

R E V I E W

Post-Cerebrovascular Stroke and early Dysphagia assessment: A Systematic Review

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Abstract. *Background and aim:* We performed a systematic review on the early assessment of swallowing function after cerebrovascular stroke. *Methods:* A systematic review of the English language literature of the past 20 years was performed regarding swallowing function and cerebrovascular stroke. All articles reporting swallowing evaluation through clinical examination validated scores, and diagnostic tools were included in the summary. *Results:* The systematic review of the literature identified 1,768 potentially relevant studies with 7 papers retrieved with a total of 589 stroke dysphagic patients. While at the clinical neurological assessment, The National Institutes of Health Stroke Scale was more frequently used as a clinical outcome predictor. The Bedside screening approach was carried out in 6 papers to assess patients with probable swallowing disorders. Among the diagnostic tools, seven studies performed the Flexible Fiberoptic Endoscopic evaluation assessing scoring validated system while two papers reported early swallowing outcomes Videofluoroscopic Swallow Study. *Conclusions:* Our systematic review revealed the findings significantly associated with dysphagia in post-cerebrovascular patients. Endoscopic evaluation of swallowing proved to be the most used method in the literature, effective in identifying early predictors of dysphagia. Given the presence of different assessing scores employed and reduced study samples enrolled, further studies with large courts are necessary for a greater significance. (www.actabiomedica.it)

Key words: dysphagia, stroke, FEES, VFFS, BDS

Introduction

Cerebrovascular stroke concerns a high percentage of people, especially the elderly(1-3). It is well-reported in the literature that patients affected by cerebrovascular stroke frequently present swallowing function impairment subsequently to the neurological damage (4-6). This could result in a reduction or complete disability to the eating processes. Besides, elderly patients already have a physiological swallowing reserve reduction due to the aging effect, defined as presbyphagia (2-4), which could certainly worsen in case of cerebrovascular damage. Different studies showed as patients with. In this regard has been showing that 80% of subjects developing to a mild disorder at the short-term follow-up. Besides, dysphagia in these patients with neurological impairment could be a risk factor for more serious systemic complications, such as malnutrition, the risk of aspiration and pneumonia, poor rehabilitation with average hospital stays longer than in non-dysphagic patients(11,12). Dysphagia is also considered a relevant risk factor for mortality in cardiovascular stroke patients for these severe complications. The main findings described in post-stroke dysphagia patients are: delayed pharyngeal phase, longer oral phase duration, reduced laryngeal sensibility, and a larger pharyngeal space due to sarcopenia (5,6, 13-17). In patients with cerebrovascular disorders, the swallowing impairment findings are different from other neurological diseases dysphagia-related as Alzheimer's(7,18). Patients with demyelinating diseases suffer from dysphagia correlated to a sensory impairment due to temporoparietal area dysfunctions, motor alterations from the corticobulbar tract are typical of vascular swallowing disorders.

According to this evidence, a correct clinical, performed in the days following the ischemic event, is useful to prevent several related-comorbidities such as aspiration pneumonia, frailty, and sarcopenia (19-21).

Several screening tests or evaluation scales associated with diagnostic tools such as the Fiberoptic Evaluation of Swallowing or the fibroendoscopic swallowing study have been described in the literature to evaluate possible post-acute dysphagia due to neurological events (19-26). However, there is no agreement between the various tests used, but above all, a clear line of conduct is not described in the case of early dysphagia in the patient with stroke.

In this study, we systematically reviewed the last 20 years' literature, identifying the main clinical-diagnostic tools used to evaluate early post-stroke swallowing disorders. Findings of dysphagia emerged, and correlation with severity of the neurological impairments has been evaluated and discussed.

Materials and Methods

Protocol Data extraction and outcomes evaluated

The authors A.M, F.C and C.F analyzed the literature according to the last twenty years' data. The authors discussed any disagreements to solve them among the study's team. After the paper's inclusion, all available data were analyzed to obtain and guarantee eligibility for all subjects. Main patient's features, symptoms, clinical and diagnostic assessment, outcomes scores, and follow-up were collected.

Thus, the data obtained regarding subjective and objective assessment correlated swallowing symptoms were discussed separately according to the main scores achieved and each procedure performed. If required for missing data, authors of the included studies were contacted using correspondence author's email or Research Gate (<http://www.researchgate.net/>).

Electronic database search

According to the PRISMA checklist for review and meta-analysis, we performed a systematic review of the current literature. PubMed, Scopus, Web of Science electronic, Scholar, and Scielo databases were searched for studies on Oropharyngeal dysphagia in patients with Cerebrovascular Disorders of the last 20 years of literature (from December 1st, 2001 to March 1st, 2021) by three different authors. The related search keywords were used: "Oropharyngeal Dysphagia," "Vascular Dysphagia," and "Stroke Dysphagia." The Boolean operator and/or were used for each combination. The "Related articles" option on the PubMed homepage and Scholar was also considered. The investigators examined titles and abstracts of papers available in the English language. We used Reference manager software (EndNote X7®, Thomson Reuters,

Philadelphia, PA) to collect references and remove duplicates. The identified full texts were screened for original data, and the related references were retrieved and checked manually for other relevant studies.

Eligibility criteria

The PICOTS approach was used, including Medical Subject Headings (MeSH), Entry Terms, or keywords found in articles of the area. We considered Participants (stroke patients); Intervention (bedside examination and fiber optic endoscopic evaluation of swallowing); Control (not applied); Outcome (association between early swallowing assessment and cerebrovascular stroke), and study type (experimental studies, longitudinal studies).

We used as restrictions language, publication date, and publication status. The saccharin transit time repeatability was considered as the primary outcome. Instead, other parameters assessed in the studies were considered secondary outcomes.

Studies were included when the following criteria were met:

1. original observational articles;
2. the article was published in English;
3. the studies included only clinically confirmed cases of oropharyngeal dysphagia in stroke patients;
4. the studies reported detailed information on subjective or objective evaluation through several validated subjective dysphagia questionnaires, outcomes scores obtained after fiberoptic or videofluoroscopic analysis;
5. studies performing an early assessment of swallowing disorders after stroke (within three months)(22)

All studies reporting long-term swallowing results (follow-up beyond three months) were excluded from the qualitative analysis.

Synthesis of results

We identified different laboratory procedures and various comorbidities that could influence the

outcomes of quantitative analysis. Therefore, we performed a narrative synthesis employing the guidelines of the Synthesis without Meta-analysis reporting items.

Statistical Analysis

This protocol was performed in line with the approved reporting items' quality requirements for systematic review and meta-analysis protocols (PRISMA) declaration(23). Statistical analysis was performed using statistical software (IBM SPSS Statistics for Windows, IBM Corp. Released 2017, Version 25.0. Armonk, NY: IBM Corp). Furthermore, we assessed the potential risk of bias in observational studies through the Joanna Briggs Institute Critical Assessment Checklist for Observational Studies (24). The studies' quality assessment (QUADAS-2) instrument to estimate the included studies' study design features was adopted, and the results of the risk of bias were presented descriptively (25).

Results

The systematic review of the literature identified 1,768 potentially relevant studies (Fig. 1). After removing the duplicates and applying the criteria listed above, an overall number of 1708 records screened were potentially relevant to the topic. We excluded all the studies that did not match inclusion criteria through the records analysis and subsequent articles full-text screening. The remaining 7 papers were included in qualitative synthesis for the data extraction.

Assessment of the studies

All included studies had adequate relevance to the subject of this review. None was a randomized controlled trial. Five reports were uncontrolled retrospective studies, one case-control study, one Prospective controlled study, and a remaining randomized controlled trial(1,9,17,19,26-28). According to the Oxford Centre for Evidence-based Medicine, the quality of the evidence was low for ratings of individual studies (30): one study was level 3 of evidence (27), and the others were level 4.

Epidemiology and demographics data

We provided 7 articles in our systematic literature review for a total of 589 stroke dysphagic patients, of which 40,81% F vs 59,19% (271 F vs 393 M). The patients' average age was 67.35 ± 4.27 years. Early assessment after the stroke occurred in all studies, ranging from <48 hours up to 90 days (1,17,19,26-29).

De Stefano et al. did not find any statistically significant difference between DRS and PAS outcomes and ischemic and hemorrhagic stroke ($p < 0.05$) (17). Moreover, there was no correlation between the

area of the brain involved by stroke and the severity of dysphagia at discharge ($p > 0.05$).

Clinical assessment

Neurological stroke assessment

The National Institutes of Health Stroke Scale (NIHSS) was a major clinical outcome predictor in stroke patients in 4 papers (1,17,19,26). The NIHSS score was calculated in collaboration with a neurologist

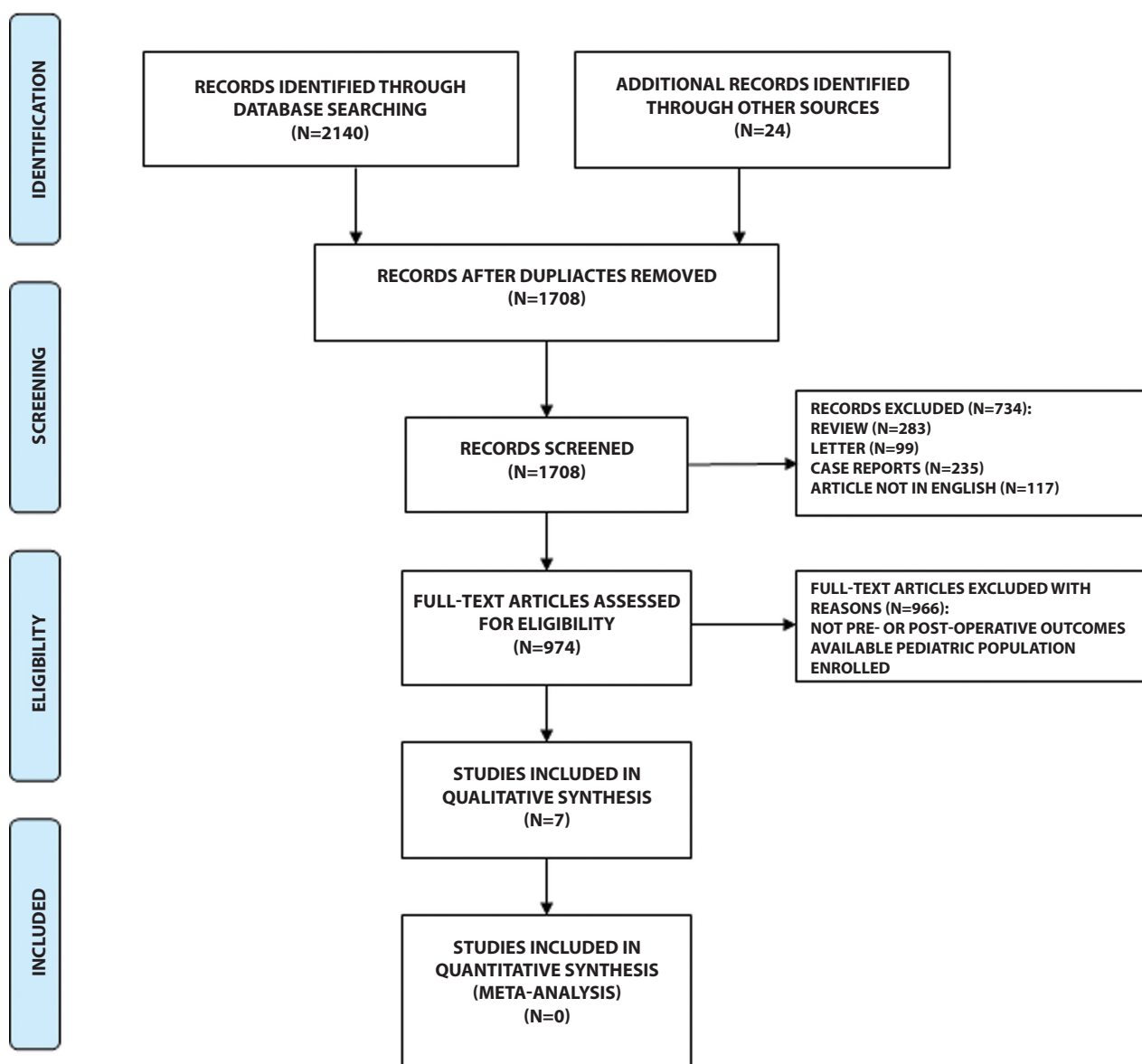


Figure 1. PRISMA flow-diagram

or emergency caregiver. The mean score obtained ranging from 7.79 ± 5.79 (19) to 11.9 ± 9.08 (17). Furthermore, NIHSS outcome was reported as an independent predictor of the functional outcome on admission on multivariate linear regression analysis (beta = 0.343)(19).

The Korean version of the Modified Barthel Index (K-MBI) was performed in one paper to measure the patient's general functions, particularly daily living activities, mobility, continence of bowels, and bladder (29). The remaining three papers did not administer a systematic assessment tool that provides a quantitative measure of stroke-related neurologic deficit (9,27,28).

Bedside Dysphagia Screening

The first approach to the patient with probable swallowing disorders was carried out through bed screening tests in 6 papers (1, 9, 17, 27-29). However, the validity of this tool in the diagnosis of aspiration has been highly variable, requiring further investigation. Two studies administered Bedside dysphagia score (BDS), neurological examination dysphagia score (NEDS) to assess early at bedside examination patients with stroke and higher risk to aspiration (1,27). Moreover, the same authors reported the Total Dysphagia Score (TDS) obtained through the first two sums. The tests indicated ease of application in patients with early stroke possessing specific items for both dysphagia and neurological indices. On regression analysis, the BDS was an effective factor in detecting dysphagic patients by the FEES method ($p = 0.021$, $OR = 0.146$)(27). Instead, there was no significant difference in the NEDS and TDS scores between dysphagic and healthy ($p=0.676$; $p=0.067$, respectively). One study included performing the Dysphagia Risk Score (DRS), reported an average mean of 5.68 ± 4.5 , with a positive linear correlation with NIHSS score ($r 0.50$)(17). No significant difference in DRS between ischemic or hemorrhagic stroke was reported ($p > 0.05$).

Moreover, Edmiaston *et al.* in 2013 demonstrated a sensitivity and specificity of the bedside screen (BJH-SDS) to detect dysphagia of 94% and 66% in 225 acute stroke patients, while sensitivity and specificity to detect aspiration of 95% and 50%, respectively (31).

Fiberoptic Endoscopic Evaluation of Swallowing (FEES)

FEES is recognized as an objective swallowing evaluation instrument, allowing superior diagnostic Accuracy and feasibility for early stroke patients acute(26,28,29).

Seven studies performed the Flexible Fiberoptic Endoscopic assessment to reveal endoscopic swallowing disorders in acute stroke patients through a 6-point scoring validated system(1,19,26,27) (Table 1).

De Stefano *et al.* divided patients into three groups based on the Penetration Aspiration Scale, with higher scores expressing an increased aspiration risk(17). The authors reported a positive linear correlation between FEES outcomes and clinical scores (NIHSS score, $r=0.65$; DRS, $r=0.50$).FEES assessment confirmed in stroke dysphagia patients the typical oral phase disorder (28). Umay *et al.* in 2017 stated oral dysfunction up to 95.8% of the cases while the pharyngeal phase was involved individually in 5.6% or combined with 30.6% of the subjects(1). The effectiveness of fiberoptic assessment was validated by Umay *et al.* in 2013 by comparing electrophysiological evaluation (E.E.) outcomes (27). The authors found the FEES level dysphagia patients an influential factor as E.E. detecting dysphagic patients ($p=0.018$, $OR=0.364$).

Warnecke *et al.* demonstrated FEES as independent predictors of functional outcome and complications after a stroke at multivariate linear regression analysis (beta = 0.349), more relevant than age and fairly significant as NIH-SS (beta = 0.343) (19).

Moreover, Dziewas *et al.* at multivariate logistic regression analysis found FEES scores significantly associated with endotracheal intubation ($OR=10.58$; $p < 0.001$)(26). Therefore, the authors suggested in patients with saliva pooling with penetration/aspiration at FEES a close monitoring and eventual preventive intubation with a tracheotomy.

Videofluoroscopic Swallow Studies (VFSS)

Two papers reported early swallowing outcomes analyzed by VFSS (9, 29). The early study of swallowing by videofluoroscopy (VFSS) effectively detects dysphagia patterns in stroke patients, especially correlated with the type of brain injury (29,30).

Table 1. Abbreviations FEES, fiberoptic evaluation of swallowing; DS, Dysphagia Score; MASA, Mann Assessment of Swallowing Ability; NIHSS, National Institutes of Health Stroke Scale; BDS, bedside dysphagia score; NEDS, neurological examination dysphagia score; NA, not available.

Reference	Study design	Patients (n)	Age	Gender	Timing (h/ days)	Clinical Scale	Bedside Screening Test	FEES
Warnecke T et al. 2009	Retrospective Uncontrolled	153	68.5 ± 13.20	80 F, 83 M	< 2 days	NIH-SS 7.79 ± 5.79	NA	FEDSS 2.29 ± 1.57
Dziewas R et al. 2008	Retrospective Uncontrolled	25	73 ± 9,6	12 F, 13 M	< 3 days	NIH-SS 9.7 ± 4.5	NA	DS 3.96 ± 1.39
Umay EK et al. 2017	Randomized Controlled Study	98	61.59 ± 9.97	22 F, 76 M	14.52 ± 5.53 days	NIH-SS 9.58 ± 4.07	BDS 5.71 ± 1.44 NEDS 6.35 ± 1.74 TDS 10.03 ± 2.62	DS 3.74 ± 1.21
Umay EK et al. 2013	Prospective Controlled Study	24	64.83 ± 10.73	9 F, 15 M	< 90 days	NA	BDS 3.59 ± 1.35 NEDS 4.21 ± 1.94 TDS 7.8 ± 1.92	DS 3.08 ± 0.94
De Stefano A et al. 2020	Retrospective Uncontrolled	54	75.1 ± 12.4	24 F, 30 M	< 60 days	NIH-SS 11.9 ± 9.08	DRS 5.68 (± 4.5)	PAS 3.8 ± 2.06
Bahceci K et al. 2017	Retrospective Controlled	72	63.32 ± 11.17	25 F, M 47	16.51 ± 8.32 days	NA	MASA 118.47 ± 28.31	DS 3.52 ± 1.65
Kim SB et al. 2018	Retrospective Uncontrolled	163	67.55 ± 12.19	63 F, 100 M	4,8 ± 1,45 days	K-MBI 46.79 ± 25.8	NA	DOSS 3.72 ± 1.98

Kim *et al.* performed VFSS within 7 days of stroke onset in stroke patients in 2018, noting a 19.0% discrepancy between Water Swallowing Test (WST) and VFSS (29).

The scores from the swallowing study (VFSS) have also been shown to be effective in correlating the quality of life of stroke patients and their outcomes as rehabilitators of pharyngeal dysphagia.

Discussion

The evaluation of dysphagia in stroke patients is still difficult, especially in identifying a clear line of conduct on the resumption of nutrition. Several factors could influence the severity of dysphagia, including age, gender, comorbidity, or area of the brain affected by stroke(21,32).

The concomitant presence of a cognitive-behavioral deficit has been shown to correlate with swallowing disorders, associated in particular with inattention, asthenia, and poor appetite(13,17).

Various swallowing disorders may arise after early strokes, such as repetitive tongue movements, prolonged swallowing due to slow oral transit, or reduced hyoid-laryngeal excursion(32,33).

Furthermore, cerebrovascular disorders are associated with the development of a reduction in pharyngeal and supraglottic sensitivity, increasing the risk of aspiration(34,35).

The presence of aspiration in patients with dysphagia after stroke can be easily detected during FEES, representing a predictor of pneumonia development(21).

Delayed pharyngeal swallowing is often accompanied by laryngeal excursion and laryngeal vestibule deficiency with penetration and aspiration, symptoms more evident in diffuse than focal lesions(37,38). Suh *et al.* described in patients with Alzheimer's dementia a significant delay in oral transit with liquids ($p = 0.008$). In contrast, patients with cerebrovascular disorders show a deficit in the formation of bolus and chewing ($p = 0.039$), a reduced hyolaryngeal excursion ($p = 0.043$) and increased silent suction ($p = 0.01$)(7). Conversely, patients

may have an almost regular oral phase in both the introduction and progression of the posterior bolus; however, patients with cognitive impairment may take inconsistently during phonation(39,40).

Clinical bed screening could difficult to assess swallowing disorders due to insufficient sensitivity and specificity alone being limited in detecting residual volume or silent aspiration and providing false-negative outcomes (19,41). Similarly, if swallowing shows no improvement during the first ten days, the recovery process may take up to a few months(41,42). The early VFSS assessment of the stroke patient possesses limitations as an altered consciousness state or unable to maintain a sitting position. However, the dynamic swallowing evaluation concerning the anatomical

structures allows obtaining objective and measurable parameters(43-45). Therefore, after the first evaluation with screening tests and FEES, especially in the presence of sudden neurological changes, VFSS could be indicated, allowing an objective point of the situation for a dietary and rehabilitative strategy (46,47).

The main limitation of the present study is the heterogeneity between included studies regarding the patient population, inclusion criteria, and methods of assessment of dysphagia after cerebrovascular stroke (Fig. 3). All of these points may limit the draw of a clear conclusion (Fig. 4). However, our study represents the first systematic review investigating such association and could provide a literature overview, possibly useful for future studies.

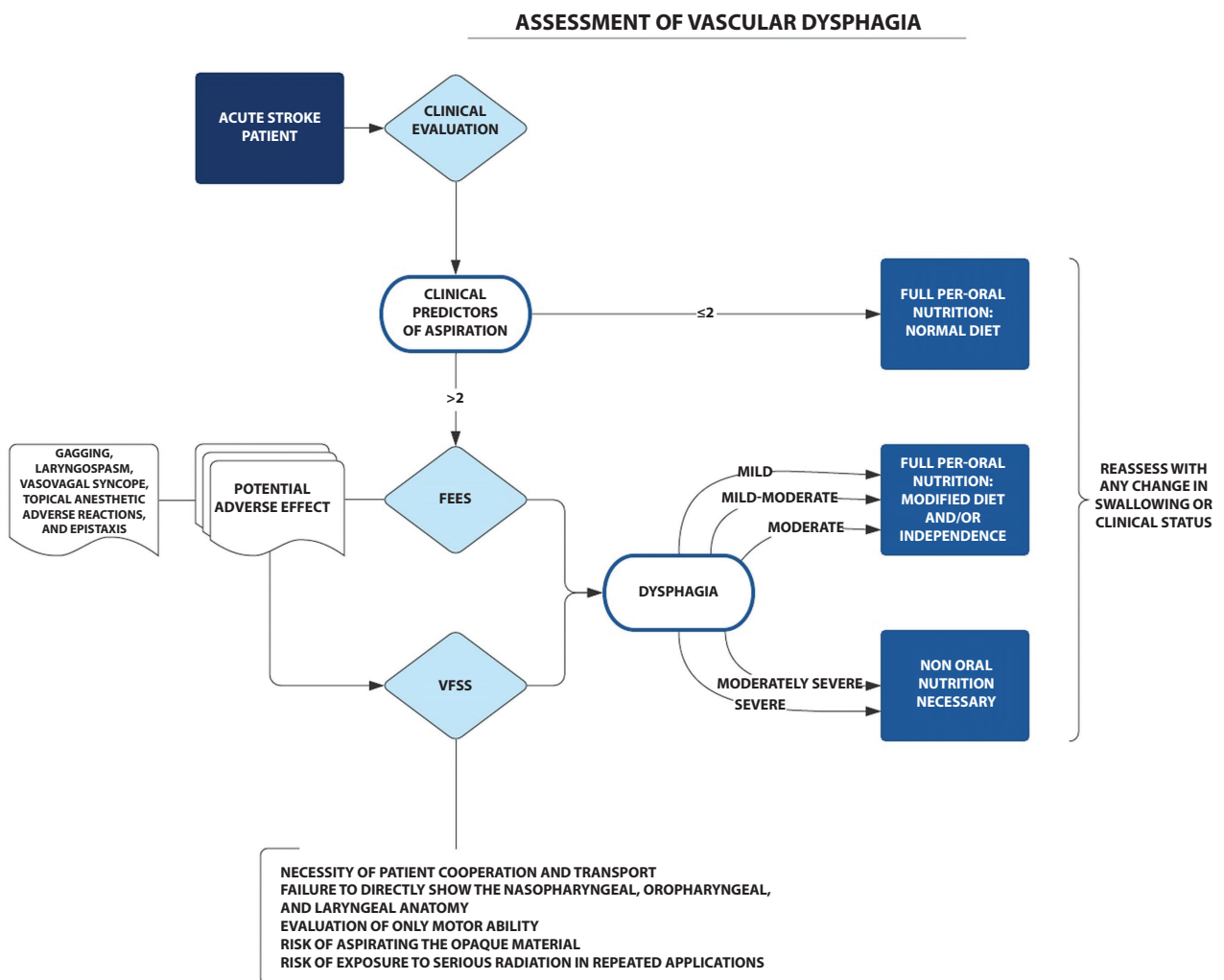


Fig. 2 Flow-chart Dysphagia assessment

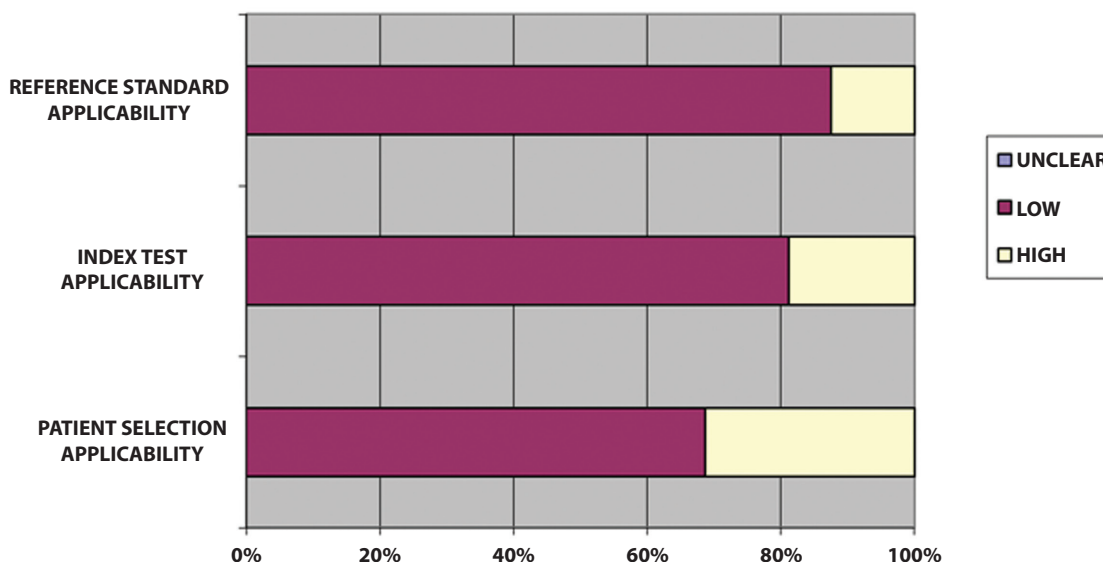
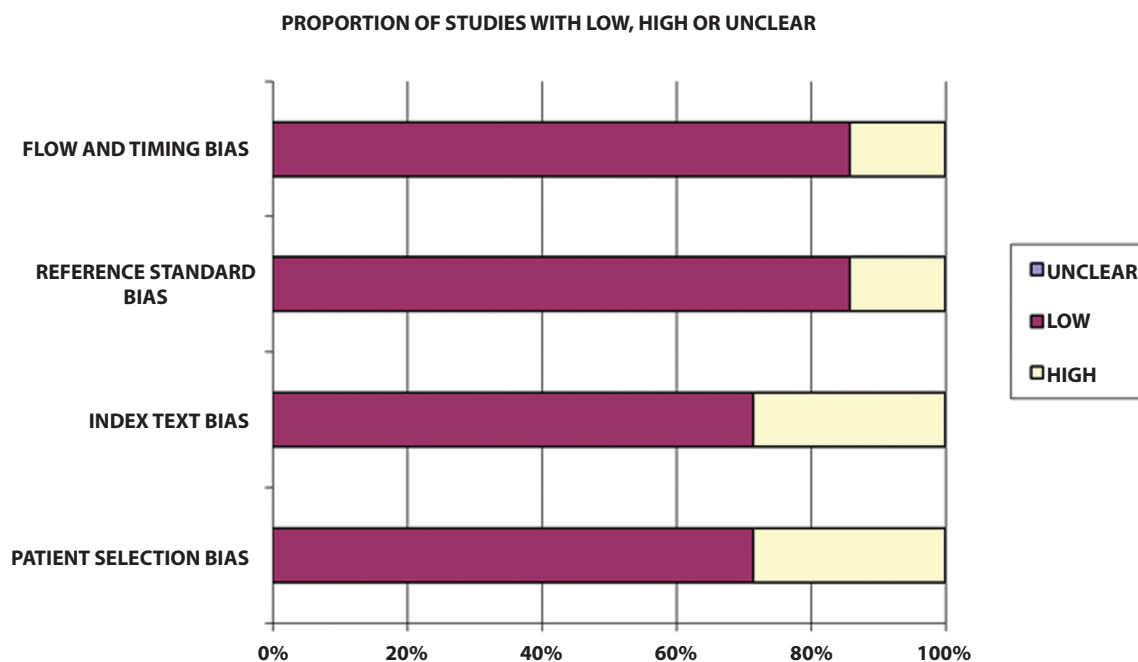


Figure 3. QUADAS-2 tool

Conclusion

It is critically important to have all patients with cerebrovascular stroke evaluated for early swallowing to establish a clear nutritional policy and avoid aspiration and penetration complications.

The first approach to the patient is the Bedside Dysphagia Screening, using evaluation scores that

also include items on neurological function and carried out with the observation of the speech therapist. Although significant results have been reported on the short-term assessment of dysphagia after VFSS, little evidence is available in the literature to date. On the contrary, the evaluation of swallowing in the endoscopic vision represents an effective tool for detecting patients with level dysphagia, correlating the

	1. WERE THE GROUPS COMPARABLE OTHER THAN THE PRESENCE OF DISEASE IN CASES OR THE ABSENCE OF DISEASE IN CONTROLS?	2. WERE CASES AND CONTROLS MATCHED APPROPRIATELY?	3. WERE THE SAME CRITERIA USED FOR IDENTIFICATION OF CASES AND CONTROLS?	4. WAS EXPOSURE MEASURED IN A STANDARD, VALID AND RELIABLE WAY?	5. WAS EXPOSURE MEASURED IN THE SAME WAY FOR CASES AND CONTROLS?	6. WERE CONFOUNDING FACTORS IDENTIFIED?	7. WERE STRATEGIES TO DEAL WITH CONFOUNDING FACTORS STATED?	8. WERE OUTCOMES ASSESSED IN A STANDARD, VALID AND RELIABLE WAY FOR CASES AND CONTROLS?	9. WAS THE EXPOSURE PERIOD OF INTEREST LONG ENOUGH TO BE MEANINGFUL?	10. WAS APPROPRIATE STATISTICAL ANALYSIS USED?
WARNECKE T, RITTER MA ET AL. 2009	+	+	+	+	+	-	-	+	+	+
DZIEWAS R, WAMECKE T ET AL. 2009	+	+	+	+	+	-	-	+	+	?
UMAY EK, YAYLACI A ET AL. 2017	+	+	+	+	+	-	-	+	+	+
UMAY EK, UNLU E ET AL. 2013	+	+	+	+	+	-	-	+	+	+
DE STEFANO A, DISPENZA F ET AL. 2020	+	+	+	+	+	-	-	?	+	+
BAHCECI K, UMay EK ET AL. 2017	+	+	+	+	+	-	-	+	+	+
KIM SB, LEE SJ ET AL. 2018	+	+	+	+	+	-	-	+	+	+

Figure 4. Risk of Bias summary author's judgments for each included study, assessed by the Joanna Briggs Institute (JBI). Critical Appraisal Checklist for Case-Control studies

aspiration and penetration scores to the neurological outcomes recorded.

Conflict of Interest: Each author declares that he or she has no commercial associations that might pose a conflict of interest in connection with the submitted article

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