New Model for Predicting Surgical Feeding Tube Placement in Patients With an Acute Stroke Event

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Background and Purpose—The need for surgical feeding tube placement after acute stroke can be uncertain and associated with further morbidity.

Methods—Retrospective data were recorded and compared across patients with acute ischemic stroke and intracerebral hemorrhage. We identified all feeding tubes placed as percutaneous endoscopic gastrostomy (PEG) tubes. A prediction score for PEG tube placement was developed separately for patients with acute ischemic stroke and intracerebral hemorrhage using logistic regression models of variables known by 24 hours from admission.

Results—Of 407 patients included, 51 (12.5%) underwent PEG tube placement (25 acute ischemic stroke and 26 intracerebral hemorrhage). The odds of a patient with acute ischemic stroke with PEG score ≥3 of getting a PEG are greater than those with PEG score <3 (odds ratio, 15.68; 95% confidence interval, 4.55–54.01). The odds of a patient with intracerebral hemorrhage with PEG score ≥3 of getting a PEG are greater than those with PEG score <3 (odds ratio, 12.49; 95% confidence interval, 1.54–101.29).

Conclusions—The PEG score, comprised by variables known within the first day of admission, may be a powerful predictor of PEG placement in patients with acute stroke.

Key Words: acute ischemic stroke | enteral nutrition | gastric feeding tube | intracerebral hemorrhage

Results

Patient Population
A total of 734 patients were identified for the study, and 407 patients met inclusion criteria. Of these patients, 51 (12.5%) underwent PEG placement during hospital admission (Table 1). Of those undergoing PEG placement, there were 25 patients with AIS (7.6% of patients with AIS) and 26 patients with ICH (34.2% of patients with ICH; Table 2).

Risk Prediction Model: AIS
The AIS-PEG score was developed with 1 point being awarded for each of the following: age ≥80 years, 24-hour National Institutes of Health Stroke Scale (NIHSS) 8 to 14 (with an
extra point for 24-hour NIHSS score >14), 1 point for black race, and 1 point for the infarct location involving cortex with a maximum of 5 points. Severity of dysphagia documented by speech therapy, dichotomized as nil per os versus liquid or solid foods permissible, was not predictive of PEG placement, and therefore not included in the model ($P=0.252$). We found that for the entire cohort, the odds of patients with PEG score $\geq 3$ getting a PEG as an inpatient were 15× higher than those with PEG score <3 (odds ratio, 15.68; 95% confidence interval, 4.55–54.01), and a score of $\geq 3$ points is 91.7% sensitive and 62.8% specific for undergoing PEG placement during hospitalization for patients with AIS with stroke (Figure).

### Table 1. Demographic Information: PEG vs No PEG

<table>
<thead>
<tr>
<th>Age, median (IQR)</th>
<th>No PEG (n=356)</th>
<th>PEG (n=51)</th>
<th>$P$ Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>65 (19–97)</td>
<td>63 (42–95)</td>
<td>0.5363</td>
<td></td>
</tr>
<tr>
<td>Female, n (%)</td>
<td>151 (42.4)</td>
<td>25 (49.0)</td>
<td>0.3733</td>
</tr>
<tr>
<td>Black race, n (%)</td>
<td>235 (66.4)</td>
<td>40 (78.4)</td>
<td>0.1517</td>
</tr>
</tbody>
</table>

### Medical history

- Stroke, n (%) 134 (37.6) 15 (29.4) 0.2539
- IV tPA (AIS only), n (%) 119/304 (39.1) 11/25 (44.0) 0.6331

Medical history data were self-reported unless otherwise found in patient medical records. AIS indicates acute ischemic stroke; CAD, coronary artery disease; DM, diabetes mellitus; HLD, hyperlipidemia; HTN, hypertension; IQR, interquartile range; IV tPA, intravenous tissue-type plasminogen activator; and PEG, percutaneous endoscopic gastrostomy.

### Table 2. Admissions, Discharge, and Outcome Data in Patients With AIS vs ICH

<table>
<thead>
<tr>
<th>AIS (n=25)</th>
<th>ICH (n=26)</th>
<th>$P$ Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Admission NIHSS (for AIS patients) or GCS (for ICH patients), median score (IQR)</td>
<td>19 (3–31)</td>
<td>10 (5–15)</td>
</tr>
<tr>
<td>Delay from LSN to ED arrival, min; median (IQR)</td>
<td>180 (28–791)</td>
<td>65 (20–956)</td>
</tr>
<tr>
<td>Dysarthria at admission, n (%)</td>
<td>16 (64.0)</td>
<td>20 (76.9)</td>
</tr>
<tr>
<td>Impaired LOC at admission, n (%)</td>
<td>1 (4.0)</td>
<td>9 (56.3)</td>
</tr>
<tr>
<td>Discharge disposition</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Home, n (%)</td>
<td>0 (0.0)</td>
<td>0 (0.0)</td>
</tr>
<tr>
<td>Inpatient rehabilitation, n (%)</td>
<td>9 (36.0)</td>
<td>7 (26.9)</td>
</tr>
<tr>
<td>Skilled nursing facility, n (%)</td>
<td>8 (32.0)</td>
<td>11 (42.3)</td>
</tr>
<tr>
<td>LTAC, n (%)</td>
<td>3 (12.0)</td>
<td>6 (23.1)</td>
</tr>
<tr>
<td>Hospice, n (%)</td>
<td>1 (4.0)</td>
<td>2 (7.7)</td>
</tr>
<tr>
<td>Expired, n (%)</td>
<td>3 (12.0)</td>
<td>0 (0.0)</td>
</tr>
<tr>
<td>LOS, d; median (IQR)</td>
<td>21 (6–45)</td>
<td>21 (7–86)</td>
</tr>
<tr>
<td>Discharge NIHSS, median score (IQR)</td>
<td>19 (5–42)</td>
<td>17 (5–32)</td>
</tr>
<tr>
<td>Discharge mRS, median score (IQR)</td>
<td>5 (3–6)</td>
<td>5 (4–5)</td>
</tr>
</tbody>
</table>

### Outcome data

- Neurological deterioration, n (%) | 21 (84.0) | 6 (75) | 0.3198 |
- Tracheostomy placed, n (%) | 3 (12.0) | 11 (42.3) | 0.0137 |
- Bacteremia, n (%) | 8 (32.0) | 5 (19.2) | 0.1494 |
- Pneumonia, n (%) | 11 (44.0) | 14 (56) | 0.1572 |

All laboratory and clinical information is taken from chart or patient reported. AIS indicates acute ischemic stroke; ED, emergency department; GCS, Glasgow coma scale; ICH, intracerebral hemorrhage; IQR, interquartile range; LOC, level of consciousness; LOS, length of stay; LSN, last seen normal; LTAC, long-term acute care; mRS, modified Rankin Scale; NA, not available; and NIHSS, National Institutes of Health Stroke Scale.

### Figure

A, Predicting percutaneous endoscopic gastrostomy (PEG) placement in patients with acute ischemic stroke (AIS). A maximum of 5 points can be achieved from the AIS-PEG model. An area under the curve (AUC) of 0.8032 shows the model is predictive of PEG tube placement. B, Predicting PEG placement in patients with intracerebral hemorrhage (ICH). A maximum of 5 points can be achieved from the ICH-PEG model. An AUC of 0.7004 for the model shows a moderate predictive value of PEG tube placement.

### Risk Prediction Model: ICH

The ICH-PEG score was developed with 1 point being awarded for each of the following: black race, 24-hour NIHSS score 8 to 14 (with an extra point for 24-hour NIHSS score >14), midline shift on initial head computed tomographic scan (>3 mm), and edema on follow-up head computed tomography with a maximum of 5 points. Again, severity of dysphagia did not reach statistical significance for predicting PEG placement ($P=0.523$). With this risk prediction model, the odds of patients with ICH with PEG score of $\geq 3$ undergoing PEG placement...
placement as an inpatient were nearly 12× higher than those with PEG score <3 (odds ratio, 12.49; 95% confidence interval, 1.54–101.29), and a score of ≥3 points is 96.2% sensitive and 33.3% specific for having a PEG tube placed (Figure).

**Discussion**

Severe strokes, baseline dysarthria, and impaired level of consciousness were associated with PEG tube placement, which is consistent in the literature.\(^2\,6\,7\) Despite this association, dysarthria and level of consciousness were not included in the models because of nonsignificance.

The AIS risk prediction model was found to be more prognostic of future PEG placement than the ICH risk model. The PEG score could be used to demonstrate need for surgical feeding tube insertion by the day after admission, potentially minimizing length of stay.

Our study is limited by its small sample size involving only 1 academic center, making our results difficult to generalize to larger populations, and by the retrospective nature of this study. We mitigated these limitations by extensively documenting admission physical examination data, allowing us to create an effective model to predict PEG placement early during hospitalization. The study is further limited by the method of classifying the severity of dysphagia, as it does not use a validated dysphagia scoring system.

In summary, our data present a new tool for estimating who will undergo PEG placement. With the expedited placement of a PEG, enteral nutrition can be initiated and the risks of malnutrition, prolonged length of stay, and mortality could be minimized. To appreciate the full implications of such a scoring system, we recommend validating this risk prediction model prospectively and with other stroke registries.

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**Disclosures**

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**References**

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Supplemental Methods

Data Collection

All patients received bedside clinical swallow assessment from a speech and language therapist within 24 hours of the admission unless unable to participate, and videofluoroscopic swallowing assessments (unless the patient was unable to participate or a diet was recommended based on lack of aspiration predictors on the bedside clinical swallow assessment). Decision for PEG placement was individualized to each patient through the interdisciplinary evaluation and made after sequential attempts to demonstrate a functional swallow on clinical bedside assessments or persistent inability to participate with the assessments. NIHSS evaluations were performed daily before morning rounds and upon detection of clinical worsening as part of the standard of care at our institution, which allowed clinicians to assess neurological recovery and/or decline. All examiners were certified in the NIHSS examination. Only investigators certified to perform the modified Rankin Scale (mRS) exam documented the mRS score for each patient at the time of discharge.

We compared admission, clinical and discharge information between patients who received a PEG tube and patients who did not receive a PEG tube. We sub-analyzed the differences between AIS and ICH patients who underwent PEG tube placement. The primary outcome of interest was PEG tube or other surgical feeding tube placement, which we also identified as PEG tube placement for the study. Secondary outcome measures were compared across patients with and without PEG tube placement, and included neurological deterioration (increase in NIHSS of 2 or more points in a 24 hour period), discharge disposition, mRS and NIHSS at discharge, length of stay (LOS), and in-hospital mortality.

Statistics

The prediction models were built by using a random sample of 55% of the dataset (build group) and subsequently tested on the remaining random 45% (test group). Additionally, the scores were tested on the entire population after score development. The patients in the build group were used in logistic regression models with the outcome variable of PEG placement. Independent predictors of PEG placement (e.g., race) with p values ≤0.2 entered our final score as score variables and were evaluated at different values and dichotomizations using sensitivity analysis and logistic regression to identify cutoff points. We tested every variable that would be available at 24 hours after admission for the PEG predictors. Each continuous variable was evaluated using receiver operator characteristics (ROC) curves. After the variables were assessed individually using the <0.2 cut point for the p-value we then placed variables that met this requirement in the multivariable model. The points assigned to the variables in the score were determined through the beta coefficients from the final multivariable logistic regression model. Once in the multivariable model we then used the area under the curve (AUC) of the ROC curve from the multivariable models to develop the most predictive scoring algorithm. Spearman’s correlation and ROC curves were used to evaluate the final score. This process was done separately for AIS patients and for ICH patients. Additional logistic regression analyses were conducted to assess the relationship between PEG
placement and outcomes as well as PEG scoring cut points and PEG placement. As this was an exploratory analysis, no adjustments were made for multiple comparisons. An alpha of 0.05 was set as the level of significance.

**Supplementary References**

Supplementary Table 1: Logistic Regression Variables

<table>
<thead>
<tr>
<th></th>
<th>Odds Ratio</th>
<th>95% CI</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>AIS Score</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>1.85</td>
<td>0.72-4.79</td>
<td>0.203</td>
</tr>
<tr>
<td>Black Race</td>
<td>1.39</td>
<td>0.49-3.85</td>
<td>0.532</td>
</tr>
<tr>
<td>Cortical Involvement</td>
<td>7.77</td>
<td>0.99-60.7</td>
<td>0.051</td>
</tr>
<tr>
<td>NIHSS Score</td>
<td>2.78</td>
<td>1.51-5.10</td>
<td>0.001</td>
</tr>
<tr>
<td><strong>ICH Score</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Black Race</td>
<td>1.80</td>
<td>0.51-6.31</td>
<td>0.357</td>
</tr>
<tr>
<td>Edema</td>
<td>1.99</td>
<td>0.54-7.38</td>
<td>0.303</td>
</tr>
<tr>
<td>Midline Shift</td>
<td>1.92</td>
<td>0.66-5.34</td>
<td>0.230</td>
</tr>
<tr>
<td>NIHSS Score</td>
<td>2.31</td>
<td>0.96-5.59</td>
<td>0.063</td>
</tr>
</tbody>
</table>

Odds ratios and 95% confidence intervals for variables in logistic regression models.

Abbreviations: Acute ischemic stroke (AIS), National Institute of Health Stroke Score (NIHSS), intracerebral hemorrhage (ICH).