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ORIGINAL ARTICLE

A Retrospective Review of Swallow Dysfunction in Patients with Severe Traumatic Brain Injury

Amy Mandaville · Anjea Ray · Henry Robertson · Careen Foster · Christine Jesser

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Abstract In the acute-care setting, it is difficult for clinicians to determine which patients with severe traumatic brain injury will have long-term oropharyngeal dysphagia (>6 weeks) and which patients will begin oral nutrition quickly. Patients frequently remain in the acute-care setting while physicians determine whether to place a percutaneous endoscopic gastrostomy (PEG) tube. To improve the acute-care clinician's ability to predict long-term oropharyngeal dysphagia and subsequent need for PEG tube placement in patients with severe traumatic brain injury [Glascow Coma Scale (GCS) $\leq$8), a novel prediction model was created utilizing clinical information and acute-care swallowing evaluation findings. Five years of retrospective data were obtained from trauma patients at a Level 1 trauma hospital. Of the 375 patients who survived their hospitalization with a GCS $\leq$8, a total of 269 patients received Ranchos Los Amigos (RLA) scores. Of those patients who were scored for RLA, 219 patients underwent swallowing evaluation. Ninety-six of the 219 patients were discharged from the hospital with a feeding tube, and 123 patients were discharged without one. Logistic regression models examined the association between clinical and patient characteristics and whether a patient with severe traumatic brain injury exhibited long-term oropharyngeal dysphagia. Multivariable logistic regression analysis revealed that increased age, low RLA score, tracheostomy tube placement, and aphonia observed on the initial swallowing evaluation significantly increased the odds of being discharged from the acute-care hospital with a feeding tube. The resultant model could be used clinically to guide decision making and to counsel patients and families.

Keywords Deglutition · Deglutition disorders · Clinical prediction model · Long-term dysphagia · Severe traumatic brain injury · Percutaneous gastrostomy tube

Introduction

Oropharyngeal dysphagia, or swallowing disorder, is a common diagnosis for patients with neurological disorders and can result in significant medical sequelae without early identification and treatment. However, patients recover at variable rates from different neurological disorders, and some patients require long-term alternative nutrition and hydration during the recovery process. Two alternative means of nutrition and hydration are available to patients with dysphagia: nasogastric tube feeding and percutaneous endoscopic gastrostomy (PEG) tube feeding. In general, long-term nutrition and hydration deficits for patients with severe, persistent oropharyngeal dysphagia are managed with placement of a PEG tube. PEG tube placement is an endoscopic surgical procedure with concomitant surgical

A. Mandaville (✉) · A. Ray
University Medical Center at Brackenridge, 601 E. 15th Street, Austin, TX 78701, USA
e-mail: amandaville@seton.org; admandaville@gmail.com

A. Ray
e-mail: aeray@seton.org

H. Robertson · C. Jesser
Seton Family of Hospitals Analytics and Health Economics, 1345 Philomena Street, Austin, TX 78723, USA
e-mail: htrobertson@seton.org

C. Jesser
e-mail: cajesser@seton.org

C. Foster
Trauma Trust, 315 Martin Luther King Jr. Way, Tacoma, WA 98405, USA

risks, including perforation, bleeding, infection, dislodgement, and death [1]. However, patients who need long-term nutritional support often prefer a PEG tube to a nasogastric feeding method. Nasogastric feeding is tolerated poorly by patients, and the nasogastric tubes easily become clogged or dislodged, resulting in the need for uncomfortable reinsertion [2]. In addition, nasogastric tube feedings can result in gastroesophageal reflux and aspiration pneumonia and with use longer than 6 weeks, patients can develop lesions of the nasal wing and chronic sinusitis [3]. Timely determination of prognosis for swallowing function recovery and assessment of adequate oral intake are necessary to decide which patients with dysphagia will require enteral nutritional support and which patients will not.

Most oropharyngeal dysphagia research has been conducted on patients following cerebrovascular accidents (CVA) [4–7]. Studies on patients who have had a stroke reported prognostic indicators for long-term oropharyngeal dysphagia (>6 weeks), including dysphonia, dysarthria, abnormal gag reflex, abnormal volitional cough, cough after swallow, and voice change after swallow [8]. Delayed oral transit, delayed or absent swallow reflex, increased age, and male gender were reported by Mann et al. [9] to be indicative of severe dysphagia. Linden et al. [10] also included aphonia as a predictor of persistent oropharyngeal dysphagia.

There are few studies that have examined oropharyngeal dysphagia in the traumatic brain injury (TBI) population. However, existing studies have identified a number of variables associated with long-term oropharyngeal dysphagia, including a low Glascow Coma Scale (GCS) score, a low Ranchos Los Amigos (RLA) score, computerized tomography (CT) findings, prolonged ventilator use [11, 12], and tracheostomy tube placement [13, 14]. Even fewer studies have addressed oropharyngeal dysphagia prognosis for patients with TBI in the acute-care setting. Many studies about oropharyngeal dysphagia in patients with brain injury have been conducted in the inpatient rehabilitation setting [15–17]. Results and prognostic factors obtained from inpatient rehabilitation studies may not apply to acute-care patients. Patients in a rehabilitation setting are medically stable and their long-term nutrition method has already been determined during the acute-care hospital stay. However, there is currently no standardized process used by acute-care medical teams that delineates whether to place a PEG tube or leave a nasogastric tube in place prior to transfer to the rehabilitation unit, skilled nursing facility, or home with home health or outpatient services.

However, the prognostic indicators of oropharyngeal dysphagia do not provide direction for determining when to place a PEG tube in the traumatic brain injury population, given that patients cannot have nasogastric tubes placed indefinitely without risk of infection and other complications. There is a need for research to determine which patients with traumatic brain injuries in the acute-care setting will need a PEG tube placed to avoid an unnecessarily long hospital stay, the need to return to the acute-care facility for PEG tube placement after moving to another level of care, or the need to have a PEG tube removed when the patient recovers swallow function soon after PEG tube placement. Drawing on the aforementioned oropharyngeal dysphagia research from CVA patients and the limited research on patients with brain injuries, variables to consider as prognostic indicators may include low GCS, prolonged ventilation, low RLA score, tracheostomy tube placement, dysphonia, aphonia, voice quality changes post-swallow, cough after swallow, and dysarthria [8–10, 14, 18].

The present study of patients at a Level 1 trauma hospital was undertaken to determine factors predictive of PEG tube placement following severe TBI.

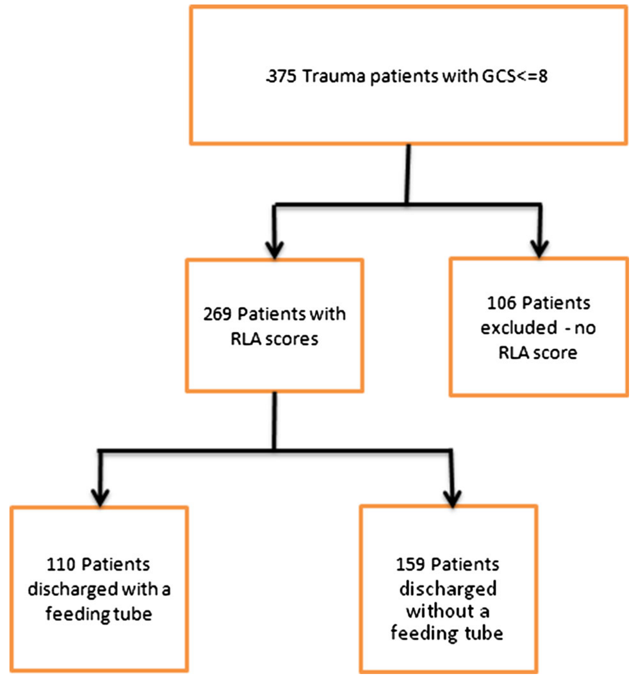

Fig. 1 Flowchart showing primary study outcomes of patients considered for development of prediction model

Materials and Methods

Data Source

Electronic medical records were reviewed of patients admitted to the University Medical Center at Brackenridge (UMCB) trauma service in Austin, Texas, between June 2006 and June 2011. Speech-language pathologists and trained medical students performed the medical records review. Records were periodically checked by an additional reviewer for consistency and accuracy.

A total of 867 patients were admitted to the UMCB trauma service with a GCS of 8 or less during this 5-year period, of which 375 patients survived their hospitalization for inclusion in the current study. RLA scores were indicated and performed for 269 of the patients with severe brain injury. Of those 269 patients, 219 had swallowing evaluations ordered and performed (either bedside swallowing evaluations, modified barium swallow studies, or both), resulting in the target population for analysis. A flowchart detailing patient inclusion in the present study is presented in Fig. 1.

A detailed clinical history was obtained for each patient prior to initiation of therapy services. The initial RLA score was assigned by rehabilitation staff evaluation (physical therapy, occupational therapy, or speech-language pathology). All of the rehabilitation staff at UMCB were Certified Brain Injury Specialists from the Brain Injury Association of America or were in the process of obtaining certification at the time of the study. If a discrepancy was observed in RLA scores between rehabilitation staff members, the speech-language pathologist's score was utilized. Medical variables included in the study were age, gender, GCS score, number of days spent on a ventilator, time frame until RLA score was completed, initial RLA score, time frame until first swallow evaluation was completed, and presence or absence of a tracheostomy tube.

Predictor Variables

Age, gender, initial GCS, days on a ventilator, days to RLA score, initial RLA score, days to swallow evaluation, days to oral intake, days to PEG tube placement, duration of tube feeding, days to full oral intake, tracheostomy tube placement, and duration of tracheostomy tube placement were considered as clinical variables that may predict PEG tube placement in patients with severe traumatic brain injury. All clinical indicators are continuous, except for gender and tracheostomy tube placement, which are binary. These predictors were selected based on author consensus of the predictive importance of a given variable, literature support of the predictive importance of a given variable, and the ease with which the given variable could be determined. Additional predictor variables from the swallowing evaluation were also selected.

Utilizing swallowing criteria from the Schroeder et al. [8] stroke study, dysphonia (voice disturbance), dysarthria (impaired speech intelligibility due to muscular control disturbance), cough after swallow, and voice change after swallow were included in the current analysis. In addition, aphonia (absence of voice) and absent swallow reflex were considered, due to the prevalence of these features in the trauma population. All swallowing variables were modeled as binary predictors. Continuous variables were modeled without transformation.

Table 1 Patient characteristics among severe traumatic brain injury patients at the University Medical Center at Brackenridge, June 2006 to June 2011

Factor	All ($n = 219$)	Discharge with feeding tube ($n = 96$)	Discharge without feeding tube ($n = 123$)
Age (±SD)	36.5 (16.9)	38.9 (17.9)	34.6 (15.9)
Initial Glasgow Coma Scale[a] (±SD)	4.4 (1.9)	4.1 (1.6)	4.7 (2.0)
Ventilator days	8.0 (6.0)	9.5 (6.6)	6.9 (5.3)
Days to Ranchos Los Amigos score[b] (±SD)	10.1 (7.5)	12.0 (7.7)	8.6 (6.9)
Initial Ranchos Los Amigos score[b] (±SD)	4.5 (1.9)	3.7 (1.6)	5.1 (1.8)
Days to swallow evaluation (±SD)	12.1 (11.0)	16.9 (12.8)	8.3 (7.5)
Days to oral intake (±SD)	13.1 (10.7)	19.3 (11.0)	10.3 (9.4)
Days of tube feeds (±SD)	21.8 (20.2)	27.0 (17.5)	16.3 (21.5)
Days to full oral intake (±SD)	17.6 (13.6)	26.3 (12.2)	15.3 (13.1)
Tracheostomy tube [*n* (%)]			
Yes	75 (34.2)	54 (56.3)	21 (17.1)
No	144 (65.8)	42 (43.7)	102 (82.9)
Initial absent swallow reflex [*n* (%)]			
Yes	38 (17.3)	27 (28.1)	11 (8.9)
No	181 (82.7)	69 (71.9)	112 (96.1)
Initial cough after swallow [*n* (%)]			
Yes	111 (50.7)	48 (50.0)	63 (51.2)
No	108 (49.3)	48 (50.0)	60 (48.8)
Initial voice change after swallow [*n* (%)]			
Yes	94 (42.9)	43 (44.8)	51 (41.5)
No	125 (57.1)	53 (55.2)	72 (58.5)
Initial dysphonia [*n* (%)]			
Yes	115 (52.5)	62 (64.6)	53 (43.1)
No	104 (47.5)	34 (35.4)	70 (56.9)
Initial aphonia [*n* (%)]			
Yes	66 (30.1)	44 (45.8)	22 (17.9)
No	153 (69.9)	52 (54.2)	101 (82.1)
Initial dysarthria/impaired speech intelligibility [*n* (%)]			
Yes	90 (41.1)	47 (49.0)	43 (35.0)
No	129 (58.9)	49 (51.0)	80 (65.0)

[a] Glascow Coma Scale scores 1–8 were used in this model

[b] Ranchos Los Amigos score 1–8 were used in this model

Statistical Methods

Model Creation

All analyses were performed using Stata ver. 11 (StataCorp, College Station, TX) and R statistical software ver. 2.15.0 (R: A Language and Environment for Statistical Computing; Vienna, Austria). Predictor variables were tested in univariable logistic regression models. Variables that were statistically significant at $p \leq 0.05$ were added to a multivariable logistic regression model with backward elimination to identify independent predictors of the outcome. The sample size of 219 patients in this study had 80 % power to detect any odds ratio of 2.25 or higher at $\alpha = 0.05$.

Model Validation

The model was cross-validated through 75:25 % random sampling without replacement to construct receiver operator characteristic curves. The random samples were constructed 10,000 times. The area under the curve (AUC) is a summary measure of the discriminative ability of the model, with values between 0.90 and 1.00 indicative of excellent predictive discrimination. AUC values from each of the samples were averaged to create a single value quantifying model discrimination.

Results

Study Population

Demographic, clinical, and swallowing characteristics of the 219 target patients are summarized in Table 1. The age range was 15–88 years, with a mean age of 36 years. There were 169 males and 50 females included in the study. Two hundred five patients had been orally intubated and 75 patients had tracheostomy tubes placed during their hospitalization. Forty-seven of those patients received tracheostomy tubes and PEG tubes during the same operative session.

Outcome

The study outcome of interest was the number of patients discharged from the acute-care hospital with long-term oropharyngeal dysphagia, as measured in the study by discharge with tube feeding. One hundred twenty-three patients who had swallowing evaluations were discharged from the hospital with oral diets. The remaining 96 patients were discharged from the hospital with a feeding tube.

Table 2 Results of univariable regression analysis for predictor variables of oropharyngeal (>6 weeks) dysphagia among severe traumatic brain injury patients at the University Medical Center at Brackenridge, June 2006 to June 2011

Variable	Outcome (*n*)	OR (95 % CI)
Age (years)	96	1.015 (1–1.03)
Gender		
Female	21	1.00 (Ref)
Male	75	1.102 (0.58–2.09)
Initial Glasgow Coma Scale[a]	96	0.851 (0.73–0.99)
Ventilator days	96	1.077 (1.03–1.13)
Days to Ranchos Los Amigos score[b]	96	1.068 (1.03–1.11)
Initial Ranchos Los Amigos score[b]	96	0.628 (0.53–0.75)
Days to swallow evaluation	96	1.104 (1.07–1.14)
Tracheostomy tube placement		
No	42	1.00 (Ref)
Yes	54	6.245 (3.36–11.6)
Initial absent swallow reflex		
No	11	1.00 (Ref)
Yes	27	3.984 (1.86–8.54)
Initial cough after swallow		
No	48	1.00 (Ref)
Yes	48	0.952 (0.56–1.62)
Initial voice change after swallow		
No	53	1.00 (Ref)
Yes	43	1.145 (0.67–1.96)
Initial dysphonia		
No	34	1.00 (Ref)
Yes	62	0.408 (1.39–4.17)
Initial aphonia		
No	52	1.00 (Ref)
Yes	44	3.885 (2.11–7.16)
Initial dysarthria/impaired speech intelligibility		
No	49	1.00 (Ref)
Yes	49	1.785 (1.03–3.08)

Outcome defined as discharge from the hospital with a feeding tube

[a] Glascow Coma Scale scores 1–8 were used in this model

[b] Ranchos Los Amigos scores 1–8 were used in this model

Model Development and Validation

Univariable logistic regression found statistically significant associations ($p \leq 0.05$) between age, initial GCS score, days on a ventilator, time frame until RLA score was completed, initial RLA score, days to swallow evaluation, tracheostomy tube placement, initial absent swallow reflex, initial dysphonia, initial aphonia, and initial dysarthria/impaired speech intelligibility, and discharge with PEG tube (Table 2).

Table 3 Results of multivariable regression analysis for predictor variables of oropharyngeal dysphagia (>6 weeks) among severe traumatic brain injury patients at the University Medical Center at Brackenridge, June 2006 to June 2011

Variable	Outcome	Log OR	OR (95 % CI)
Intercept		−0.097	0.907 (0.29–2.8)
Age (years)	96	0.030	1.030 (1.01–1.05)
Initial Ranchos Los Amigos score[a]	96	−0.479	0.620 (0.51–0.75)
Tracheostomy tube placement			
No	42		1.00 (Ref)
Yes	54	1.846	6.333 (3–13.35)
Initial aphonia			
No	22		1.00 (Ref)
Yes	44	0.768	2.155 (1.05–4.44)

Outcome defined as discharge from the hospital with a feeding tube

[a] Ranchos Los Amigos scores 1–8 were used in this model

Backward elimination was applied to these statistically significant univariable predictors using a multivariable logistic regression model. After adjusting for age, the only independent predictors of long-term dysphagia that remained were initial RLA score, tracheostomy tube placement, and initial aphonia (Table 3). Figure 2 illustrates the relationship between the independent predictors for an overall prediction of long-term oropharyngeal dysphagia and need for PEG tube placement. No interactions among the four predictor variables were significant.

Logistic regression probabilities are predicted by the equation

$$P(\text{outcome} = 1) = \frac{1}{1 + e^{-X\beta}}$$

where X is the matrix of covariates and β is the vector of coefficients (on the log-odds scale). Alternatively,

$$P(\text{outcome} = 1) = e^{X\beta}/e^{X\beta} + 1$$

Based on the results, the probability of long-term oropharyngeal dysphagia is as follows:

$$\frac{\text{Exp}[-0.097 + 0.030(\text{Age}) - 0.497(\text{Initial RLA Score}) + 1.846(\text{Trach}) + 0.768(\text{Aphonia})]}{1 + \text{Exp}[-0.097 + 0.030(\text{Age}) - 0.497(\text{Initial RLA Score}) + 1.846(\text{Trach}) + 0.768(\text{Aphonia})]}$$

where Age is a continuous variable >14, Initial RLA Score is a continuous variable 1–8, Trach is 1 if tracheostomy tube is present and 0 if there is no tracheostomy tube present, Aphonia is 1 if aphonia is present and 0 if there is no aphonia present. For example, a 33-year-old patient with an initial RLA score of 5, a tracheostomy tube, and no initial aphonia will have the probability of long-term oropharyngeal dysphagia of:

$$\frac{\text{Exp}[-0.097 + 0.030(33) - 0.497(5) + 1.846(1) + 0.768(0)]}{1 + \text{Exp}[-0.097 + 0.030(33) - 0.497(4) + 1.846(1) + 0.768(0)]}$$

$$= \frac{\text{Exp}(0.254)}{1 + \text{Exp}(0.254)} \approx \frac{1.289}{2.289} \approx 0.56$$

or 56 % probability of long-term oropharyngeal dysphagia. The model was validated by random sampling. The mean AUC was 0.81, with a standard deviation of 0.05 (Fig. 3).

Discussion

Level 1 trauma hospitals treat large numbers of patients with TBI. In the past few years, clinicians had noted reluctance on the part of UMCB surgeons to place PEG tubes, preferring to utilize nasogastric tubes for extended periods of time. Although literature from the 1990s [19–22] strongly advocated for PEG tube placement with tracheostomy tube placement, more recent stroke literature [23, 24] advocated waiting 2–5 weeks before placing a PEG tube in that patient population. The UMCB surgeons appeared to generalize those stroke recommendations to the brain injury population and began deferring PEG tube placement. For example, in the data from 2009 to 2011, 47 % of patients who received a tracheostomy tube did not undergo PEG tube placement at the same time, compared to 30 % who did not receive both a tracheostomy tube and a PEG tube simultaneously between 2006 and 2008.

Given the difficulty of determining which patients with severe TBI will exhibit long-term oropharyngeal dysphagia which would require PEG tube placement in the acute-care setting, a novel prediction model was created utilizing clinical information and acute-care swallowing evaluation findings. Logistic regression models examined the association between clinical and patient characteristics to create the predictive model. Increased age, low RLA score, tracheostomy tube placement, and aphonia observed on the initial swallowing evaluation were found to be statistically significantly associated with being discharged from an acute-care Level 1 trauma center with a feeding tube.

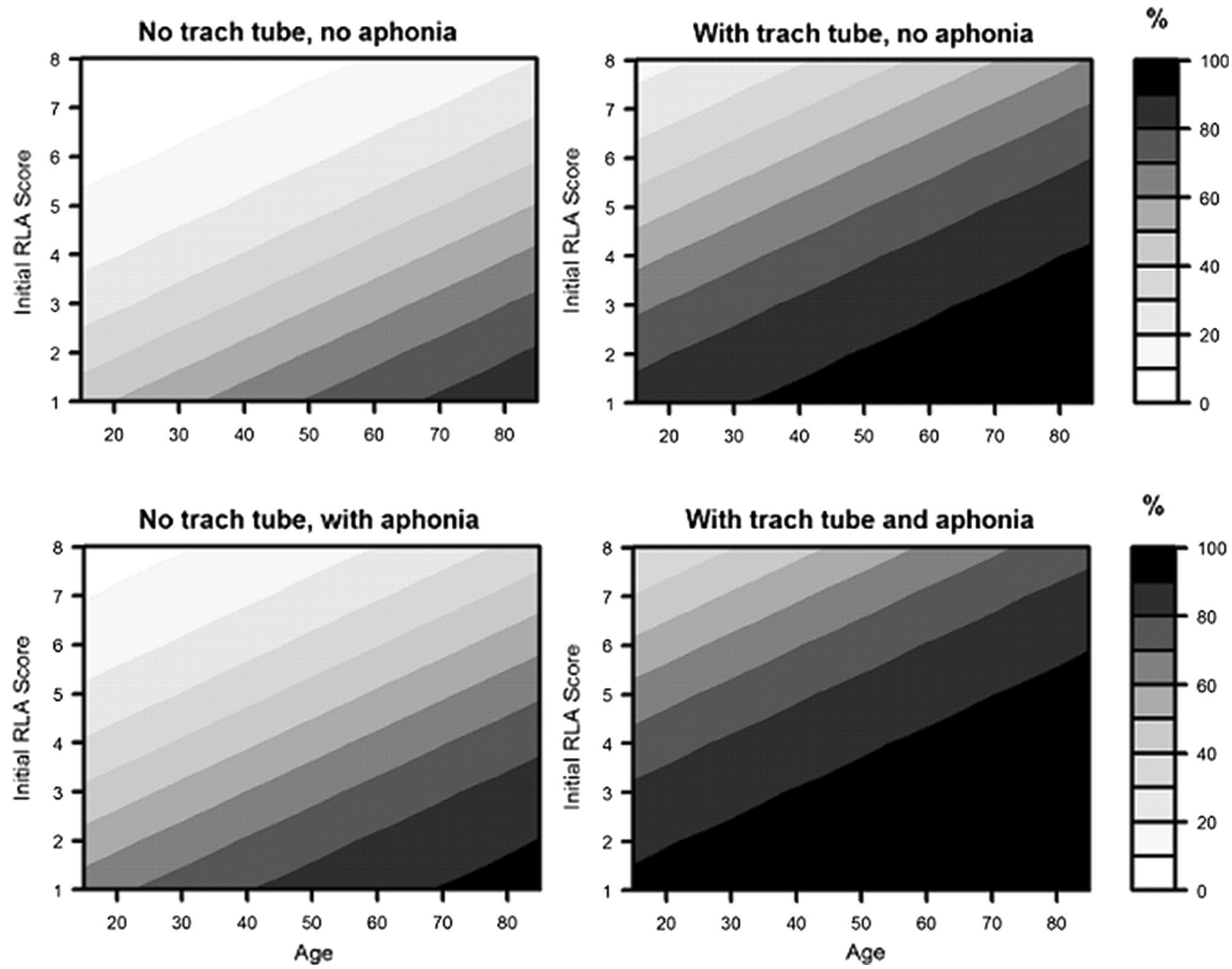

Fig. 2 Probability of being discharged from the hospital with a feeding tube by initial Ranchos Los Amigos (RLA) level of cognitive functioning score and age for each of four patient groups defined by the presence or absence of a tracheostomy tube and initial aphonia status

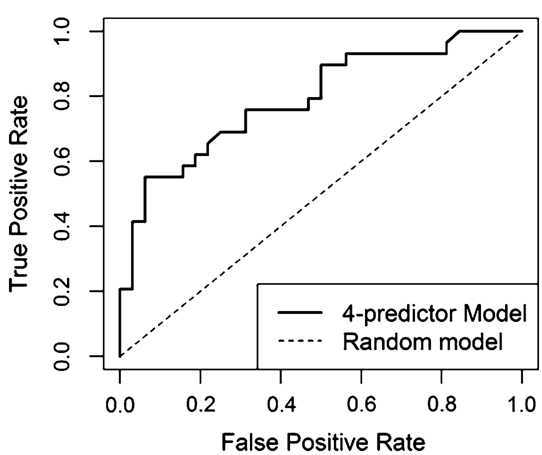

Fig. 3 Receiver operating characteristic curves for the probability model of discharge with a feeding tube using four predictors: age, Ranchos Los Amigos score, tracheostomy tube placement, and aphonia observed on the initial swallowing evaluation compared to the random intercept model

These findings appear accurate in light of the previous research on long-term oropharyngeal dysphagia in the stroke population. Although the research on dysphagia in CVA patients is extensive and informative, discrepancies exist between population demographics of patients with stroke and patients with traumatic brain injuries. Age has been identified as an independent prognosticator for functional recovery following neurological damage, with increased age in adults correlating with poorer overall outcomes [25–27]. Approximately 75 % of stroke patients are older than 65 years of age [28], whereas 75 % of the traumatic brain injury population is aged 65 or younger, with an average age range of 25–34 years [29]. Older patients are more likely to have chronic medical conditions, such as hypertension, diabetes, or heart disease, compared with typically younger healthy patients seen with TBI. In addition, the medical comorbidities seen in older populations often complicate the recovery course following a traumatic brain injury, resulting in a longer ICU stay, a more complicated medical course during acute-care hospitalization, and prolonged rehabilitation time. Younger patients are more likely to demonstrate overall faster recovery with fewer medical complications. Therefore, the current study's finding that older patients with TBI are more likely to exhibit long-term oropharyngeal dysphagia corresponds with the previously reported research.

Dysphagia recovery prognosis and time to oral intake in patients with acute CVA have been studied extensively. Schroeder et al. [8] found that four of six clinical features, including dysphonia, dysarthria, abnormal gag reflex, abnormal volitional cough, cough after swallow, and voice change after swallow, were significant in predicting long-term oropharyngeal dysphagia. Mann et al. [9] found videofluoroscopic evidence of delayed oral transit, delayed or absent swallow reflex, penetration of contrast into the laryngeal vestibule, age >70, and male gender to be predictors of continued swallowing dysfunction at 6 months post-stroke. Aphonia, a severe form of dysphonia in which no voicing can be achieved, has also been cited in the dysphagia literature as a prognostic indicator of dysphagia. Linden et al. [10] reported nine clinical parameters, including aphonia, as being indicative of dysphagia, regardless of diagnosis. The current study found only aphonia to be an independent predictor of long-term oropharyngeal dysphagia in the severely brain injured population, suggesting that patients with CVA and patients with TBI are fundamentally different with respect to the clinical swallowing characteristics that determine long-term oropharyngeal dysphagia. Given the different neurological mechanisms of injury for the two patient populations, this finding appears relevant.

Oropharyngeal dysphagia following TBI is well documented in the rehabilitation literature. Mackay et al. [11] identified several risk factors for dysphagia associated with TBI in the acute-care hospital setting. A low admitting GCS, a low RLA score, CT scan findings (midline shift, brainstem involvement, or brain pathology requiring emergent operative procedures), and prolonged ventilator time ($\geq$15 days) accurately predicted impaired oral intake in patients with TBI [18]. Morgan et al. [12] also found low GCS and prolonged ventilator use predictive of dysphagia in pediatric patients with TBI. The present study found a low RLA score, but not a low GCS or prolonged ventilator use, to be an independent predictor of long-term oropharyngeal dysphagia. The previous studies were conducted prior to technological advancements in trauma medicine which may account for the difference in ventilator time as a predictor. The GCS variable may not be statistically significant in the current study due to sample size.

Another difference that should be considered between CVA patients and TBI patients is the placement of a tracheostomy tube. A tracheostomy tube is placed following TBI when the patient is unable to wean from the ventilator. The incidence of patients with severe TBI having tracheostomy tube placement is common, with Gurkin et al. [13] reporting 44 % of patients with GCS $\leq$9 having this intervention. In addition, research has indicated that tracheostomy tube placement results in aspiration in 50–83 % of patients [14]. The presence of a tracheostomy tube is likely another prognostic indicator of long-term oropharyngeal dysphagia and need for PEG tube placement, as tracheostomy tubes typically are not placed for a short duration. The current study found that patients with tracheostomy tube placement were six times more likely to exhibit long-term oropharyngeal dysphagia and to be discharged from the hospital with a feeding tube. In addition, days on a ventilator, days to RLA score, days to swallow evaluation, days to oral intake, days to PEG tube placement, duration of tube feeding, days to full oral intake, duration of tracheostomy tube placement, and days to tube feeding were not predictive of whether a patient was discharged with a feeding tube. Therefore, giving patients more time to recover in the acute-care setting only increased length of stay rather than contributed to improved outcomes. In summary, younger patients and patients with higher initial RLA scores had a better chance of being discharged from the acute-care hospital without a feeding tube than older patients or patients with lower initial RLA scores. The presence of a tracheotomy tube or initial aphonia increased the chances of being discharged with a feeding tube. The findings suggest that patients with severe brain injury differ from patients with CVA in terms of their swallowing dysfunction and clinical predictors of long-term oropharyngeal dysphagia. Dysphonia, dysarthria, cough after swallow, and voice quality change after swallow were all significant clinical predictors of severe oropharyngeal dysphagia in the stroke population but did not predict discharge from the hospital with a feeding tube in patients with severe brain injuries. It should also be noted that tracheostomy tube placement is not common in the stroke population but is common in the severe brain injury population and should be considered in long-term oropharyngeal dysphagia assessment.

Study Limitations

It should be noted that this study utilized discharge from the hospital with enteral nutritional support as a surrogate for long-term oropharyngeal dysphagia. There are no data post-discharge from the acute-care hospital to determine the amount of time that patients required tube feeding. Therefore, the authors have utilized PEG tube feeding as an approximation.

Additional limitations of the study include the relatively small sample size for the number of variables studied and all additional limitations associated with retrospective chart review-based data collection. Replication of the current study to verify findings with a larger sample size may provide additional validation of the results for the severe brain injury population throughout the United States. A prospective analysis, given a prescribed test protocol for patients with severe brain injury in the acute-care setting, may yield additional information that was not found in the current study, including a time frame to recovery of swallow function based on the predictor variables.

Conclusion

Given the clinical heterogeneity of traumatic brain injury patients, identifying variables that will accurately predict long-term oropharyngeal dysphagia (>6 weeks) and the need for PEG tube placement, as opposed to temporary oropharyngeal dysphagia that could be managed with nasogastric tube feeding, is challenging. Previous studies with stroke populations provided a potential framework but did not allow for additional factors that occur with trauma patients. In response to this dilemma facing clinicians and its impact on length of stay in the acute-care hospital, the following prediction model was created and internally validated. Age of patient, initial RLA score, presence or absence of tracheostomy tube, and presence or absence of initial aphonia were found to be an effective model, accurately predicting gastrostomy tube placement, with the patient population at UMCB Level 1 Trauma hospital. Future clinical trials will determine if implementation of the model as a prognostic tool in other acute clinical settings will produce more accurate assessments and determination of patients who will ultimately exhibit long-term oropharyngeal dysphagia and will need PEG tube placement. Timely PEG tube placement should reduce unnecessary testing and decrease length of stay in the acute-care setting.

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Amy Mandaville MBA, MA

Anjea Ray MS

Henry Robertson PhD

Careen Foster MD

Christine Jesser PhD