Factors related to swallowing prognosis in patients with acute ischemic stroke at a specialized institution in Medellín, Colombia

Factores asociados con el pronóstico deglutorio en pacientes con accidente cerebrovascular isquémico agudo en una institución especializada en Medellín, Colombia

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Abstract

Objetive: To analyze the factors associated with swallowing prognosis among individuals with acute ischemic stroke who received treatment at a specialized neurology institution in Medellín, Colombia, in 2020.

Methods: This registry-based retrospective cohort study evaluated clinical factors influencing dysphagia, employing parametric survival models for interval-censored data.

Results: 270 patients were included, 52.2% female, with a mean age of 68.7 years (SD 14.4), with a mean follow-up of 4.91 days. The median survival time was 4.1 days (95% CI 3.7-4.6), with a cumulative seven-day survival rate of 22.72%. Main variables associated with dysphagia were TOAST small vessel occlusion (TR = 0.57, 95%CI 0.39-0.84) and large vessel atherosclerosis (TR=0.66, 95%CI 0.46-0.99), NIHSS severe (TR = 0.30, 95%CI 0.17-0.53), moderate (TR = 0.38, 95%CI 0.22-0.68), and mild to moderate scores (TR = 0.52, 95%CI 0.32-0.86), history of Parkinson's disease (TR = 0.50, 95%CI 0.27-0.96) and older age (p = 0.043).

Conclusion: These findings have implications for developing a risk score to aid decision-making.

Keywords: Ischemic Stroke, Swallowing, Dysphagia, Prognosis

Resumen

Objetivo: analizar los factores asociados con el pronóstico deglutorio en personas con accidente cerebrovascular isquémico agudo que recibieron tratamiento en una institución de neurología especializada en Medellín, Colombia, en 2020.

Métodos: este estudio de cohorte retrospectivo basado en registros evaluó los factores clínicos que influyen en la disfagia, empleando modelos paramétricos de supervivencia para datos censurados en intervalo.

Resultados: Se incluyeron 270 pacientes, 52,2% mujeres, edad media 68,7 años (DE 14,4), con un seguimiento medio de 4,91 días. La mediana del tiempo de supervivencia fue de 4,1 días (IC del 95%: 3,7-4,6), con una tasa de supervivencia acumulada a siete días del 22,72%. Las principales variables asociadas con la disfagia fueron TOAST oclusión de vasos pequeños (TR = 0,57, IC 95% 0,39-0,84) y aterosclerosis de grandes vasos (TR = 0,66, IC 95% 0,46-0,99), puntajes NIHSS grave (TR = 0,30, IC 95% 0,17 -0,53), moderado (TR = 0,38, IC 95% 0,22-0,68) y leves a moderado (TR = 0,52, IC 95% 0,32-0,86), antecedentes de enfermedad de Parkinson (TR = 0,50, IC 95% 0,27- 0,96) y mayor edad (p = 0,043).

Conclusión: Estos hallazgos tienen implicaciones para el desarrollo futuro de un score de riesgo que pueda ayudar en la toma de decisiones.

Palabras clave: Accidente Cerebrovascular Isquémico, Deglución, Disfagia, Pronóstico

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Introduction

Acute cerebrovascular accident is characterized by the onset of neurological deficits caused by an acute focal injury in the central nervous system, attributable to a vascular cause, with 62.4% of these cases being of ischemic origin.[1] According to the Global Burden of Disease study, in 2019, the incidence of ischemic stroke was 274 cases per one hundred thousand persons, with a prevalence of 2.55%. Additionally, the estimated burden of ischemic stroke per hundred thousand persons was 42.6 deaths and

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820.4 disability-adjusted life years (DALYs), ranking it as the second leading cause of death and the ninth leading cause of DALYs, respectively.[2] Strokes imply high costs for the healthcare system in terms of treatment, rehabilitation, and follow-up.[3]

Different impairments explain post-stroke disability, which has been reported to persist in up to 47% of patients at three years of follow-up.[4] Among the less-studied impairments are those related to swallowing, which can affect up to 65% of patients immediately after the event, with some cases persisting over time.[5] Different diagnostic criteria can explain the variability in estimates of swallowing complications, patient populations studied, and follow-up durations.[6] This potential post-stroke complication is also essential due to its association with nutritional deficiencies, aspiration, dehydration, and pneumonia, not to mention the increased risk of mortality.[7]

In patients with ischemic stroke, factors such as the location, size, and severity of the event have been identified as risk factors for developing dysphagia.[8] Similarly, predictors of prolonged dysphagia and aspiration have been reported, including malnutrition and the use of enteral feeding upon admission, cough, and tongue strength, secretion management, presence of dysphonia or dysarthria, age, NIHSS score, bilateral infarctions, and infarct size.[9] However, there is a lack of studies, particularly in Latin America, analyzing factors associated with swallowing prognosis in these patients, providing context-specific information that could potentially impact clinical practice for better prevention and intervention decisions.

Therefore, this study aimed to analyze the factors associated with swallowing prognosis in patients with acute ischemic stroke treated at a specialized neurology institution in the city of Medellín (Colombia) in the year 2020.

Methods

The protocol of this study was approved by the Institutional Committee on Ethics of Research in Human Beings of Universidad CES. This report follows the recommendations of the STROBE statement.[10]

Study design and context

A registry-based retrospective follow-up study. Follow-up time was estimated in days, from the moment of ischemic stroke presentation until the occurrence of dysphagia or censoring due to discharge from the service. Records from patients treated between Jan 1 and Dec 31, 2020, were collected. The study was conducted at the Fundación Instituto Neurológico de Colombia (Medellín, Colombia), an institution dedicated to providing high-complexity healthcare services specialized in neurology, including comprehensive and multidisciplinary management of patients with stroke.

Participants

All patients who met the following criteria were included: 1) aged 18 years or older, 2) admitted spontaneously or by referral, 3) diagnosed with acute ischemic stroke (within 24 hours), 4) had at least one neuroimaging study (CT or MRI) confirming the diagnosis, 5) evaluated by a neurologist within the first 24 hours of admission. Patients with the following criteria were excluded: 1) pre-existing documented swallowing disorders in their medical history, 2) presence of recurrent stroke during the hospital stay, 3) known pregnancy, 4) external studies referred for therapy, 5) incomplete studies, or 6) incomplete records where confirmation of the outcome variable presentation was not possible.

Patient identification was based on a potentially eligible database filtered by the epidemiology group using ICD-10 codes I639 (Cerebral infarction, unspecified) and I679 (cerebral disease, unspecified). The eligibility criteria were applied to all potentially eligible patients.

Variables and data sources

The outcome variable was dysphagia-free survival time. Dysphagia was defined as difficulty or inability to swallow liquids or solids based on clinical assessment by general medicine, neurology, nursing, or speech therapy. Records at admission, on the seventh day of hospital stay, and at discharge were reviewed to determine the time to event. Additional demographic and clinical variables were collected from medical records, including sex, age, dysarthria, facial paralysis, modified Rankin Scale (mRS), comorbidities, risk factors, history of neurodegenerative disorders, the Trial Org 10172 classification in Acute Stroke Treatment (TOAST) classification, the National Institute of Health Stroke Scale (NIHSS) score, and stroke lesion characteristics.

Bias and study size

To control information bias, four second and third-year Neurology residents underwent training for data collection. The extraction was conducted using standardized extraction formats and predefined variable definitions. To control selection bias, eligibility criteria were confirmed through a two-step process: initially identifying potentially eligible patients from administrative records and verifying inclusion and exclusion criteria through medical records. No a priori sample size estimation was performed; all eligible patients during the study period were included. Through post hoc analysis, with the 120 observed events in the sample, 80% statistical power, assuming an Alpha of 0.05 and a proportion of 0.50, would be achieved for HR>1.67 or HR<0.60.

Statistical analysis

Descriptive analysis was performed with mean and standard deviation (SD) for quantitative variables and frequencies and percentages for categorical variables. Seven-day dysphagia-free and median survival times were estimated using parametric survival models for interval-censored data. The lognormal distribution was selected as it showed the best fit based on the Akaike and Bayesian information criteria. Median survival times were estimated for the entire cohort and subgroups of variables of interest. Time Ratios (TR) were estimated for the analysis of associated factors along with 95% confidence intervals (95% CI) and p-values. Instead of Hazard Ratios, TR was estimated because the lognormal model is an accelerated failure time method that does not assume proportional hazards.[11] TR was calculated as the ratio of median survival times between subgroups compared to a reference. Bivariate and multivariate models were computed, with variables having a p-value < 0.25 retained in the multivariate model. Survival functions are presented for statistically significant variables in the final model. Statistical significance was set at 0.05. Bivariate estimates of candidate variables not included in the final model are presented. The analysis was performed using Stata 16.1 (College Station, TX).

Results

Participants

A total of 451 potentially eligible patients were identified. Among them, 290 met the inclusion criteria. Twenty patients were excluded, 15 due to insufficient information and five due to a history of dysphagia. Finally, 270 patients were included, contributing a total of 1,325 days of follow-up (mean = 4.91 days).

Descriptive data

Table 1 presents the demographic and medical history characteristics of included patients. Of the 270 patients included in the analysis, 52.2% were women. The mean age was 68.7 years (SD 14.4). Regarding clinical presentation, 57.4% of patients were admitted as hyperacute stroke (within the first 4 hours of symptom onset). At admission, 75.6% of patients presented with dysarthria, and 66.3% presented with facial paralysis. Approximately 29.3% of patients were treated with reperfusion therapy, such as intravenous thrombolysis or mechanical thrombectomy.

Regarding the characteristics of the stroke (Table 2), the middle cerebral artery (MCA) was the most frequently involved, occurring in 61.5% of patients. In 25.6% of cases, the etiology of the stroke could not be identified with a complete TOAST evaluation, yielding a negative result. Large vessel atherosclerosis was identified as the etiology of the stroke in 24.8% of patients. Small vessel disease was identified as the etiology of the stroke in 14.6% of patients. Incomplete evaluation of TOAST studies was found in 15.5% of patients, leading to classification as an undetermined cause.

Table 1. Demographic and clinical characteristics of included patients.

	n	%
Women	141	52,2
Age, mean (SD)	68,7	(14,4)
Rural residence	28	10,4
Subsidized healthcare	78	28,9
Length of hospital stay, mean (SD)	4,9	(4,7)
Reperfusion therapy		
Conservative	191	70,7
rtPA	55	20,4
Mechanical thrombectomy	8	3,0
rtPA + mechanical thrombectomy	16	5,9
Dysarthria at admission	204	75,6
Facial paralysis at admission	179	66,3
Hyperacute stroke (0-6h)	155	57,4
mRS[a]		
0	162	60,0
1	45	16,7
2	18	6,7
3	27	10,0
4	7	2,6
5	10	3,7
Medical history		
Hypertension	250	55,4
Diabetes mellitus	78	17,3
Coronary artery disease	50	11,1
Chronic kidney disease	40	8,9
Cancer	26	5,8
Other	253	56,1
Atrial fibrillation	14	3,1
Dyslipidemia	32	7,1
Smoking	10	2,2
Previous stroke	25	5,5
Hypothyroidism	18	4,0
Obesity	3	0,7
Parkinson's disease	4	0,9
Alzheimer's disease	8	1,8
Dementia	3	0,7

a. data missing for one patient.
rTPA: recombinant tissue plasminogen activator.

Outcome data

A median dysphagia-free time of 4.1 days (95% CI 3.7 to 4.6) was observed. The dysphagia-free survival at seven days was 22.72%. The patients who showed

Table 2. Characteristics related to acute ischemic stroke.

	n	%
TOAST		
Large-artery atherosclerosis	67	24,8
Cardioembolism	31	11,5
Small-vessel occlusion	39	14,4
Stroke of other determined etiology	10	3,7
stroke of undetermined etiology, two or more determined etiology	12	4,4
stroke of undetermined etiology, negative evaluation	69	25,6
stroke of undetermined etiology, incomplete evaluation	42	15,6
NIHSS, at admission, mean (SD)[a]	8,5	(7,6)
Normal (0)	27	10,0
Mild (1-4)	73	27,0
Mild to moderate (5-15)	118	43,7
Moderate (16-20)	22	8,1
Severe (21-36)	27	10,0
Type of neuroimage[b]		
Right	48	17,8
Left	148	54,8
Bilateral	73	27,0
Arterial territory		
MCA (Middle cerebral artery)	166	61,5
ACA (Anterior cerebral artery)	6	2,2
PCA (Posterior cerebral artery)	20	7,4
Basilar artery (AB)	16	5,9
Vertebral artery (AV)	2	0,7
Lacunar	20	7,4
ICA (Internal carotid artery)	9	3,3
Multivessel	24	8,9
PICA (Posterior inferior cerebellar artery)	4	1,5
SCA (Superior cerebellar artery)	3	1,1
Lesion side b		
Right	116	43,0
Left	134	49,6
Bilateral	19	7,0

a. Data missing for three patients, b. data missing for one patient.

faster progression to dysphagia were as follows: those with TOAST indeterminate etiology due to incomplete evaluation had a median of 2.6 days. Regarding the NIHSS scores, patients with moderate severity (NIHSS: 16 to 20) had a median of 2.9 days, and patients with severe severity (NIHSS: 21 to 36) had a median of 2 days. Patients who presented with dysarthria upon admission had a median of 3.7 days, while those with facial paralysis upon admission had a median of 3.6 days. In terms of medical history, patients with idiopathic Parkinson's disease had a median of 1.6 days, those with coronary artery disease had a median of 3.1 days, and those with Alzheimer's disease had a median of 2.1 days. Regarding the affected arterial territory, the median was 3.6 days for the superior cerebellar artery, 3.3 days for multivessel involvement, and three days for the basilar artery. Patients with right-sided infarction had a median of 3.6 days. Patients who did not undergo reperfusion therapy had a median of 3.9 days.

Main results

Table 3 presents the association results, both observed and adjusted, for the variables included in the model, and Figure 1 displays the survival functions for the statistically significant variables. In the adjusted analyses, TOAST classification and NIHSS categories were identified as having a statistically significant association with shorter dysphagia-free survival. Regarding the TOAST classification (Figure 1a), shorter dysphagia-free survival was observed for indeterminate etiology due to incomplete evaluation (TR = 0.51, 95%CI 0.34-0.77), other determined etiology (TR = 0.52, 95%CI 0.28-0.96), small vessel occlusion (TR = 0.57, 95%CI 0.39-0.84), and large vessel atherosclerosis (TR = 0.66, 95%CI 0.46-0.99). For the NIHSS (Figure 1b), a significant gradient was observed for the severe category (TR = 0.30, 95%CI 0.17-0.53), moderate category (TR = 0.38, 95%CI 0.22-0.68), and mild to moderate category (TR = 0.52, 95%CI 0.32-0.86). A history of Parkinson's disease (Figure 1c) was also associated with shorter dysphagia-free survival (TR = 0.50, 95%CI 0.27-0.96), as well as older age (p = 0,043) at the time of ischemic stroke (Figure 1d).

The results of the unadjusted association for the explored candidate variables that were not included in the model are presented in Table 4.

Discussion

This registry-based retrospective follow-up of 270 ischemic stroke patients in a tertiary care setting, found a median dysphagia-free time of 4.1 days, with a cumulative survival at seven of 22.72%. TOAST, NIHSS, history of Parkinson's disease, and older age at the time of stroke were associated with lower dysphagia-free survival. Dysphagia, a common complication in patients suffering cerebrovascular events, may be transient and persist in only a minor group of patients.[5] Current guidelines suggest the use of a nasogastric tube if it is anticipated that the patient will not recover the oral route in the first seven days and indicate the use of gastrostomy if the patient is presumed to have dysphagia for more than 30 days.[12] According to the literature, predictors of prolonged dysphagia and aspiration include malnutrition, use of an enteral method on admission, cough, and tongue strength, secretion management, presence of dysphonia or dysarthria, age, NIHSS value, bilateral infarcts, and infarct size.[9]

Taking the above into consideration, it is observed in clinical practice that there are difficulties in defining

Table 3. Demographic and clinical factors associated to dysphagia.

		Observed		Adjusted	
	Media n	TR	p value (95%CI)	TR	p value (95%CI)
TOAST					
Cardioembolism	5,4	1,00		1,00	
Undetermined etiology, negative evaluation	4,8	0,89	0,515 (0,61-1,28)	0,77	0,156 (0,54-1,10)
Undetermined etiology, two or more determined etiology	5,5	1,01	0,962 (0,58-1,79)	0,75	0,304 (0,44-1,29)
Large-artery atherosclerosis	3,9	0,72	0,077 (0,50-1,04)	0,66	0,019 (0,46-0,93)
Small-vessel occlusion	3,9	0,72	0,111 (0,48-1,08)	0,57	0,005 (0,39-0,84)
Other determined etiology	4,0	0,75	0,352 (0,40-1,38)	0,52	0,035 (0,28-0,96)
Undetermined etiology, incomplete evaluation	2,6	0,48	<0,001 (0,33-0,72)	0,51	0,001 (0,34-0,77)
NIHSS, at admission					
Normal (0)	9,0	1,00		1,00	
Mild (1-4)	5,4	0,60	0,080 (0,34-1,06)	0,71	0,196 (0,43-1,19)
Mild to moderate (5-15)	4,0	0,45	0,005 (0,26-0,78)	0,52	0,010 (0,32-0,86)
Moderate (16-20)	2,9	0,33	0,001 (0,17-0,62)	0,38	0,001 (0,22-0,68)
Severe (21-36)	2,0	0,22	<0,001 (0,12-0,42)	0,30	<0,001 (0,17-0,53)
Age					
Per additional year	N/A	0,99	0,001 (0,98-0,99)	0,99	0,043 (0,99-1,00)
Medical history					
Parkinson's disease	1,6	0,4	0,011 (0,18-0,80)	0,50	0,037 (0,27-0,96)
Coronary artery disease	3,1	0,72	0,038 (0,52-0,98)	0,79	0,095 (0,60-1,04)
Alzheimer's disease	2,1	0,50	0,020 (0,28-0,89)	0,66	0,137 (0,38-1,14)

TR: Time Ratio, N/A: not applicable.

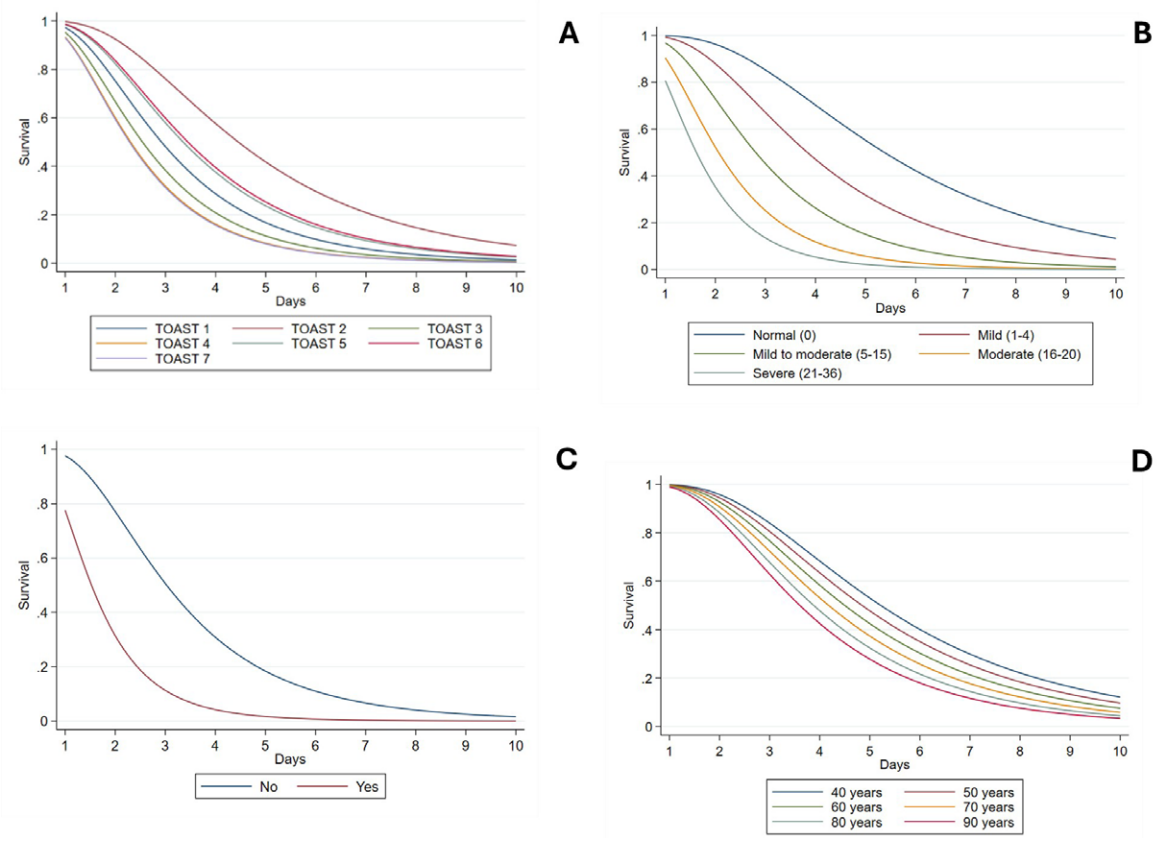

Figure 1. Adjusted survival function (log-normal distribution) by (a) TOAST classification, (b) NIHSS score, (c) history of Parkinson´s disease and, (d) age. **TOAST:** 1. Large-artery atherosclerosis, 2. Cardioembolism, 3. Small-vessel occlusion, 4. Stroke of other determined etiology, 5. stroke of undetermined etiology, two or more determined etiology, 6. Stroke of undetermined etiology, negative evaluation, 7. Stroke of undetermined etiology, incomplete evaluation.

Table 4. Candidate variables not included in the adjusted model.

	Median	TR	p value	95%CI
Facial paralysis at admission				
No	5,8	1,00		
Yes	3,6	0,62	<0,001	(0,48-0,81)
Dysarthria at admission				
No	6,5	1,00		
Yes	3,7	0,57	<0,001	(0,42-0,76)
Arterial territory				
Lacunar	5,1	1,00		
PCA (Posterior cerebral artery)	5,0	0,98	0,937	(0,54-1,76)
ICA (Internal carotid artery)	4,7	0,92	0,832	(0,44-1,92)
Vertebral artery (AV)	4,4	0,86	0,823	(0,22-3,28)
MCA (Middle cerebral artery)	4,1	0,80	0,326	(0,5-1,26)
PICA (Posterior inferior cerebellar artery)	4,0	0,79	0,627	(0,3-2,09)
SCA (Superior cerebellar artery)	3,6	0,70	0,526	(0,23-2,11)
Multivessel	3,3	0,65	0,127	(0,38-1,13)
Basilar artery (AB)	3,0	0,58	0,069	(0,32-1,04)
ACA (Anterior cerebral artery)	N/E			
Type of neuroimage				
Right	4,6	1,00		
Left	4,1	0,90	0,415	(0,69-1,17)
Bilateral	3,6	0,79	0,154	(0,56-1,09)
Medical history				
Chronic kidney disease	3,1	0,73	0,062	(0,52-1,02)
Cancer	3,2	0,76	0,205	(0,50-1,16)

TR: Time Ratio, N/E: not estimable.

the definitive feeding route for these patients because there is no consensus on the appropriate way to assess dysphagia[13] and the lack of a tool that can link the above variables and generate a prognostic model.[14] This information gap led us to conduct a study to estimate dysphagia-free survival and associated factors in patients with acute ischemic stroke in an institution specializing in neurology in the city of Medellin in the year 2020 so that in the future, we can use the variables included in our model as a starting point for the development of a risk score to facilitate decision making.

Our study included 270 patients with demographic variables that behave like the known epidemiology of acute ischemic stroke. Of the total number of patients, 75.6% presented dysphagia, with a median dysphagia-free time of 4.1 days. This allows us to highlight the variables that are associated with a faster onset of dysphagia by identifying, in the adjusted analyses, statistically significant characteristics associated with shorter dysphagia-free time, which were mainly the TOAST classification with large vessel involvement and a stroke classified as moderate or severe by NIHSS score. A history of Parkinson's disease was also significantly associated with shorter dysphagia-free time, as was older age at presentation of ischemic stroke.

In contrast to what has been previously found in the literature, in our study, facial paralysis and dysarthria at admission behaved as confounding variables when adjusted for clinical severity according to the NIHSS scale.

The identification of these variables, found to be significantly associated with the occurrence of dysphagia, is essential because up to 10% of hospitalized patients with ischemic stroke may present with aspiration pneumonia in the first week after the event, increasing the probability of death and, in case of survival, a higher level of functional dependency.[15] Furthermore, post-aspiration pneumonia is the leading cause of death in stroke patients during the first year of follow-up after hospital discharge.[16] Nutritional complications are another possible complication, occurring in as many as 26.4% of stroke patients within seven days of hospitalization.[17] Moreover, it is often underdiagnosed and inadequately treated.[18] This can lead to worse outcomes, complications, and impairments in immune function, resulting in an increased infection rate and higher mortality.[19]

Although early evaluation to recognize and diagnose dysphagia is recommended to reduce the deleterious effects of dysphagia, there is little information on the impact of this intervention. Small studies show that early evaluation can prevent aspiration pneumonia.[13] In addition, it has been evidenced that healthcare institutions implementing formal, mandatory post-stroke swallow screening tools have lower rates of aspiration-derived lower respiratory infections than those without such a protocol.[9]

For the treatment and rehabilitation of patients with post-stroke dysphagia, it is essential to make an early decision regarding the definitive feeding route, oral route with or without restrictions, enteral feeding by nasogastric tube, or gastrostomy.[20] It is a challenge to define the next step for these patients, considering the multiple variables that will influence the decision, including the probability of survival in the next six months and the joint decision of the health professional, the patient, and the family.[21]

A significant strength of the study was the site at which it was conducted: a neurology referral center and Angels-certified for managing stroke patients. Regarding limitations, it is highlighted that the study was conducted in a single hospital center; however, as mentioned above, it is a referral center for neurological pathologies. Although professionals diagnosed dysphagia with three different profiles (neurologist, speech therapist, and nurse), and this could be considered a limitation, in the institution, there is a high degree of standardization among the above for the management and diagnosis according to international guidelines.[22] Another significant limitation is the restricted inclusion of variables reported in the clinical history due to the study's retrospective nature; however, the results are not invalidated since most of the frequently associated and clinically relevant variables reported in the literature were included.[23]

Conclusion

Dysphagia was frequent among ischemic stroke patients. However, the results reveal a lower day dysphagia-free survival among patients with TOAST classification, indicating large vessel involvement and those with moderate to severe NIHSS scores. Additionally, Parkinson's disease and older age at the time of the event were identified as variables associated with a faster onset of dysphagia. These findings have implications for the future development of a risk score that can aid in decision-making for ischemic stroke patients with dysphagia in our specific population.

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