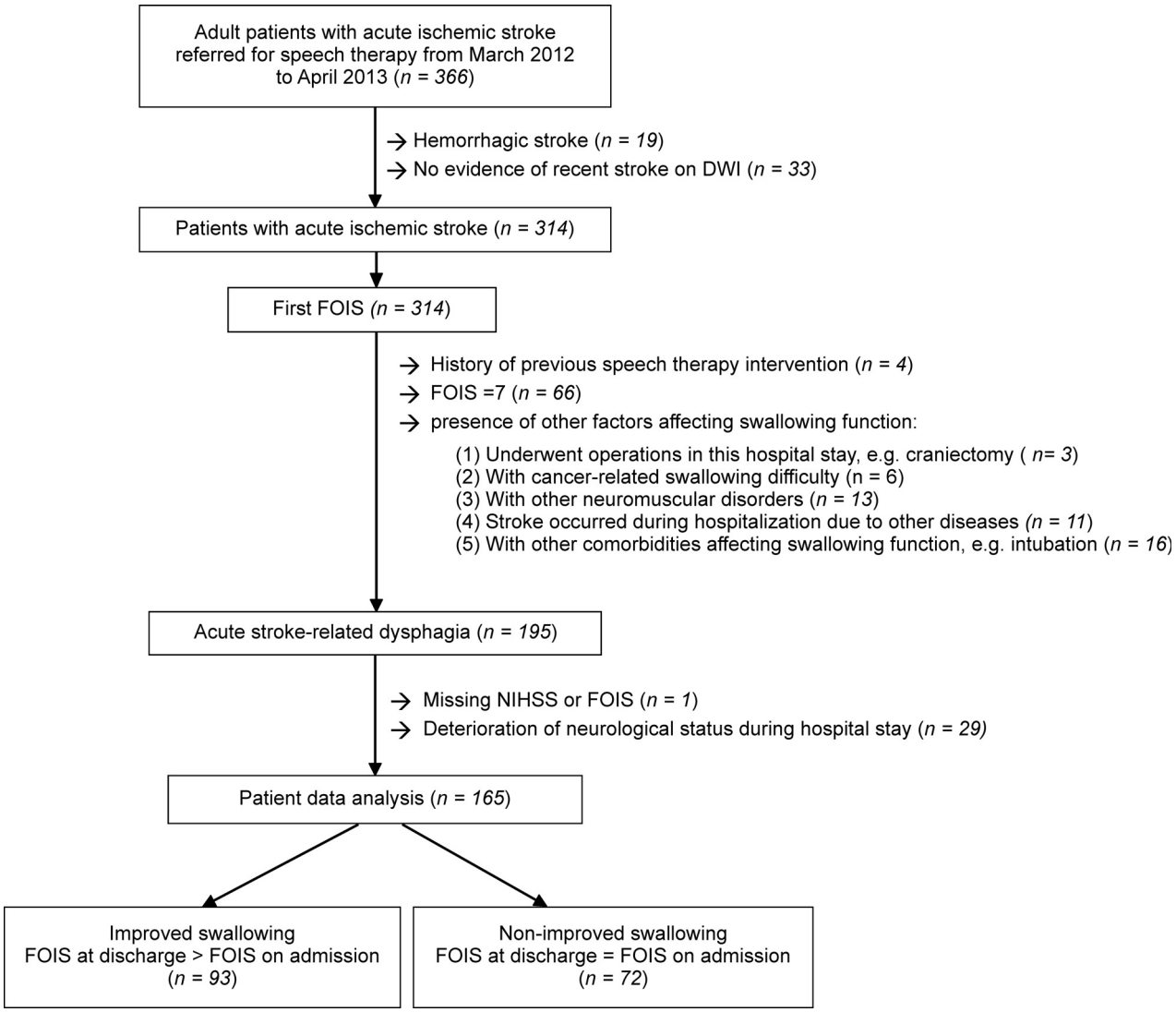

Figure 1. *Flowchart depicting the inclusion and exclusion criteria of participants. Abbreviations: DWI, diffuse weighted imaging; FOIS, functional oral intake scale; NIHSS, National Institutes of Health Stroke Scale.*

Prediction of early improvement in poststroke dysphagia after early ST had beneficial effects; a higher proportion of patients returned home after discharge in the improved group, whereas a higher proportion went to a nursing home in the nonimproved group (chi-square, P = .0031). The logistic regression analysis demonstrated that improvements in the FOIS were significantly correlated with a favorable discharge (returning home; OR = 4.14, 95% CI = 2.53-11.23, P = .005; Table 3). This indicated that any early improvement in poststroke dysphagia was of clinical significance.

Discussion

In this cohort of patients with poststroke dysphagia who underwent early ST interventions, we observed the following: (A) a low initial score of facial palsy (NIHSS items 4) and language/aphasia (NIHSS item 9) was associated with a higher possibility of early improvements in oral intake function after early ST intervention; and (B) patients with poststroke dysphagia exhibiting any early improvement in the acute to early-subacute stage had a higher probability of favorable discharge destination, which was determined on the basis of the entire clinical spectrum of each patient. Although limited by unavoidable confounding factors, our findings provide the first evidence from an acute ischemic stroke cohort that certain items of the NIHSS can be used at the onset of stroke to identify dysphagic patients at risk of achieving limited improvement in the acute ward and may need tailored medical treatments and aggressive rehabilitation programs at the beginning of stroke therapy to obtain a favorable discharge destination.

Previous studies predicting the weaning of NGT or PEG have demonstrated that it affects discharge destination, mortality, morbidity, quality of life, and medical

Table 1. *Characteristics of the study cohort*

Item	Overall	Improved (FOIS at discharge—FOIS on admission ≥1)	Nonimproved (FOIS at discharge—FOIS on admission <1)
N (%)	165	93 (56.36)	72 (43.63)
Median age, y (IQR)	71 (59-79)	71 (58-78)	72 (63-79)
Male (N, %)	110 (66.67)	66 (70.97)	44 (61.11)
Median admission FOIS (IQR)	5 (2-6)	5 (2-6)	5 (2-6)
Thrombolysis (N, %)	5 (3.03)	2 (2.15)	3 (4.17)
Comorbidity (N, %)			
Old stroke	62 (37.58%)	33 (35.48%)	29 (40.28%)
DM	72 (43.64%)	47 (50.54%)	25 (34.72%)
Hypertension	130 (78.79%)	69 (74.19%)	61 (84.72%)
Dyslipidemia	69 (41.82%)	38 (40.86%)	31 (43.06%)
Af	20 (12.12%)	11 (11.83%)	9 (12.50%)
Active smoker	41 (24.85%)	24 (25.81%)	17 (23.61%)
Asthma or COPD	5 (3.03%)	3 (3.23%)	2 (2.78%)
Cancer	12 (7.27%)	7 (7.53%)	5 (6.94%)
PAOD	4 (2.42%)	2 (2.15%)	2 (2.78%)
CAD	16 (9.70%)	10 (10.75%)	6 (8.33%)
Median days of hospitalization (IQR)	9 (5-13)	10 (6-15)	7 (5-12)
Median days of first FOIS (IQR)	4 (3-6)	5 (3-6)	4 (3-6)
Median days of ST intervals (IQR)	3.0 (2.1-4.5)	3.0 (2.2-4)	3.5 (2.1-5)
Median discharge mRS (IQR)	3 (2-4)	3 (2-4)	3 (2-4)
Complications during hospitalization (n, %)			
UTI	10 (6.06%)	7 (7.53%)	3 (4.17%)
Pneumonia	18 (10.91%)	9 (9.68%)	9 (12.50%)

Abbreviations: Af, atrial fibrillation; CAD, coronary artery disease; COPD, chronic obstructive pulmonary disease; DM, diabetes mellitus; FOIS, functional oral intake scale; IQR, interquartile range; mRS, modified Rankin scale; PAOD, peripheral arterial occlusive disease; ST, speech therapy; UTI, urinary tract infection.

Table 2. *Scores of National Institutes of Health Stroke Scale (NIHSS) items in the 2 groups*

Item	Overall	Improved N = 93	Nonimproved N = 72	*P* value Mann−Whitney U test
Median admission NIHSS (IQR)	6(3-10)	6(3-11)	5(3-9)	0.6268
Median discharge NIHSS (IQR)	4(2-7)	4(2-7)	4(2-9)	0.4140
Median difference of NIHSS (IQR)	−1(-2-0)	−1(-3-0)	−1(-2-0)	0.2000
Median admission score of each NIHSS item (IQR)				
1a Level of consciousness	0(0-0)	0(0-0)	0(0-0)	0.6363
1b Ask month and age	0(0-0)	0(0-0)	0(0-1)	0.2401
1c Blink eyes & Squeeze hands	0(0-0)	0(0-0)	0(0-0)	0.1700
2 Horizontal extraocular movements	0(0-0)	0(0-0)	0(0-0)	0.2562
3 Visual fields	0(0-0)	0(0-0)	0(0-0)	0.1146
4 Facial palsy	1(0-1)	1(0-1)	1(0-1)	0.0343*
5a Left arm motor drift	0(0-2)	1(0-2)	0(0-2)	0.9520
5b Right arm motor drift	0(0-1)	0(0-1)	0(0-1)	0.5066
6a Left leg motor drift	1(0-2)	1(0-2)	0.5(0-2)	0.8059
6b Right leg motor drift	0(0-1)	0(0-1)	0(0-1)	0.7049
7 Limb ataxia	0(0-0)	0(0-0)	0(0-0)	0.9403
8 Sensation	0(0-1)	0(0-1)	0(0-1)	0.5222
9 Language/Aphasia	0(0-0)	0(0-0)	0(0-0)	0.1891
10 Dysarthria	1(0-1)	1(0-1)	1(0-1)	0.3022
11 Extinction/Inattention	0(0-0)	0(0-0)	0(0-0)	0.1692

Difference in NIHSS, discharge NIHSS—admission NIHSS.
*$P < .05$.

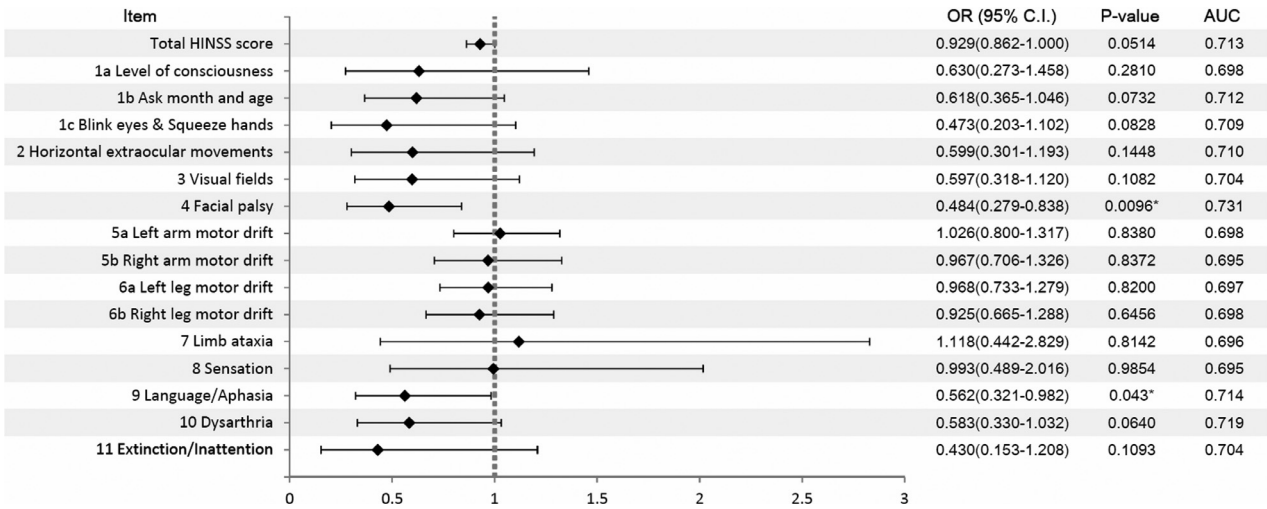

Figure 2. *Logistic regression analyses for the associations between the individual National Institutes of Health Stroke Scale (NIHSS) items and the improvement in functional oral intake scale (FOIS). Variables adjusted: gender, age, old lesions on MRI, diabetes mellitus, hypertension, dyslipidemia, atrial fibrillation, asthma or chronic obstructive pulmonary disease, cancer, peripheral arterial occlusive disease, coronary artery disease, in-hospital pneumonia, admission FOIS, speech therapy (ST) intervals, and days of hospital stay. X-axis, odds ratio (OR). Y-axis, NIHSS items. AUC, area under the curve. *P < .05.*

appendices.[11,14,15] However, in all patients that were tube-dependent (FOIS score of <3), the risk of pneumonia in those with an FOIS score of 1 and an FOIS score of 2 or 3 are distinct.[21] This highlights the importance of the semiquantitative functional grading of dysphagia beyond the status of being with or without tube. Using FOIS enabled us to determine that any degree of improvement in early stage, even short of tube removal, benefited the discharge destination of patients with post-stroke dysphagia.

The total NIHSS score has been most commonly reported as a predictor for the presence of initial dysphagia at the onset of stroke.[13,23-27] The presence of dysphagia at the onset may be associated with prior lesion burden and new lesion site and size.[29-32] However, the improvement in dysphagia involves 2 domains of neurological function: the physiological factor relevant to the dysfunction of swallowing organs and the cognitive factor relevant to the capability of understanding, following, and adhering to the guidance of speech therapists. The physiological factor may result in the basal swallowing function before ST interventions, which was associated with multiple documented predictors.[10,11,29-33] In this study, item 4 of the NIHSS (assessing facial palsy, motor control of oral cavity) may have denoted the function of the oral phase in swallowing and was more likely to be a physiological factor. By contrast, identified item 9 (assessing language/aphasia) was more likely to be a cognitive factor that affected the interactions between patients and therapists. In our analysis, item 10 (assessing articulation) and item 1b and 1c (assessing communication) exhibited marginal significance in the perception that improvements may also imply the effect of physiological factors and cognitive function, respectively, on the efficacy of ST interventions.

In this cohort, patients with larger lesions may have been excluded from participation due to high oxygen demands or reduced level of consciousness at the acute stage of stroke. This is a potential limitation of our study, as we could only include patients who were ST referred. These subjects were identified by clinicians as having problems in verbal expression, articulation, and swallowing as well as with a capability to receive ST interventions. In addition, patients should be capable of completing the FOIS within 3-6 days of stroke onset. Patients who did not have a short period of wakefulness for accessing the risk of aspiration in response to oral diet regardless of NGT dependency were excluded. Although this cohort was a group selected by treating physicians with limited

Table 3. *Discharge destination of the improved and nonimproved swallowing groups*

	Discharge destination						
	Home		Institute				
Swallowing	N	%	N	%	OR	95% CI	*P*value
Improved (N = 93)	87	93.55	6	6.45	4.14	2.53-11.23	0.005*
Nonimproved (N = 72)	56	77.78	16	22.22			

Abbreviation: CI, confidence interval.
*$P < .01$.

generalization, it displayed the real-world condition in terms of epidemiology. We utilized the readily available, easily applied, and broadly used NIHSS at admission to identify patients at a high risk of developing long-lasting dysphagia. This is of clinical value in several aspects. First, it may lead to expedient (eg, videofluoroscopy) and time-dependent (more ST time) interventions. Second, it may mitigate adverse events, such as pneumonia, by increasing the vigilance and proactivity of medical teams in recognizing and treating these conditions in acute wards. Third, it can promote early preparation for postdischarge rehabilitation program.

Conclusion

This study demonstrated that the early improvement in poststroke dysphagia through ST intervention in the acute and early-subacute stages is associated with a more favorable discharge destination. The widely used NIHSS subitem of facial palsy and language/aphasia (items 4 and 9) can be used to determine the prognosis of early ST interventions. Screening patients with stroke at a high risk of limited improvements and developing long lasting dysphagia as early as possible will prompt clinicians to tailor individualized rehabilitation strategies and initiate discharge rehabilitation planning timely. Recommendations arising from this study may aid in early decision-making, enhance the use of healthcare resources, improve patient outcomes, and decrease financial burden.

Conflict of Interest

None.

Acknowledgments

We thank Mrs Mei-Ju Ko, a speech therapist at the department of rehabilitation medicine, Chi Mei Medical Center, Tainan, Taiwan for the acquisition of data and providing useful advice in writing the manuscript.

Author Contribution Statement

C.Y.H. and W.L. have contributed equally to this work. W.L. was involved in study design, analysis, and writing. C.Y.H. was involved in analysis and writing. L.L. was involved in analysis. Y.C. was involved in writing, and C.H.H. was involved in analysis. Y.S. was involved in study design, analysis, and writing.

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