Predictors of nasogastric tube removal in patients with stroke and dysphagia
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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].

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 \times \text{functional independence before stroke} + 1.1279 \times \text{ability to answer simple question} + 0.5345 \times \text{lip-close status} + 0.0546 \times \text{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.

Keywords: stroke, dysphagia, nasogastric tube, deglutition, deglutition disorders

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,
stroke type (ischemic or hemorrhagic), medical history (diabetes mellitus, hypertension, coronary artery disease, hyperlipidemia, atrial fibrillation, prior stroke), and functional status at admission (ambulatory/standing or wheelchair-bound). We also performed a stepwise multivariate logistic regression model 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 stroke + 1.1279 × ability to answer simple questions + 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
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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].

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

![ROC Curve for Model](image)

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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