Predictors of nasogastric tube removal in patients with stroke and dysphagia

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Dysphagia is present in 25–50% of patients with stroke. Therefore, studying the probability of nasogastric tube removal in such patients before discharge from the rehabilitation ward is crucial. In this study, we developed a model to predict the outcome of dysphagia in patients with stroke. A retrospective study was performed from May 2015 to December 2018. We reviewed the medical charts of all patients with a diagnosis of stroke receiving nasogastric tube feeding. Patients were divided into weaned and nonweaned groups to compare baseline characteristics and functional status. The weaned and nonweaned groups comprised 55 and 65 patients, respectively. In the final logistic regression analysis model, the Barthel index at admission, lip closing status, ability to answer simple questions and functional independence before stroke were used to develop a predictive model (Logit = 0.8942 × functional independence before this stroke + 1.1279 × ability to answer simple question + 0.5345 × lip-close status + 0.0546 × Barthel index at admission − 2.2805). The optimal cutoff point based on Youden's index was more than −0.8403 with a sensitivity and specificity of 85.45 and 73.85%, respectively. The positive predicted value was 73.44%. In patients with stroke and dysphagia, a high Barthel index, intact lip closing status, ability to answer simple questions and better functional status before stroke appeared to affect nasogastric tube removal before discharge from the rehabilitation ward. Based on the final regression model, the proposed equation will help physicians and speech pathologists in planning patient care. *International Journal of Rehabilitation Research* **44: 205–208 Copyright © 2021 The Author(s). Published by Wolters Kluwer Health, Inc.**

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Introduction

The swallowing function begins from intrauterine growth and is sustained throughout life. Maintaining nutrition and coordination with respiration is vital to avoid choking. The swallowing process is divided into the following phases: oral preparatory, oral propulsive, pharyngeal and esophageal. Events in any of these phases may ultimately affect the entire swallowing process. Dysphagia is common morbidity after stroke. Its incidence ranges between 25 and 50% [1]. Pontine, medial medullary and lateral medullary lesions increase the risk of dysphagia [2]. The most frequent disorder is a delayed swallowing reflex [3].

Dysphagia has been associated with aspiration pneumonia, malnutrition and death [4]. Exercise training and compensatory strategies predominate swallowing rehabilitation. Half of the patients with dysphagia after acute stroke improve spontaneously within 2 weeks, whereas the condition worsens in the other half to chronic dysphagia [5].

In chronic dysphagia, tube feeding is required to maintain nutrition. Percutaneous endoscopic gastrostomy is the gold standard in long-term enteral nutrition [6]. Prolonged dysphagia has been observed with baseline National Institutes of Health Stroke Scale scores, aspiration on swallowing evaluation, bihemispheric infarcts, dysarthria and intubation [7]. We aimed to detect the predictors of nasogastric tube removal in the rehabilitation ward. Alternatively, we also used logistic regression to create a model to anticipate nasogastric tube removal.

Participants and methods

We retrospectively identified ischemic or hemorrhagic stroke patients with tube feeding treated at our hospital from May 2015 to December 2018. Patients were included if they were 18 years or older. We excluded patients who had a history of Parkinson's disease, advanced dementia, psychosis, multiple sclerosis, inflammatory myopathies, myasthenia gravis, muscular dystrophies, <1 week of hospital stay, tube feeding prior to the current episode of stroke or underwent tracheostomy. Patients underwent physical therapy, occupational therapy and swallowing training for a total of 3 h per day while hospitalized. Demographic and clinical variables included age, sex,

Table 1 Baseline characteristics of the patients

Characteristic	Weaned group ($n = 55$)	Nonweaned group ($n = 65$)	ALL ($n = 120$)	P value
Median age (IQR), year	67 (58–77)	74 (64–81)	70 (62–79)	0.08
Men	28 (50.9%)	39 (60.0%)	67 (55.8%)	0.32
Median stroke onset time (IQR), day[a]	42 (30–65)	63 (35–76)	50 (30–73)	0.06
Type of stroke				0.29
Ischemic	33 (60.0%)	45 (69.2%)	78 (65.0%)	
Hemorrhage	22 (40.0%)	20 (30.8%)	42 (35.0%)	
Stroke laterality				0.76
Left	26 (47.3%)	27 (41.5%)	53 (44.2%)	
Right	24 (43.6%)	30 (46.2%)	54 (45.0%)	
Bilateral	5 (9.1%)	8 (12.3%)	13 (10.8%)	
Brainstem involvement	5 (9.1%)	5 (7.7%)	10 (9.1%)	0.78
Median Barthel index (IQR)	15 (5–25)	0 (0–10)	5 (0–15)	<0.0001*
Lip close-intact	40 (72.7%)	36 (55.4%)	76 (63.3%)	0.0495*
Ability to answer simple question	33 (60.0%)	13 (10.0%)	46 (38.3%)	<0.0001*
Functional independence before this stroke[b]	52 (94.6%)	53 (81.5%)	105(87.5%)	0.03*
Functional status at admission				0.04*
Ambulation or stand with device	17 (30.9%)	10 (15.8%)	27 (22.5%)	
Wheelchair-bound	38 (69.1%)	55 (84.6%)	93 (77.5%)	
Prior stroke[c]	11 (20.0%)	16 (24.6%)	27 (22.5%)	0.55
Diabetes mellitus	16 (29.1%)	29 (44.6%)	45 (37.5%)	0.08
Hypertension	44 (80.0%)	54 (83.1%)	98 (81.7%)	0.66
Hyperlipidemia	13(23.6%)	21(32.3%)	34(28.3%)	0.29
Atrial fibrillation	13 (23.6%)	16 (24.6%)	29 (24.2%)	0.90
Coronary artery disease	10 (18.2%)	7 (10.8%)	17 (14.2%)	0.25
Cigarette smoking	13 (23.6%)	10 (15.4%)	23 (19.2%)	0.25
Education-less than a high school diploma	32 (58.2%)	41 (63.1%)	73 (60.8%)	0.58

Values are median (interquartile range, IQR) or number of patients.
[a]Stroke onset time (day): duration from stroke onset to time of evaluation.
[b]Prior stroke: history of stroke before this episode of ischemic infarction or intracerebral hemorrhage.
[c]Functional independence before this stroke: ability to perform activities of daily living independently before this stroke.
*Significant difference among groups ($P < 0.05$).

stroke type (ischemic or hemorrhagic), medical history (diabetes mellitus, hypertension, coronary artery disease, hyperlipidemia, atrial fibrillation, prior stroke (history of stroke before this episode of ischemic infarction or intracerebral hemorrhage and tobacco use), education level and length of hospital stay. We reviewed their medical charts to minimize missing data and to abstract additional relevant information, including stroke laterality (left, right and bilateral), stroke onset time (duration from stroke onset to time of evaluation), brainstem involvement, Barthel index at hospital admission, lip closing status, ability to answer simple questions (such as, 'What do you do at a stoplight?'), functional independence before this stroke (ability to perform activities of daily living (ADL) independently before this stroke) and functional status at admission (ambulatory/standing vs. wheelchair-bound). Swallowing rehabilitation involved modification of food and liquid properties (in terms of texture and viscosity), postural compensatory strategies (chin tuck and head turn/ tilt), supraglottic swallow, thermal tactile stimulation, isometric lingual exercise, pharyngeal wall contraction exercise (Masako maneuver), laryngeal elevation exercise (Shaker exercise) and effortful swallow. These are applied in all patients as possible. Patients were divided into weaned and nonweaned groups depending on the removal of the nasogastric tube. The above study has been approved by Institutional Review Board, Taipei Tzu-Chi Hospital, Buddhist Tzu Chi Medical Foundation (08-X-022).

Statistical analysis

SAS 9.4 (SAS Institute Inc., Cary, North Carolina, USA) was used to perform all statistical analyses. We used two sample t tests, chi-square test or Mann–Whitney U test to compare baseline variables between the weaned and nonweaned patient groups. Demographic, clinical and medical history variables were entered into the logistic regression model. Statistical significance was set at $P < 0.05$ We also performed a stepwise multivariate logistic regression to develop the final models, with only variables with a significance level of $P < 0.35$ being retained in the model.

Results

Of the 132 identified patients with stroke receiving nasogastric tube feeding, 120 patients met the inclusion criteria. Of these patients, 55 (45.8%) had the nasogastric tube removed during their hospital stay (weaned group). Table 1 summarizes the results of demographic, clinical and medical history variables of the study. The Barthel index at admission, lip closing status, ability to answer simple questions, functional independence before stroke and functional status at admission (ambulatory or standing with a device or wheelchair-bound) were significantly associated with nasogastric tube removal in the univariate analysis. In the final multivariate logistic regression model, we analyzed the effect of the aforementioned significant variables to create a predictive model (Logit = 0.8942 × functional independence before this stroke + 1.1279 × ability to answer simple question + 0.5345 × lip-close status + 0.0546 × Barthel index at admission – 2.2805) (Table 2). The area under the receiver operating characteristic curve was 0.8204 (Fig. 1). The optimal cutoff point based on Youden's index was more than –0.8403 with a sensitivity and specificity of 85.45 and 73.85%, respectively. The positive predicted value for return to oral feeding was 73.44%.

Discussion

Our study used the Barthel index at admission, lip closing status, ability to answer simple questions and functional independence before stroke to develop a predictive model by using multivariate logistic regression (Table 2). Our findings provided new information regarding the prediction of swallowing recovery in patients with stroke and severe dysphagia. The proposed equation (Logit = 0.8942 × functional independence before this stroke + 1.1279 × ability to answer simple question + 0.5345 × lip-close status + 0.0546 × Barthel index at admission – 2.2805, when

logit more than –0.8403). The positive predicted value for return to oral feeding was 73.44%., and it will assist both physicians and speech pathologists in determining the probability that an individual patient will improve sufficiently to remove the nasogastric tube before discharge from the rehabilitation ward.

In our study, the rate of nasogastric tube removal was 45.8%. This finding is in agreement with those of other studies, in which the weaned rate was 31–74% [1,8–10].

Table 2 Final multivariate logistic model

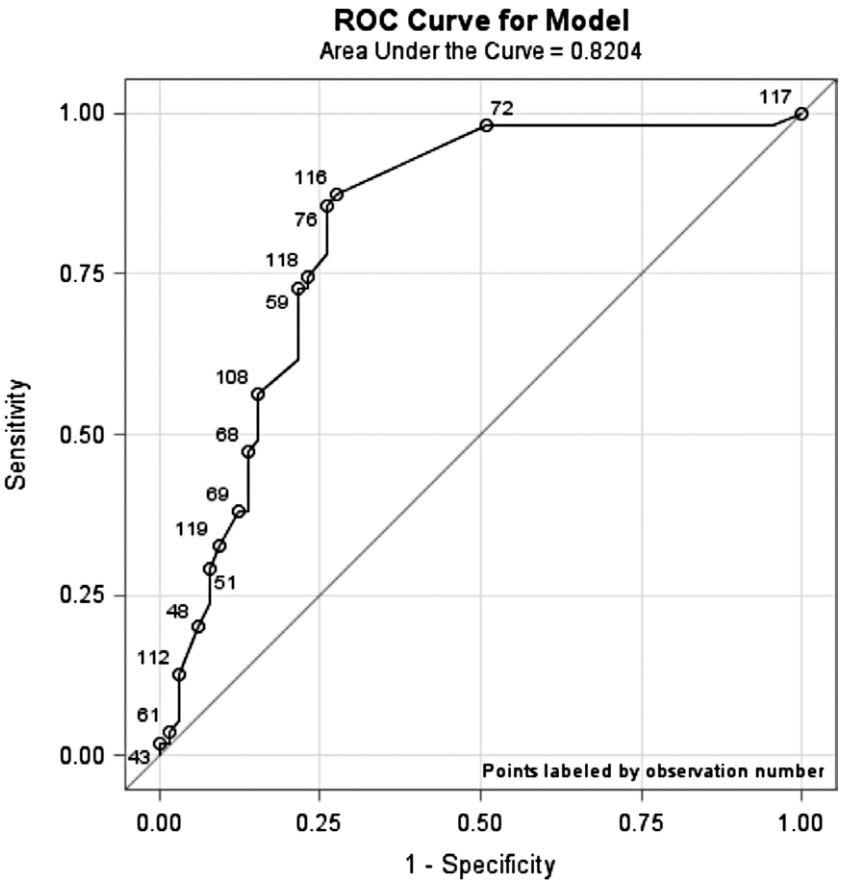
Parameter	Estimate	Standard error	Wald chi-square	Pr > ChiSq
Intercept	−2.2805	0.7705	8.7601	0.0031
Functional independence before this stroke	0.8942	0.7382	1.4673	0.2258
Ability to answer simple question	1.1279	0.4634	5.9245	0.0149
Lip-close status	0.5345	0.4498	1.4121	0.2347
Barthel index at admission	0.0546	0.0205	7.1038	0.0077

Logit = 0.8942 × functional independence before this stroke + 1.1279 × ability to answer simple question + 0.5345 × lip-close status + 0.0546 × Barthel index at admission − 2.2805.

Previous studies have reported that younger patients were more likely to have tube feeding removed before discharge compared with older patients [1,9]. We also noted that the weaned group was younger than the nonweaned group; however, this difference was not strong enough to achieve statistical significance. In contrast to previous studies [8], no significant association was observed between prior stroke and nasogastric tube removal (P value = 0.55); however, functional status before this stroke was statistically different (P value = 0.03).

Our finding that type of stroke (infarct or hemorrhage) had no significant effect on nasogastric tube removal in patients with dysphagia is similar to those of previous studies [8,11]. Several studies have shown no significant association between the lateralization of brain injury and dysphagia [11,12]. Brainstem lesions, particularly the pons and medulla, are well-known predictors of swallowing problems [2]; however, they are inconsistent as predictors of nasogastric tube removal. Our study indicated that brainstem lesions were not statistically significant between the two groups. This finding was confirmed by

Fig. 1



The area under the receiver operating characteristic (ROC) curve is 0.8204.

previous studies [1,8]. We also found that risk factors for stroke, such as diabetes mellitus, hypertension, hyperlipidemia, atrial fibrillation and coronary artery disease, did not predict the outcome in our study sample.

The Barthel index is one of the most widely used functional assessment tools that measure independence in ADL on a scale of 0–100, with lower scores implying greater nursing dependence. It describes 10 tasks and is scored according to the amount of time or assistance required by the patient and shows excellent reliability in patients with stroke [13,14]. Our study revealed that Barthel index scores can also be used to predict nasogastric tube removal before discharge from the rehabilitation ward, which implied that independence in performing ADL was associated with feeding tube removal.

This study found that the ability to answer simple questions (such as 'What do you do at a stoplight?') was related to feeding tube removal. Patients who could not answer such questions exhibited cognitive impairment and aphasia. Previous studies have revealed that functional independence measure (FIM)-cognition could predict nasogastric tube removal [10]. Aphasia is present in 21–38% of patients with acute stroke and is associated with poor cognition [15,16]. Our research included aphasic patients could extend the practical utility.

We describe two studies similar to ours. One used FIM-motor, FIM-cognition, days after onset and age to construct the equation [10]; the other used the findings of video-fluoroscopic swallowing studies (VSS), age, prior stroke, duration from stroke onset to receive VSS and functional status at discharge [8]. We used the Barthel index at admission, lip closing status, ability to answer simple questions and functional independence before stroke to construct the equation in our study. We believe that our equation can be used clinically to predict nasogastric or feeding tube removal in the rehabilitation ward.

Study limitations

Our study has some limitations that must be considered when using these results. First, this is a retrospective study. We cannot understand some factors that may affect removal, such as the patient's appetite, nutritional status and family support. Second, we did not follow up with the patients after discharge. Third, our prediction model predicted outcomes only in patients with stroke. In future studies, we may extend the prediction model to cross-predict outcomes in other patients with similar conditions.

Conclusion

We used the Barthel index at admission, lip closing status, ability to answer simple questions and functional independence before stroke to develop a predictive model by using multivariate logistic regression. The model has high sensitivity and positive predictive value to identify the probability of a patient's nasogastric tube removal before discharge from the rehabilitation ward. These findings are of practical assistance for physicians and speech pathologists to plan patient care.

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Conflicts of interest

There are no conflicts of interest.

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