Original Article

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Predictors for Failed Removal of Nasogastric Tube in Patients With Brain Insult

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Objective: To construct a prognostic model for unsuccessful removal of nasogastric tube (NGT) was the aim of our study.
Methods: This study examined patients with swallowing disorders receiving NGT feeding due to stroke or traumatic brain injury in a regional hospital. Clinical data was collected, such as age, sex, body mass index (BMI), level of activities of daily living (ADLs) dependence. Additionally, gather information regarding the enhancement in Functional Oral Intake Scale (FOIS) levels and the increase in food types according to the International Dysphagia Diet Standardization Initiative (IDDSI) after one month of swallowing training. A stepwise logistic regression analysis model was employed to predict NGT removal failure using these parameters.
Results: Out of 203 patients, 53 patients (26.1%) had experienced a failed removal of NGT after six months of follow-up. The strongest predictors for failed removal were age over 60 years, underweight BMI, total dependence in ADLs, and ischemic stroke. The admission prediction model categorized patients into high, moderate, and low-risk groups for removal failure. The failure rate of NGT removal was high not only in the high-risk group but also in the moderate-risk groups when there was no improvement in FOIS levels and IDDSI food types.
Conclusion: Our predictive model categorizes patients with brain insults into risk groups for swallowing disorders, enabling advanced interventions such as percutaneous endoscopic gastrostomy for high-risk patients struggling with NGT removal, while follow-up assessments using FOIS and IDDSI aid in guiding rehabilitation decisions for those at moderate risk.

Keywords: Deglutition disorders, Gastrointestinal intubation, Stroke, Traumatic brain injury

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INTRODUCTION

Dysphagia is a common complication following stroke and traumatic brain injury (TBI), with reported incidence rates ranging from 27% to 80% [1,2]. Patients with these conditions often require nasogastric tube (NGT) feeding to maintain nutritional supply in acute stage and are frequently encountered in rehabilitation settings. Dysphagia can lead to malnutrition, aspiration pneumonia, prolong hospitalization, and increase the risk of morbidity and mortality [3,4]. NGT feeding may suffice for patients requiring nutritional support for up to 4 weeks [5]. Extended utilization of an NGT can lead to various adverse events,

such as nasal wing lesions, chronic sinusitis, gastroesophageal reflux, gastrointestinal bleeding, and aspiration pneumonia [6-8]. Therefore, for extended periods, the placement of a gastrostomy tube should be taken into consideration to avoid the side effects of long-term usage of NGT for nutrition supply [5].

Bedside swallowing assessments can quickly detect dysphagia, but predicting its recovery is challenging. Early identification of dysphagia recovery prognosis would enable prompt administration of appropriate therapies and consideration of suitable feeding methods such as NGT or gastrostomy tube. Preexisting studies have found that patients with high National Institutes of Health Stroke Scale (NIHSS) scores, aspiration during swallowing assessments, advanced age, dysarthria, and intubation are at a higher risk of experiencing prolonged dysphagia lasting for more than 6 weeks [9-11]. However, no work has mentioned the exact percentage of failure of complete oral feeding through the above mentioned parameters. As a result, our work attempts to develop a model capable of predicting the unsuccessful removal of NGT in dysphagia patients who have experienced a stroke or TBI. Additionally, the model may provide the information for the early intervention of gastrostomy tube.

METHODS

From January 2020 to December 2022, we retrospectively analyzed clinical data of patients admitted to the rehabilitation department in a regional hospital, who experienced stroke or TBI with dysphagia and requiring NGT feeding. A total of 203 patients, comprising 133 males and 70 females, were enrolled in the study, and their NGT removal failure rates were tracked over a six-month period. Baseline demographic characteristic of age, sex, admission diagnosis (ischemic stroke, hemorrhagic stroke, or TBI), initial Glasgow Coma Scale (GCS), body mass index (BMI), Functional Independence Measure (FIM) score, level of activities of daily living (ADLs) dependence were recorded. We define a patient as ADLs total dependent when they are completely unable to perform four aspects: personal hygiene, heavy hygiene (toilet and bathing), eating, and dressing. If the criteria mentioned above are not met, the patient is referred to as ADLs partial dependent. Clinical variables were correlated after one month of swallowing training, including the improvement in Functional Oral Intake Scale (FOIS) levels and variation in the numbers of food type according to International Dysphagia Diet Standardization Initiative (IDDSI). The swallowing training consists of direct method such as modifying food texture, utilizing chin tuck and head turn/tilt compensatory techniques, and indirect method such as applying thermal tactile stimulation, practicing pharyngeal wall contraction exercises (Masako maneuver) and practicing effortful swallowing, according to the evaluation of swallowing condition of the patients. We utilized both videofluoroscopic swallowing study, fiberoptic endoscopic evaluation of swallowing, or bedside clinical swallow assessment by physicians to evaluate patients' swallowing function. Simultaneously, we integrate the assessment conducted by the speech-language therapist to determine the optimal timing for NGT removal.

This study received approval from the Research Ethics Committee of Hualien Tzu Chi Hospital, Buddhist Tzu Chi Medical Foundation (approval number: IRB112-206-B). Due to its retrospective nature, the requirement for informed consent was waived.

SAS Software version 9.4 (SAS Institute) was used for statistical analysis. Exclude patients with missing data and conduct individual subgroup analyses on the available data, resulting in variations in the total number of patients for different variables. The categorical variables were demonstrated as counts and percentages. The continuous variables were presented. Comparisons of these clinical data between each group were made by using the chi-square test for categorical variables and the two sample t-test for continuous variables. A stepwise logistic regression analysis was used to develop a model for predicting failure of NGT removal. A p-value of less than 0.05 was considered statistically significant.

RESULTS

A total of 203 patients were included in the study, of which 150 (73.9%) had their NGT successfully removed, while 53 (26.1%) experienced removal failure after six months of follow-up. Table 1 provides an overview of the subjects' demographic and clinical variables. Univariate analysis demonstrates a significant correlation between age, admission diagnosis, BMI, FIM score, and ADLs dependence and the failure of NGT removal. The age stratification involves incorporating patients' age groups into the logistic regression analysis to obtain odds ratios (ORs), and both the age groups of 60–70 and over 70 were found to be significant variables. Using a stepwise regression analysis, we examined the effect of these significant variables. Age between 60–70 years (OR, 3.44; $p<0.05$), age over 70 years (OR, 6.16; $p<0.05$), underweight BMI (OR, 5.09; $p<0.05$), total depen-

dence in ADLs (OR, 9.90; p<0.05), and ischemic stroke (OR, 4.10; p<0.05) were found to be the strongest predictors for failed removal (Table 2). According to the OR values of significant variables, directly rounding to the nearest integer to convert to weight scores, for example: the OR for low BMI was 5.09, then its weight score would be 5. Using the weight scores derived from the predictive model for tube removal failure, the total weight score for tube removal failure in patients is calculated. Analysis of the OR distribution derived from spline regression reveals three distinct risk trends within the graphic representation (Fig. 1). Further categorization stratifies risk into groups scoring 0–6, 7–16, and 17 points or more. Following these groupings, logistic regression is utilized to estimate the ORs prior to the adjustment of other variables (Table 3). The failure rates of NGT removal were 5.1% in the low-risk group, 21.5% in the moderate-risk group, and 73.0% in the high-risk group (Table 3).

After swallowing training in high-risk and low-risk populations, the degree of improvement in FOIS and IDDSI does not impact the risk of failure in NGT removal as much as it does in the moderate-risk population. Therefore, we primarily focused on the moderate-risk population for further analysis. As shown in Table 4, for patients who did not show improvement in FOIS levels after training, the failure rate of NGT removal was 81.2% six months later. For those who improved by one FOIS level, the failure rate was 50.0%, while for those who improved by two FOIS levels, the failure rate was 37.5%. For patients whose IDDSI food types did not change after training, the failure rate

Table 1. Baseline clinical variables of the patients

Variable	Total		Nasogastric tube weaning				p-value
			Success		Failure		
	n	% or mean±SD	n	% or mean±SD	n	% or mean±SD	
Age	203	64.7±15.5	150	61.8±15.4	53	73.2±12.3	<0.0001*
Sex							0.5622
Female	70	34.5	50	33.3	20	37.7	
Male	133	65.5	100	66.7	33	62.3	
BMI	198	23.9±8.0	148	24.4±8.7	50	22.4±5.4	0.1344
BMI level							0.0124*
Normal (18.5≤BMI≤24.0 kg/m^2)	92	45.3	67	44.7	25	47.2	
Underweight (<18.5 kg/m^2)	25	12.3	13	8.7	12	22.6	
Overweight (>24.0 kg/m^2)	86	42.4	70	46.7	16	30.2	
Diagnosis							0.0016*
Hemorrhagic stroke	76	37.4	63	42.0	13	24.5	
TBI	43	21.2	36	24.0	7	13.2	
Ischemic stroke	84	41.4	51	34.0	33	62.3	
GCS	191	10.4±3.9	139	10.6±3.8	52	9.7±4.0	0.1665
ADLs							<0.0001*
Partial dependent	100	49.3	89	59.3	11	20.8	
Totally dependent	103	50.7	61	40.7	42	79.2	

BMI, body mass index; TBI, traumatic brain injury; GCS, Glasgow Coma Scale; ADLs, activities of daily living.
*Significant difference among groups (p<0.05).

Table 2. Stepwise logistic regression analysis for predicting nasogastric tube removal failure model

Variable	Odds ratio	95% Wald CI		p-value	Assigned weight points
		Lower	Upper		
60≤Age<70 yr	3.44	1.09	10.86	0.0352*	3
70 yr≤Age	6.16	2.10	18.08	0.0009*	6
Ischemic stroke	4.10	1.69	9.95	0.0018*	4
BMI underweighted (<18.5 kg/m^2)	5.09	1.57	16.46	0.0066*	5
ADLs totally dependent	9.90	4.04	24.27	<0.0001*	10

CI, confidence interval; BMI, body mass index; ADLs, activities of daily living.
*Significant difference among groups (p<0.05).

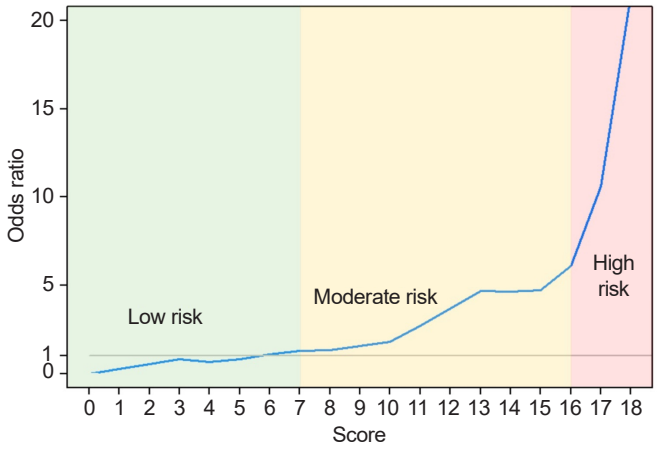

Fig. 1. Estimated graph of the odds ratio between weight scores and the likelihood of nasogastric tube removal.

Table 3. Predictive nasogastric tube removal failure model for risk stratification of tube removal failure

Group	Score	Weaned (n)	Non-weaned (n)	Non-weaned/ total (%)
Low risk	0–6	56	3	5.1
Moderate risk	7–16	84	23	21.5
High risk	≥17	10	27	73.0
Total		150	53	

of tube removal was 85.7%. However, for those who improved by one type of food, the failure rate was 10.0%, and for those who improved by two types of food, the failure rate was 21.4%. In the moderate-risk group, improvements in FOIS levels and an increase in IDDSI food types after one month of swallowing training may be used to predict the likelihood of NGT removal failure after six months of follow-up observation. We amplified our model sample using bootstrapping by 1,000 times for internal validation and obtained the area under the receiver operating characteristic (ROC) curve. The area under the ROC curve is 0.829. The sensitivity and specificity were 75.5% and 23.3%, respectively. In the Fig. 2, the blue line represents our model, while the dashed line represents the results obtained through bootstrapping. The Fig. 2 shows that the two lines almost overlap (DeLong test p-value=0.9831).

DISCUSSION

In this work, we identified several strong predictors for failed remove of NGT after six months of follow-up, including age between 60–70 years, age over 70 years, underweight BMI, total

Table 4. In the moderate-risk group, the improvement in FOIS level and the increase in the number of food types base on IDDSI correspond to the non-weaned rate of NGT removal

	Total (n)	Success (n)	Failure (n)	Non-weaned rate (%)
Improvement of FOIS levels	102	79	23	
0	16	3	13	81.2
1	14	7	7	50.0
2	8	5	3	37.5
3	64	64	0	0
Increase in the number of IDDSI food types (item)	99	76	23	
0	21	3	18	85.7
1	10	9	1	10.0
2	14	11	3	21.4
3	54	53	1	1.9

FOIS, Functional Oral Intake Scale; IDDSI, International Dysphagia Diet Standardization Initiative; NGT, nasogastric tube.

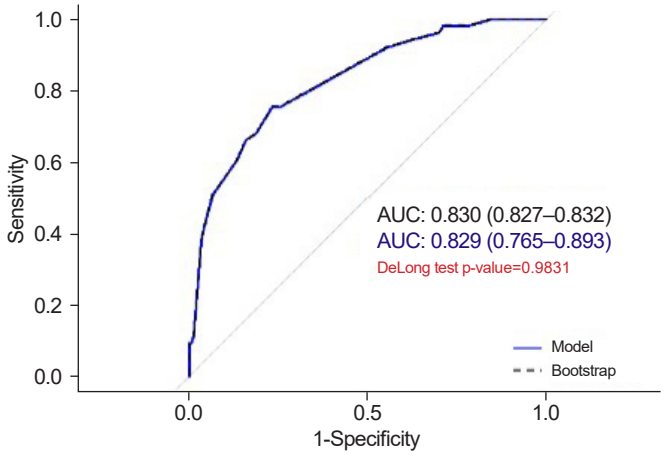

Fig. 2. The area under the receiver operating characteristic curve is 0.829. AUC, area under curve.

dependence in ADLs, and ischemic stroke. We also utilized the weighted scores of the ORs to create a formula to forecast the risk of NGT removal failure and found the risk score greater than 17 have 73.0% of failure of removing NGT.

For patients requiring nutritional support for up to 30 days, NGT feeding alone may be sufficient, but for longer durations, consideration should be given to percutaneous endoscopic gastrostomy (PEG) tube placement [5]. Compared to NGT, PEG offers several advantages, including a lower risk of intervention failure, fewer incidences of pneumonia among PEG recipients, improved quality of life, and higher levels of albumin [8]. Currently, PEG has become a recognized treatment option for temporary or permanent dysphagia resulting from neurological

disorders and oncological conditions [12]. Implementing continuous enteral nutrition at an earlier stage holds the potential to significantly enhance prognosis [12].

Additionally, with early gastrostomy placement, the prevalence of low albumin levels and higher comorbidity, both of which are risk factors for worse outcomes, would be reduced in patients chosen for this intervention [12]. Nevertheless, the benefits of PEG feeding remain uncertain in patient with advanced dementia, and elderly patients over 80 years old [5].

With this result, we propose the following recommendations for dysphagia patients with brain insult who require tube feeding for nutrition support: those identified as high risk based on the research results could early decide whether to undergo or not. Patients with moderate risk should evaluate improvements in FOIS and IDDSI scores after the first month of swallowing training. If there is no improvement observed, these patients may benefit from early decision of further management, considering the high failure rates of 81.2% and 85.7% for the FOIS and IDDSI non-improvement groups, respectively, as indicated in Table 4. Additionally, when suggesting PEG placement, it is advisable to take into account factors such as the presence of advanced dementia and whether the patient is over the age of 80, as per our model's recommendations.

In our study, we observed that 26.1% of the patients failure of removing the NGT after six months follow up. This finding aligns with previous research, which reported removal failure rates ranging from 26% to 69% [13-15]. In spite of antecedent studies investigating the correlation between various risk factors and NGT removal in stroke patients [16,17], our study provides processional data for predicting the risk of failure of removing. Moreover, preceding research has highlighted that swallowing difficulties resulting from TBI are comparable to those observed in stroke patients [1]. Therefore, we can do early decision of alternative management of NGT feeding for the patients with dysphagia such as insertion of gastrostomy, specifically focused on patients with stroke or TBI.

The parameters in our study consistent with preexisting research findings are age, sex, initial GCS and ADLs dependence. Former research has shown that older patients and those with lower FIM scores have a reduced likelihood of NGT removal [14,15]. A lower FIM score indicates that subject has a higher degree of dependency in their daily activities. In our investigation, we also noticed significant differences in age and ADLs dependence between the nonweaned group and the weaned group. The non-weaned group comprised individuals who are older and a larger number of individuals who are completely dependent on ADLs.

Previous studies demonstrated methodological variations and reported inconsistent associations between sex and oral intake recovery [3,16,18]. Certain studies [16,18] excluded sex as a variable in their multivariable analyses due to the absence of significant differences in bivariate analysis. One study indicated that female sex was associated with better outcomes [19]. In our study, there was no significant difference in sex between the NGT-weaned group and the NGT non-weaned group. Further research is needed to explore its impact on the recovery of swallowing disorders.

In individuals with TBI, a low initial GCS consistently indicated compromised oral intake [20]. Additionally, Morgan et al. [21] noted that low GCS scores were predictive of dysphagia in pediatric TBI patients. Another study found that among stroke patients, the deterioration in verbal response, assessed using the GCS, demonstrated a notably stronger association with swallowing recovery failure [22]. However, the statistical significance of the GCS variable in the present study may be influenced by the sample size. Numerous studies [9,10,11,23] in this domain have demonstrated a link between NIHSS scores and unfavorable recovery outcomes. One study found that higher NIHSS scores were associated with delayed removal times of NGT [14]. Nonetheless, while the NIHSS is mainly employed for prognostic assessment in post-stroke patients, the GCS has broader applications, encompassing prognostic evaluation in brain injury patients and even the assessment of recovery in swallowing disorders, in addition to its use with stroke patients.

A study proposed in 2021 that there is no correlation between body weight and NGT removal [17], which differs from our research findings. Our study highlighted the significant impact of being underweight on the failure of NGT removal. A BMI below 20 is widely acknowledged as an indicator of malnutrition, and a low BMI is correlated with a higher probability of probable sarcopenia [24,25]. Previous studies have also indicated a link between malnutrition and dysphagia [26], and there is evidence of a relationship between sarcopenia and decreased swallowing function, particularly among older adults in Japan [27]. This finding may inferred that malnutrition and sarcopenia may be risk factors for the poor recovery of swallowing function in individuals who have experienced a stroke or brain injury. The decline in overall muscle mass and strength that accompanies being underweight may contribute to the weakening of the muscles involved in the swallowing process [28]. This

weakened musculature could explain the increased likelihood of NGT removal failure observed in underweight individuals in our study. Furthermore, a separate study demonstrated that stroke survivors with lower BMI values, particularly those in the lowest quartiles, exhibited more severe stroke symptoms and experienced poorer functional recovery compared to individuals with higher BMI values [29]. These studies further support the association between underweight and greater severity of stroke, poorer functional recovery, and even swallowing function.

There are limited study mentioning the correlation between stroke types and the failure rate of NGT removal [17,30], and only one study identified intracerebral hemorrhage as a predictive factor for NGT removal [31]. Our study revealed a significant association between ischemic stroke and the failure rate of tube removal. Furthermore, another study published in Stroke provided additional insights by demonstrating that patients with cerebral infarction had poorer functional and neurological recovery compared to those with hemorrhagic stroke [32]. The relationship between stroke type and removal of NGT needs further study.

A retrospective study revealed that for each increase of one FOIS level, there was a 3.7-fold higher likelihood of tube removal [33]. Consistently, our study yielded similar results, indicating that the extent of FOIS level improvement after one month of swallowing training could predict the likelihood of NGT removal failure six months later. Patients who exhibited no change in FOIS levels following the initial month of swallowing training after experiencing a brain insult had the highest rate of tube removal failure, whereas those who demonstrated greater improvements had lower failure rates. Additionally, another study found that higher FOIS levels were correlated with a higher probability of returning to complete oral intake post-stroke [34]. Furthermore, our study identified that the greater improvement in the ability to consume various food items (according to IDDSI) after one month of swallowing training, the lower the likelihood of NGT removal failure six months after the brain insult. Although one study mentioned that FOIS at admission could predict the time to return to unrestricted oral intake [35], no previous study has evaluated the probability of NGT removal failure six months after brain insult using changes in FOIS and IDDSI following one month of swallowing training, which is a relatively unique feature of our predictive model.

Using our predictive model, patients with brain insults can be initially categorized into risk groups for swallowing disorders. Subsequently, advanced swallowing interventions can be implemented for high-risk patients who encounter difficulties in NGT removal. These interventions may include the combined use of repetitive transcranial magnetic stimulation or VitalStim, long-term education on NGT care, or alternative options for enteral feeding. For individuals at moderate risk, a progress assessment of NGT removal rate using FOIS and IDDSI can be conducted one month later. If there is no improvement, rehabilitation training similar to that for high-risk cases should be followed, while others can undergo regular swallowing rehabilitation training.

One study utilized FIM-motor, FIM-cognition, days after onset, and age to construct the equation [15]; the other utilized the Barthel index at admission, lip-closing status, ability to answer simple questions, and functional independence before stroke to construct the equation [17]. In contrast, ours utilizes patient age, stroke history, BMI, and total dependence in ADLs to form a risk prediction model, and provides early intervention recommendations. Our risk factors are relatively simple and applicable for predicting NGT removal in both stroke and TBI patients.

There are certain limitations in our study that need to be taken into account when interpreting these findings. Firstly, it is important to note that this study is retrospective in nature, which means we are unable to control for participant consistency. Secondly, due to the retrospective nature of this research, there may be instances of missing and incomplete clinical data. Thirdly, we faced the challenge of not being able to control the intervention methods applied to participants. Not all individuals in the study received the same swallowing training, leading to variations in the methods used. Fourthly, we did not actually have the patients undergo nutritional assessments or tests for sarcopenia. These constraints highlight the need for future research with more controlled settings and comprehensive data collection to further validate and refine our findings.

In conclusion, our study identified factors predicting NGT removal failure, including older age, underweight, complete ADLs dependence, and ischemic stroke. We also created a predictive model to assess this risk, aiding healthcare professionals in identifying high-risk patients and providing suitable interventions and training.

CONFLICTS OF INTEREST

Fuk Tan Tang is an Editorial Board member of Annals of Rehabilitation Medicine. The author did not engage in any part of the review and decision-making process for this manuscript.

Otherwise, no potential conflict of interest relevant to this article was reported.

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AUTHOR CONTRIBUTION

Conceptualization: Huang ST, Yeh SM, Wang TG, Tang FT, Hsieh YT, Ho CS. Methodology: Huang ST. Formal analysis: Huang ST, Yeh SM, Chen WM, Jao AT. Funding acquisition: Yeh SM. Project administration: Peng MC. Visualization: Huang ST, Yeh SM, Chen WM, Jao AT. Writing – original draft: Huang ST, Yeh SM. Writing – review and editing: Wang TG, Yeh SM. Approval of final manuscript: all authors.

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REFERENCES

1. Lee WK, Yeom J, Lee WH, Seo HG, Oh BM, Han TR. Characteristics of dysphagia in severe traumatic brain injury patients: a comparison with stroke patients. Ann Rehabil Med 2016;40:432-9.
2. Takizawa C, Gemmell E, Kenworthy J, Speyer R. A systematic review of the prevalence of oropharyngeal dysphagia in stroke, Parkinson's disease, Alzheimer's disease, head injury, and pneumonia. Dysphagia 2016;31:434-41.
3. Martino R, Foley N, Bhogal S, Diamant N, Speechley M, Teasell R. Dysphagia after stroke: incidence, diagnosis, and pulmonary complications. Stroke 2005;36:2756-63.
4. Marik PE, Kaplan D. Aspiration pneumonia and dysphagia in the elderly. Chest 2003;124:328-36.
5. Rahnemai-Azar AA, Rahnemaiazar AA, Naghshizadian R, Kurtz A, Farkas DT. Percutaneous endoscopic gastrostomy: indications, technique, complications and management. World J Gastroenterol 2014;20:7739-51.
6. Metheny NA, Meert KL, Clouse RE. Complications related to feeding tube placement. Curr Opin Gastroenterol 2007;23:178-82.
7. Hsu CY, Lai JN, Kung WM, Hung CH, Yip HT, Chang YC, et al. Nationwide prevalence and outcomes of long-term nasogastric tube placement in adults. Nutrients 2022;14:1748.
8. Gomes CA Jr, Andriolo RB, Bennett C, Lustosa SA, Matos D, Waisberg DR, et al. Percutaneous endoscopic gastrostomy versus nasogastric tube feeding for adults with swallowing disturbances. Cochrane Database Syst Rev 2015;2015:CD008096.
9. Ickenstein GW, Höhlig C, Prosiegel M, Koch H, Dziewas R, Bodechtel U, et al. Prediction of outcome in neurogenic oropharyngeal dysphagia within 72 hours of acute stroke. J Stroke Cerebrovasc Dis 2012;21:569-76.
10. Kumar S, Doughty C, Doros G, Selim M, Lahoti S, Gokhale S, et al. Recovery of swallowing after dysphagic stroke: an analysis of prognostic factors. J Stroke Cerebrovasc Dis 2014;23:56-62.
11. Mandaville A, Ray A, Robertson H, Foster C, Jesser C. A retrospective review of swallow dysfunction in patients with severe traumatic brain injury. Dysphagia 2014;29:310-8.
12. Dietrich CG, Schoppmeyer K. Percutaneous endoscopic gastrostomy- too often? Too late? Who are the right patients for gastrostomy? World J Gastroenterol 2020;26:2464-71.
13. Lin YN, Chen SY, Wang TG, Chang YC, Chie WC, Lien IN. Findings of videofluoroscopic swallowing studies are associated with tube feeding dependency at discharge in stroke patients with dysphagia. Dysphagia 2005;20:23-31. Erratum in: Dysphagia 2005;20:388.
14. Lee JH, Kim SB, Lee KW, Lee SJ, Park JG, Ri JW. Associating factors regarding nasogastric tube removal in patients with Dysphagia after stroke. Ann Rehabil Med 2014;38:6-12.
15. Oto T, Kandori Y, Ohta T, Domen K, Koyama T. Predicting the chance of weaning dysphagic stroke patients from enteral nutrition: a multivariate logistic modelling study. Eur J Phys Rehabil Med 2009;45:355-62.
16. Ikenaga Y, Nakayama S, Taniguchi H, Ohori I, Komatsu N, Nishimura H, et al. Factors predicting recovery of oral intake in stroke survivors with dysphagia in a convalescent rehabilitation ward. J Stroke Cerebrovasc Dis 2017;26:1013-9.
17. Lee KC, Liu CT, Tzeng IS, Chie WC. Predictors of nasogastric tube removal in patients with stroke and dysphagia. Int J Rehabil Res 2021;44:205-8.
18. Nakadate A, Otaka Y, Kondo K, Yamamoto R, Matsuura D, Honaga

K, et al. Age, body mass index, and white blood cell count predict the resumption of oral intake in subacute stroke patients. J Stroke Cerebrovasc Dis 2016;25:2801-8.
19. Inooka Y, Yamana H, Shinoda Y, Inokuchi H, Matsui H, Fushimi K, et al. Predictive factors for oral intake recovery after acute stroke: analysis of a Japanese nationwide inpatient database. Dysphagia 2022;37:1623-32.
20. Muscari A, Falcone R, Pirazzoli E, Faccioli L, Muscari S, Pastore Trossello M, et al. Predicting failure to recover swallowing in patients with severe post-stroke dysphagia: the DIsPHAGIc score. Dysphagia 2023;38:290-304.
21. Morgan A, Ward E, Murdoch B, Kennedy B, Murison R. Incidence, characteristics, and predictive factors for Dysphagia after pediatric traumatic brain injury. J Head Trauma Rehabil 2003;18:239-51.
22. Mackay LE, Morgan AS, Bernstein BA. Swallowing disorders in severe brain injury: risk factors affecting return to oral intake. Arch Phys Med Rehabil 1999;80:365-71.
23. Rhie SH, Choi JW, Jeon SJ, Kang SD, Joo MC, Kim MS. Characteristics of patients with aneurysmal subarachnoid hemorrhage and risk factors related to dysphagia. Ann Rehabil Med 2016;40:1024-32.
24. Campillo B, Paillaud E, Uzan I, Merlier I, Abdellaoui M, Perennec J, et al. Value of body mass index in the detection of severe malnutrition: influence of the pathology and changes in anthropometric parameters. Clin Nutr 2004;23:551-9.
25. Curtis M, Swan L, Fox R, Warters A, O'Sullivan M. Associations between body mass index and probable sarcopenia in community-dwelling older adults. Nutrients 2023;15:1505.
26. Veldee MS, Peth LD. Can protein-calorie malnutrition cause dysphagia? Dysphagia 1992;7:86-101.
27. Kuroda Y, Kuroda R. Relationship between thinness and swallowing function in Japanese older adults: implications for sarcopenic dysphagia. J Am Geriatr Soc 2012;60:1785-6. Erratum in: J Am Geriatr Soc 2012;60:2385.
28. Maeda K, Takaki M, Akagi J. Decreased skeletal muscle mass and risk factors of sarcopenic dysphagia: a prospective observational cohort study. J Gerontol A Biol Sci Med Sci 2017;72:1290-4.
29. Kim Y, Kim CK, Jung S, Yoon BW, Lee SH. Obesity-stroke paradox and initial neurological severity. J Neurol Neurosurg Psychiatry 2015;86:743-7.
30. Fernández-Pombo A, Seijo-Raposo IM, López-Osorio N, Cantón-Blanco A, González-Rodríguez M, Arias-Rivas S, et al. Lesion location and other predictive factors of dysphagia and its complications in acute stroke. Clin Nutr ESPEN 2019;33:178-82.
31. Ke Z, Liu W, Chen FY, Ge WY, Li XP, Fan XN, et al. Intracerebral hemorrhage and absence of pneumonia are independent predictors for nasogastric tube removal of post-stroke dysphagia. Ann Indian Acad Neurol 2023;26:90-3.
32. Paolucci S, Antonucci G, Grasso MG, Bragoni M, Coiro P, De Angelis D, et al. Functional outcome of ischemic and hemorrhagic stroke patients after inpatient rehabilitation: a matched comparison. Stroke 2003;34:2861-5.
33. Chuang ST, Yen YH, Hsu H, Lai MW, Hung YF, Tsai SW. Predictive factors for nasogastric tube removal in post-stroke patients. Medicina (Kaunas) 2023;59:368.
34. Ikenaga Y, Fudeya M, Kusunoki T, Yamaguchi H. Factors contributing to complete oral intake in dysphagic stroke patients with enteral feeding tubes in convalescent rehabilitation wards. Prog Rehabil Med 2023;8:20230011.
35. Hansen TS, Engberg AW, Larsen K. Functional oral intake and time to reach unrestricted dieting for patients with traumatic brain injury. Arch Phys Med Rehabil 2008;89:1556-62.