

# Relationship between Dysphagia, National Institutes of Health Stroke Scale Score, and Predictors of Pneumonia after Ischemic Stroke

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**Background:** The present study aimed to evaluate the relation between the National Institutes of Health Stroke Scale (NIHSS) score and the presence of laryngeal penetration and/or laryngotracheal aspiration in ischemic stroke patients and to verify what factors are predictors of the occurrence of pneumonia in the evaluated patients.

**Methods:** This was an observational study of ischemic stroke in the acute or subacute phases. Neurologic examination included anamnesis, Bamford classification, and application of the NIHSS. Speech therapy evaluation was carried out after clinical stabilization of the patient, and all individuals who were considered dysphagic were sent for examination by means of videofluoroscopic recordings. The parameters observed in the objective examination were the presence of laryngeal penetration and/or laryngotracheal aspiration. The pneumonia data were obtained in accordance with local protocols, which were based on international guidelines. The relation of laryngeal penetration and laryngotracheal aspiration with the NIHSS score was assessed by the Mann–Whitney *U* test, and predictors for the occurrence of pneumonia were analyzed by multiple logistic regression using semiautomatic backward selection. Significance was set at *P* less than .05.

**Results:** The relations between laryngeal penetration and the NIHSS score and between laryngotracheal aspiration and the NIHSS score were not statistically significant. The predictors for pneumonia occurrence in the ischemic stroke patients with a clinical diagnosis of dysphagia were age (*P* = .002; odds ratio [OR], 1.12) and NIHSS score (*P* = .04; OR, 1.17), whereas laryngeal penetration of liquid (*P* = .065; OR, 3.70) tended to correlate with pneumonia but not significantly. **Conclusions:** There was no relation between the NIHSS score and laryngeal penetration or laryngotracheal aspiration, and the principal predictors of pneumonia in dysphagic patients after ischemic stroke were advanced age and neurologic severity. **Key Words:** Stroke—deglutition—deglutition disorders—dysphagia—neurologic impairment—pneumonia predictors.

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## Introduction

Stroke is one of the main causes of death and incapacity throughout the world. Epidemiologic studies have shown that strokes cause approximately 5.7 million deaths, with 85% occurring in underdeveloped or developing countries, where death rates are 3.5 times higher than in developed countries.<sup>1,2</sup> In Brazil, stroke is considered the main cause of death, with 10% of deaths occurring in the first 30 days and 40% in the first year.<sup>3,4</sup> As well as a high mortality index, an ischemic stroke can cause communication and swallowing disorders, with a significant impact on functional abilities.<sup>5</sup>

Oropharyngeal dysphagia is a common deficit after stroke, occurring in approximately 50%-91% of patient cases.<sup>6-8</sup> Of these cases, 65% present this symptom within the first 5 days of hospitalization, leading to a sixfold increase in risk for aspiration pneumonia and a threefold increase for mortality.<sup>9-12</sup> Pneumonia after stroke is frequently associated with the presence of laryngotracheal aspiration, 2%-25% of which are concomitant with silent aspirations.<sup>13,14</sup>

Diverse protocols have suggested that the National Institutes of Health Stroke Scale (NIHSS) can be a predictor in the identification of dysphagia risk in patients after stroke, despite not making reference to deglutition.<sup>15-19</sup> The majority of studies that describe the relationship between the NIHSS score and oropharyngeal dysphagia are based on clinical parameters observed in water and/or other consistency tests. Both screening protocols and clinical evaluations of swallowing recommend observation of specific clinical signs, such as saliva swallowing, the presence of cough, changes in vocal quality, and breathing discomfort. Even studies related to pneumonia indicators report difficulty in detecting silent aspirations using only clinical evaluation. Furthermore, dysphagia classification is often based on defining the presence or absence of a swallowing disorder, which makes it difficult to decide on a feeding route and the best food consistencies.<sup>10,15,16</sup>

Swallowing videofluoroscopy is considered the gold standard method for evaluating oropharyngeal dysphagia. Studies have highlighted the importance of an objective examination in identifying specific changes in swallowing dynamics, such as laryngeal penetration and laryngotracheal aspiration. In addition, an isolated clinical evaluation is not capable of predicting the occurrence of these signs in the poststroke patient.<sup>20,21</sup> One recent review of the screening of dysphagia found low sensitivity and specificity values for the identification of the presence of laryngeal penetration and silent aspiration using clinical characteristics.<sup>11</sup>

The present study aims to address 2 questions: (1) to evaluate the relation between the NIHSS score and the presence of laryngeal penetration and/or laryngotracheal aspiration in ischemic stroke patients and (2) to identify

what factors are predictors of pneumonia occurrence in the evaluated patients.

## Patients and Methods

### *Study Design, Setting, and Participants*

This observational study used transversal methodology and a prospective study of a series of cases to achieve objectives 1 and 2, respectively. The individuals evaluated had been diagnosed with ischemic stroke in the acute or subacute phase, which was confirmed by neuroimaging (computed tomography or magnetic resonance). Patients were excluded if they presented hemorrhagic stroke, previous complaints of dysphagia, a previous modified Rankin Scale score greater than 1, pre-existing dementia, unstable clinical status, comatose state, another neurologic disease, or had undergone decompressive hemicraniectomy. All individuals were hospitalized at the Stroke Unit of Botucatu School of Medicine—Univ Estadual Paulista, Sao Paulo, Brazil, where they were evaluated in the period from April 2010 to May 2012.

The study protocol was approved by the Research Ethics Committee, Botucatu School of Medicine, Univ Estadual Paulista. All participants or their legal representatives were aware of the study objectives and gave written informed consent.

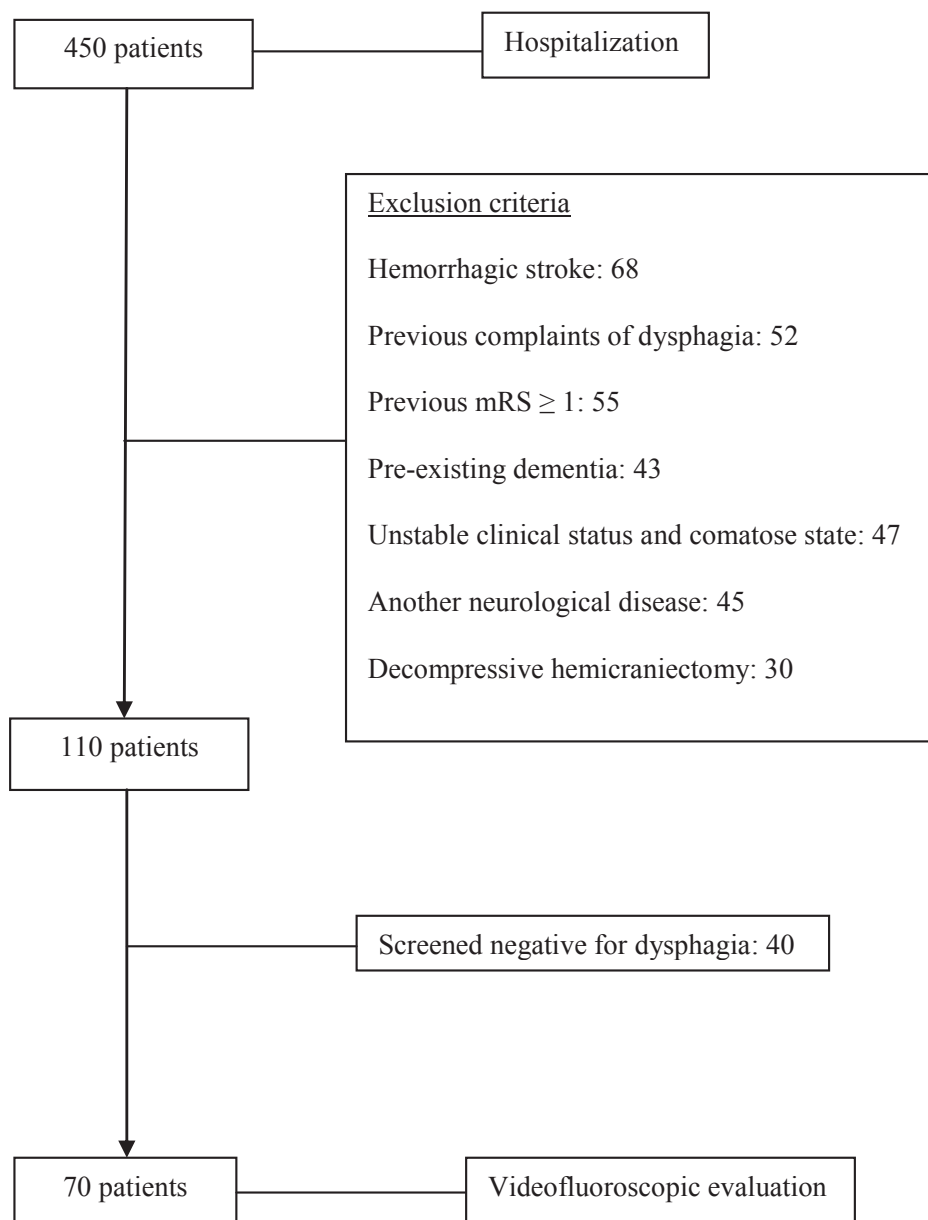
### *Measurements*

#### **Neurologic evaluation**

Neurologic examination included anamnesis, Bamford classification,<sup>22</sup> and application of the NIHSS.<sup>23</sup> In this study, a certified vascular neurologist conducted the NIHSS simultaneously with the dysphagia evaluation. To avoid compromising result viability, videofluoroscopy did not constitute part of the test. All individuals were scored at admission and then daily until discharge. To fulfill the objective of this study, only scores from the day the swallowing videofluoroscopy was performed were selected.

#### **Evaluation of dysphagia**

The speech therapy evaluation<sup>24</sup> was carried out after clinical stabilization of the patient; all individuals considered dysphagic were sent for examination by means of videofluoroscopic recordings, using foods modified with barium sulfate. The examination was initiated by offering a pasty food, followed by a liquid. It is important to emphasize that the evolution of the quantity and consistency of the offerings was directly dependent on the performance of the patient in the previous deglutition, and the examination was interrupted when the presence of laryngotracheal aspiration was observed. For the examination, the patient was advised to remain in a lateral position, which allows visualization



**Figure 1.** Flow diagram. Abbreviation: mRS, modified Rankin Scale.

of the upper and lower anatomical limits, from the oral cavity to the esophagus. The parameters observed in the objective examination were the presence of laryngeal penetration and or laryngotracheal aspiration. Laryngeal penetration is defined as the food entering the laryngeal vestibule, below the epiglottis and above the level of the vocal cords. Laryngotracheal aspiration corresponds to food entering below the level of the vocal cords.

### Pneumonia

The hospital has an internal hospital infection committee that sets the criteria for the notification of the type and severity of pneumonia and the infectious agents and therapeutic planning used. The data on pneumonia were obtained if the patient had 2 or more x-rays with one of

the following: infiltration, consolidation, or cavitation. Patients were also considered if they had one of the following symptoms: fever more than 38°C, leukopenia or leukocytosis, or decreased level of consciousness. Third, they had to have 2 of the following symptoms: purulent sputum, worsening cough, dyspnea, or tachypnea, rales or bronchial breath sounds, or worsening gas exchange, as measured by oxygen saturation or arterial blood gas. Ventilator-associated pneumonia was included in the above total but was not recorded separately.<sup>25-27</sup>

### Clinical evaluation

The patients were monitored during hospitalization and were assessed for the treatment received, complications, and the time of hospitalization until discharge.

### Statistical Methods

The relation of laryngeal penetration and laryngotracheal aspiration with the NIHSS score was assessed by the Mann–Whitney *U* test and presented graphically in a box plot. The predictors for pneumonia occurrence were analyzed by multiple logistic regression with semiautomatic backward selection, with an output criterion of *P* greater than .10. The following variables were considered: age, sex, right hemisphere, Bamford classification, treatment received, delay of videofluoroscopic evaluation, NIHSS score, presence of laryngeal penetration, and presence of laryngotracheal aspiration. Based on the incidence of dysphagia and pneumonia in this population, the power of the test was estimated to be approximately 70%, assuming, for the effect of the calculation, simple random sampling, a type I error probability of .05, and the absence of confounding effects. Significance was set at *P* less than .05. Statistical analyses were performed using the software SPSS, v. 15.0 (IBM Company, Chicago, IL).

### Results

During the study period, 450 patients were hospitalized, and of these, 380 were excluded. Of the 110 patients evaluated, 40 screened negative for dysphagia, and 70 were ultimately evaluated for the study (see Fig 1). Of the patients who screened negative for dysphagia, none had pneumonia during hospitalization. Of the patients with positive screens, 27.1% had pneumonia, and of these patients, 6 died due to respiratory infections associated with sepsis. The main infective agents found were *Staphylococcus aureus* (gram positive) and *Pseudomonas aeruginosa* (gram negative), and the medications used in these cases were fourth-generation cephalosporins and piperacillin. The clinical and demographic data are presented in Table 1.

The relation of laryngeal penetration and laryngotracheal aspiration with the NIHSS score is displayed in Table 2; the penetration of pasty food (*P* = .332), the aspiration of pasty food (nonsignificant), the penetration of liquid (*P* = .567), and the aspiration of liquid (.609) were not significantly related to the NIHSS score. The median NIHSS scores with interquartile intervals are displayed in a box plot (Fig 2) for the penetration of pasty food, the penetration of liquid, and the aspiration of liquid, with no differences among them.

The predictors for pneumonia occurrence in the ischemic stroke patients with a clinical diagnosis of dysphagia were adjusted in 8 steps by logistic regression, with an output criterion of *P* greater than .10; the variables sex, right side of stroke, Bamford classification, thrombolysis therapy, delay of videofluoroscopic evaluation, pasty food penetration, and liquid aspiration were not statistically significant for the prediction of

**Table 1.** Description of the sample

Variables	n	%
Sex		
Male	44	62.9
Age (y)*	68 (33-94)	
NIHSS*	4 (0-17)	
Delay of videofluoroscopic evaluation (d)*	3 (0-16)	
Length of stay (d)*	8 (2-58)	
Side of stroke		
Right	32	45.7
Bamford		
LACS	6	8.6
PACS	51	72.9
POCS	4	5.7
TACS	9	12.9
Thrombolysis therapy	30	42.9
Dysphagia evaluation		
Penetration of pasty food	6	8.6
Aspiration of pasty food	1	1.4
Penetration of liquid	40	57.1
Aspiration of liquid	9	12.9
Pneumonia	19	27.1

Abbreviations: NIHSS, National Institutes of Health Stroke Scale; LACS, Lacunar Syndrome; POCS, Posterior Circulation Syndrome; PACS, Partial Anterior Circulation Syndrome; TACS, Total Anterior Circulation Syndrome.

\*Values in median.

pneumonia in this population. The variables age (*P* = .002; OR, 1.12) and NIHSS score (*P* = .04; OR, 1.17) were statistically significant, whereas the laryngeal penetration of liquid (*P* = .065; OR, 3.70) presented a statistical tendency in this sample (Table 3).

**Table 2.** Relation between laryngeal penetration and laryngotracheal aspiration with NIHSS

	NIHSS	<i>P</i>
Penetration of pasty food		
No (n = 64)	4.5 (0.0-17.0)	0.332
Yes (n = 6)	3.5 (1.0-9.0)	
Aspiration of pasty food		
No (n = 69)	4.0 (0.0-17.0)	NS
Yes (n = 1)	3	
Penetration of liquid		
No (n = 30)	4.0 (0.0-17.0)	0.567
Yes (n = 40)	4.5 (0.0-17.0)	
Aspiration of liquid		
No (n = 61)	4.0 (0.0-17.0)	0.609
Yes (n = 9)	5.0 (1.0-13.0)	

Abbreviations: NIHSS, National Institutes of Health Stroke Scale; NS, nonsignificant (Mann–Whitney).

**Table 3.** Multiple logistic regression\* to explain the occurrence of pneumonia in dysphagic patients after ischemic stroke

	$\beta$	SE	Wald	P	OR	95% CI	
Age (y)	.11	.03	9.91	.002	1.12	1.04	1.19
NIHSS	.16	.08	4.20	.040	1.17	1.01	1.36
Penetration of liquid	1.31	.71	3.41	.065	3.70	.92	14.81
Constant	-10.56	3.02	12.27	.000	.00		

Abbreviations: CI, confidence interval; NIHSS, National Institutes of Health Stroke Scale; OR, odds ratio; SE, standard error.

\*Multiple logistic regression for semiautomatic backward selection with output criterion if  $P > .10$ , considering the following variables: age, sex, right hemisphere, Bamford classification, treatment received, delay of videofluoroscopic evaluation, NIHSS, laryngeal penetration, and laryngotracheal aspiration.

## Discussion

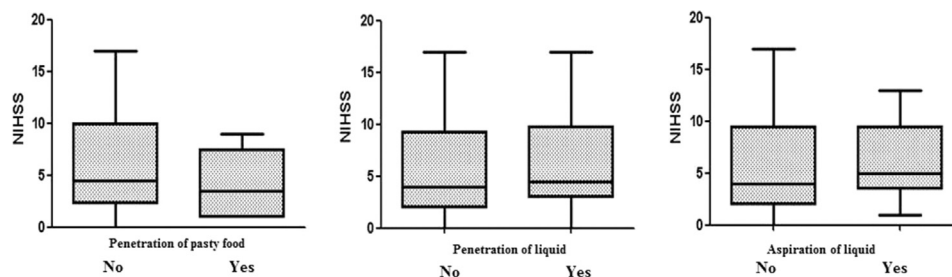
The NIHSS is the principal scale used in vascular neurology to evaluate severity in the acute phase of stroke and can predict complications during hospitalization and functional outcomes after discharge.<sup>28,29</sup> In the present study, the objective was to verify the relation between the severity of the neurologic deficits and the presence of laryngeal penetration and laryngotracheal aspiration, which was confirmed by examination of deglutition videofluoroscopy, in individuals after ischemic stroke. No statistical significance was found in relation to the associations and correlations proposed. The severity of neurologic deficits has been recognized as an important predictor of alterations in the deglutition dynamic. The variations found in the literature on the accuracy of the clinical evaluation of oropharyngeal dysphagia have justified the use of other evaluation methods, including the NIHSS, which is an instrument capable of aiding in the triage, evaluation, and indication of the feeding route in a stroke individual.<sup>13,14</sup> Diverse factors may influence these results, such as a higher NIHSS score for the left hemisphere and low accuracy for items involving the vertebral-basilar system, given that the incidence and severity of dysphagia are higher in these topographic locations.<sup>30-32</sup>

Several studies have established a relation between NIHSS score and dysphagia after stroke, especially because the NIHSS can be used as a triage instrument with high sensitivity and specificity for the presence or absence of dysphagia; a score above 13 has a sensitivity of 88% and a specificity of 85% for the prediction of

dysphagia, and the NIHSS score also facilitates the choice of an alternative feeding route within 48 hours.<sup>16</sup> Therefore, the fact that our study did not corroborate the sparse extant literature is primarily because of the fact that these studies were based only on clinical parameters for the evaluation of the deglutition dynamic, which has already been described in the literature as instruments of low sensitivity and specificity for the prediction of the occurrence of laryngeal penetration and silent aspiration. After correlating NIHSS score with an objective evaluation of deglutition, we understand that this is not the best instrument for predicting, in an isolated form, the presence of laryngeal penetration and laryngotracheal aspiration in individuals with dysphagia after stroke.<sup>33</sup>

Pneumonia is one of the most frequent medical complications of stroke and is associated with poor prognosis.<sup>34</sup> Frequently, pneumonia occurs in the acute phase of stroke and can increase mortality rates, hospitalization times, and hospital costs.<sup>35</sup> The predictors for the occurrence of pneumonia in ischemic stroke patients with dysphagia in the present study were age, NIHSS score, and the laryngeal penetration of liquid.

In our study, we observed that for each year of increased age among individuals with dysphagia after stroke, there was a 12% greater chance of presenting pneumonia during hospitalization. Aspiration pneumonia is a common and serious complication, especially among patients older than 65 years, who present higher mortality and hospitalization rates for pneumonia.<sup>36</sup> In addition, the increased incidence of aspiration pneumonia with aging may be a consequence of swallowing

**Figure 2.** Box plot of the National Institutes of Health Stroke Scale score as a function of laryngeal penetration and laryngotracheal aspiration.



impairments and the cough reflex. It has been suggested that the progressive loss of protective reflexes (eg, cough and swallowing reflexes) with age is one of the reasons for aspiration pneumonia, which is often observed in the elderly.<sup>37</sup>

In the present study, individuals who were dysphagic after stroke presented a 17% increase in the rate of pneumonia during hospitalization for every additional point on the NIHSS. A wide array of studies have suggested that the severity of stroke is an independent predictor of pneumonia,<sup>38</sup> with individuals who present higher NIHSS values at greater risk during hospitalization.<sup>39</sup>

As for the variables evaluated by videofluoroscopy, there was a threefold greater chance that a patient who was dysphagic after stroke would present pneumonia when there was penetration of liquid. This variable must be analyzed cautiously in the present study because of the large confidence interval for the reduced number of patients. Penetration and aspiration are common in stroke patients; many authors have suggested that following videofluoroscopic evaluation of deglutition, the invasion of liquid into the oral cavity is frequently associated with a high risk of aspiration,<sup>40</sup> a clinical status that predisposes this population to an increased likelihood of pneumonia.

The principal limitations of our study were the absence of a control group of nondysphagic patients for the comparison of outcomes and the variability in the time to accomplish the videofluoroscopy during hospitalization. In relation to the results, the small number of patients with pneumonia may have reduced the power to detect more predictors in this study. We hypothesize that the presence of laryngotracheal aspiration in only 1 patient may have influenced the evaluation of pneumonia outcomes during logistic regression, given that only laryngeal penetration exhibited a satisfactory statistical trend with an elevated odds ratio for the greater number of patients in this category.

Based on the results obtained, we can conclude that there was no relation between the NIHSS score and laryngeal penetration or laryngotracheal aspiration and that the principal predictors of pneumonia in patients dysphagic after ischemic stroke were advanced age and neurologic severity.

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