



Consistencies among miscellaneous scales for evaluation of post-stroke dysphagia

Wen-Ching Chen¹ · Chung-Wei Lin^{2,3} · Meng-Ni Wu¹ · Yi-On Fong¹ · Chun-Hung Chen^{1,4,5,6,7} · Sun-Wung Hsieh^{1,4,5,6,8} · Chih-Yin Elizabeth Chen⁹ · Poyin Huang^{1,4,5,6,7,8}

Received: 19 April 2023 / Accepted: 28 June 2023 / Published online: 10 July 2023
© The Author(s), under exclusive licence to Springer-Verlag GmbH Germany, part of Springer Nature 2023

Abstract

Purpose Post-stroke dysphagia (PSD) is the most common type of dysphagia. Stroke patients with sustained dysphagia have poorer outcomes. The severity of PSD is assessed using miscellaneous scales with unknown consistencies. We aim to investigate the consistencies among miscellaneous scales, which could aid in the assessment of PSD.

Methods A total of 49 PSD patients were enrolled. Functional Oral Intake Scale (FOIS), Dysphagia Severity Scale (DSS), Ohkuma Questionnaire, Eating Assessment Tool-10, and Repetitive Saliva Swallowing Test were performed. FOIS was performed by physicians, and DSS was conducted by both the physicians and nurses; the physicians used either videofluoroscopy (VF) or videoendoscopy (VE) for evaluation; while, the nurses assessed PSD by observation and subjective judgment.

Results When using VF (VF-DSS and VF-FOIS) as the gold standard for the evaluation, VE-FOIS ($\kappa=0.625$, 95% CI 0.300–0.950, $p<0.001$) has a substantial agreement with VF-FOIS, and VE-DSS ($\kappa=0.381$, 95% CI 0.127–0.636, $p=0.007$) has a fair agreement with VF-DSS. The weighted kappa of FOIS to DSS in VE (weighted $\kappa=0.577$, 95% CI 0.414–0.740, $p<0.001$) is not lower than that in VF (weighted kappa = 0.249, 95% CI 0.136–0.362, $p<0.001$).

Conclusion For both DSS and FOIS, only VE has a statistically significant agreement with VF. Though VF has been viewed as the traditional gold standard of dysphagia screening, it has the limitations of being invasive and equipment dependent. For PSD, VE could be considered as a substitution when VF is not available or suitable.

Keywords Videoendoscopy · Videofluoroscopy · Post-stroke dysphagia · Bedside dysphagia screening

Wen-Ching Chen and Chung-Wei Lin are first authors with equal contributions.

✉ Poyin Huang
u99802003@gmail.com

¹ Department of Neurology, Kaohsiung Medical University Hospital, Kaohsiung Medical University, No.100, Tzyou 1st Road, Kaohsiung City 807, Taiwan

² Department of Education, Kaohsiung Chang Gung Memorial Hospital, Kaohsiung, Taiwan

³ School of Medicine, College of Medicine, Kaohsiung Medical University, Kaohsiung, Taiwan

⁴ Department of Neurology, Kaohsiung Municipal Siaogang Hospital, Kaohsiung Medical University, Kaohsiung, Taiwan

⁵ Neuroscience Research Center, Kaohsiung Medical University, Kaohsiung, Taiwan

Introduction

Dysphagia is a common health concern that affects people around the world. It was reported that dysphagia affects 300,000–600,000 persons per year in the US [1], and was

⁶ Dysphagia Functional Reconstructive Center, Kaohsiung Municipal Siaogang Hospital, Kaohsiung Medical University, Kaohsiung, Taiwan

⁷ Multidisciplinary Swallowing Center, Kaohsiung Municipal Siaogang Hospital, Kaohsiung Medical University, Kaohsiung, Taiwan

⁸ Department of Neurology, Faculty of Medicine, College of Medicine, Kaohsiung Medical University, Kaohsiung, Taiwan

⁹ Department of General Medicine, Kaohsiung Medical University Hospital, Kaohsiung Medical University, Kaohsiung, Taiwan

a burden of health especially for the elderly [1–3]. Patients with dysphagia are at increased risks for developing medical problems such as aspiration, pneumonia, and malnutrition [1, 2]. Post-stroke dysphagia (PSD), one of the representative complications of 37–78% stroke patients [4, 5], is the most common type of dysphagia [1]. Although some PSDs recover spontaneously, 11–50% of stroke patients keep experiencing dysphagia 6 months after the previous stroke events [5, 6], which brings about poor outcomes and a life-long increase in mortality and morbidity [1, 3–6].

Due to the many adverse effects of PSD, to precisely evaluate the severity of PSD is crucial for early interventions. Nowadays, the severity of PSD is usually assessed using miscellaneous scales by means of bedside screening tests and instrumental tools [6, 7]. The bedside screening tests provide a glimpse of the patients' general condition of swallowing by observation and consultation. In instrumental tools, "videofluoroscopy (VF) swallowing study" and "fiber-optic endoscopic evaluation of swallowing (FEES)/videoescopy (VE)" are the two mostly used methods for assessment of dysphagia [1, 6, 7]. VF is a dynamic exploration that evaluates the safety and efficacy of deglutition [7]. Patients receiving VF swallowing study take radiopaque materials orally in a sitting position; then, the physicians thoroughly examine the entire swallowing process from the oral region, esophagus, down to the stomach [7], which serves as the traditional gold standard for dysphagia evaluation. VE, on the other hand, is performed by physicians using a laryngoscope to pass transnasally to the hypopharynx. By observing the movement of the laryngopharyngeal structures when taking different textures of food, the physicians examine if there are any dynamic abnormalities during this period [6, 7]. With the above-mentioned subjective and objective modalities, it is available to evaluate patients with PSD more efficiently [8, 9].

Recently, there are emerging miscellaneous scales for evaluating PSD. By quantifying the outcomes into multiple levels based on the severity of dysphagia, the clinical staffs gain more insights into the patient's situation for further intervention. Although VF remains the priority for PSD assessment due to its accuracy, it is not utilized in all hospitals due to various clinical situations and regional differences. Therefore, this study aims to investigate the consistencies among miscellaneous scales evaluated by different means, which could aid in the future assessment of patients with PSD if VF is not available.

Methods

This study followed the Declaration of Helsinki, and was audited and approved by the Institutional Review Board (IRB) of Kaohsiung Municipal Siaogang Hospital (IRB

number: KMUHIRB-F(II)-20190133). All data acquisition was agreed upon by the patients and their relatives for research purposes.

Study design

A total of 49 patients receiving swallowing examinations from 2019 to 2020 in Kaohsiung Municipal Siaogang Hospital were enrolled in this study. The inclusion criteria were patients with previous stroke events followed by symptoms of dysphagia. The exclusion criteria were those with dysphagia prior to stroke events, and those who did not experience post-stroke dysphagia. Of all the PSD patients, five swallowing examinations were conducted after the active stroke events subsided. The tests are introduced as follows:

1. *Functional Oral Intake Scale* (FOIS), which is performed by physicians with either VF or VE, reflects the patients' functional oral intake condition. There are seven levels in an ordinary FOIS with different meanings: no oral intake (level 1), tube dependent with minimal/inconsistent oral intake (level 2), tube supplements with consistent oral intake (level 3), total oral intake of a single consistency (level 4), total oral intake of multiple consistencies requiring special preparation (level 5), total oral intake with no special preparation, but must avoid specific foods or liquid items (level 6), and total oral intake with no restrictions (level 7). Those ranked from "level 1" to "level 3" are categorized into "tube-dependent group", otherwise "tube-independent group" if ranked from "level 4" to "level 7".
2. *Dysphagia Severity Scale* (DSS), which may be performed by physicians with either VF or VE and by nurse staff's judgement, serves as a useful instrument to determine the severity of dysphagia. There are seven levels in a DSS with different meanings: saliva aspiration (level 1), food aspiration (level 2), water aspiration (level 3), occasional aspiration (level 4), oral problem (level 5), minimum problem (level 6), and within normal limits (level 7). Those ranked from "level 1" to "level 4" are categorized into "choking/aspiration group", otherwise "without choking/aspiration group" if ranked from "level 5" to "level 7".
3. *Ohkuma Questionnaire*, being a convenient and validated measurement to assess the overall swallowing condition over the past 3 months, provides fifteen comprehensible questions for evaluation [10]. Each answer of the question is rated "1 for severe symptoms", "2 for mild symptoms", and "3 for absence of symptoms"; dysphagia is highly suspected if more than one answer of the questions is classified as severe symptoms, otherwise is categorized into the non-dysphagia group.

4. *Eating Assessment Tool-10* (EAT-10), a well-recognized questionnaire for dysphagia evaluation, offers ten common clinical situations in relation to patients' swallowing difficulties over the past 3 months. The answer of each question is rated based on the severity of the symptoms from "0" (no problem) to "4" (severe problem). If the sum of points of all questions is more than three, the patient is highly suspected to be abnormal in swallowing.
 5. *Repetitive Saliva Swallowing Test* (RSST), which is a convenient measurement for dysphagia evaluation that requires the aid of an operator, provides insights into the patients' functional outcome of swallowing. The operator has the patient sit upright at a cozy atmosphere, and may moisture the mouth with little amount of water. Meanwhile, the operator gently puts his index finger at the level of the hyoid bone with other fingers at the neck region in order for measurement; every move of the Adam's apple through the middle finger is counted once of swallowing. The patient then is asked to try swallowing in the next 30 s for assessment, and the results turn out to be abnormal if less than three times of swallowing are detected during this period.
2. DSS: those ranked from "level 1" to "level 4" are classified as the "choking/aspiration group (severe group)", while those ranked from "level 5" to "level 7" are classified as the "without choking/aspiration group (mild group)".
 3. Ohkuma Questionnaire: those presented with at least one "severe symptoms" in any of the 15 questions are classified as the "severe group", otherwise the "mild group".
 4. EAT-10: those with total points more than three are classified as the "severe group", otherwise the "mild group".
 5. RSST: those who swallow less than three times in 30 s are classified as the "severe group", otherwise the "mild group".

Among the above measurements, FOIS was evaluated by VF and VE; while, DSS was evaluated by VF, VE and the nurse staff.

To verify the consistencies among the gold standard VF and the miscellaneous scales and methods, we first used kappa coefficient to analyze "tube-dependent/tube-independent" groups of FOIS performed by VF (VF-FOIS) and VE (VE-FOIS), as well as "mild/severe" groups assessed by Ohkuma Questionnaire, EAT-10, and RSST. In addition, we further used kappa coefficient to analyze "choking or aspiration/without choking or aspiration" groups of DSS performed by VF (VF-DSS), VE (VE-DSS), and the nurse staff (Nurse-DSS), as well as "mild/severe" groups assessed by Ohkuma Questionnaire, EAT-10, and RSST. Lastly, we used weighted kappa coefficients to analyze the agreement between FOIS and DSS using VF (VF-FOIS vs VF-DSS) and VE (VE-FOIS vs VE-DSS), respectively. Of the data presented, $p < 0.05$ was considered of significance based on a 95% confidence interval (CI). Kappa values were interpreted based on the Landis and Koch's classification: < 0 = poor agreement; $0.01-0.2$ = slight agreement; $0.21-0.4$ = fair agreement; $0.41-0.6$ = moderate agreement; $0.61-0.8$ = substantial agreement; $0.81-1.0$ = excellent agreement [11]. All of the statistical analyses were performed with IBM SPSS Statistics Version 22.

Among the above methods, FOIS was performed by the physicians only, and DSS was conducted by both the physicians and nurse staffs; the physicians used either videofluoroscopy (VF) or videoendoscopy (VE) for evaluation, while the nurse staff assessed the patients by observation and subjective judgement. The rest of the assessment tools mentioned were adopted simply based on the patients' personal experience and subjective feelings.

As to the data collection and interpretation, we reviewed the medical records and reports of the swallowing examinations of the patients, and further investigated the consistencies among the miscellaneous scales and methods.

Data processing and statistical analysis

To enact a standardized protocol for data analysis and comparisons, we reorganized the results of the scales based on the severity of dysphagia classified by the original design of each modality. The data of each scale were categorized into "mild group" and "severe group" based on the clinical assessment of dysphagia symptoms, which made them more easily to be compared after grouping. The details are listed below:

1. FOIS: those ranked from "level 1" to "level 3" are classified as the "tube-dependent group (severe group)", while those ranked from "level 4" to "level 7" are classified as the "tube-independent group (mild group)".

Results

The basic characteristics of the PSD patients are presented as Table 1. In analysis of the "choking/aspiration" group and "without choking/aspiration" group based on VF-DSS, both groups shared similarities in gender, age, hypertension, diabetes mellitus, hyperlipidemia, atrial fibrillation, and stroke patterns. The ratings of mRS ($p = 0.014$), other than the rest of the parameters, were significantly different between the two groups. In analysis of the "tube-dependent" group and "tube-independent" group based on VF-FOIS, no significant differences were shown in all of the parameters.

Table 1 Basic characteristics of the patients receiving swallowing examinations

Basic characteristic	All (<i>n</i> = 49)	VF-DSS		<i>p</i> value	VF-FOIS		<i>p</i> value
		Mild (<i>n</i> = 21)	Severe (<i>n</i> = 27)		Mild (<i>n</i> = 44)	Severe (<i>n</i> = 4)	
Gender							
Male	37 (75.5)	14 (66.7)	22 (81.5)	0.240	34 (77.3)	2 (50.0)	0.257
Female	12 (24.5)	7 (33.3)	5 (18.5)		10 (22.7)	2 (50.0)	
Age (years)	63.04 ± 11.26	61.62 ± 7.91	64.52 ± 13.34	0.354	62.36 ± 10.94	73.00 ± 11.80	0.070
Hypertension	47 (95.9)	20 (95.2)	26 (96.3)	1.000	42 (95.5)	4 (100.0)	1.000
DM	27 (55.1)	10 (47.6)	17 (63.0)	0.288	23 (52.3)	4 (100.0)	0.121
Hyperlipidemia	35 (71.4)	15 (71.4)	19 (70.4)	0.936	32 (72.7)	2 (50.0)	0.569
Atrial fibrillation	4 (8.2)	2 (9.5)	2 (7.4)	1.000	4 (9.1)	0	1.000
Stroke							
Embolism	6 (12.2)	4 (19.0)	2 (7.4)	0.383	6 (13.6)	0	1.000
Multiple infarction	15 (30.6)	5 (23.8)	9 (33.3)	0.471	13 (29.5)	1 (25.0)	1.000
mRS							
0–3	32 (65.3)	18 (85.7)	13 (48.1)	0.014	30 (68.2)	1 (25.0)	0.121
4–6	17 (34.7)	3 (14.3)	14 (51.9)		14 (31.8)	3 (75.0)	

Data are presented either as mean ± standard deviation or *n* (%); *p* value by χ^2 /Fisher's exact test or two-tailed independent *t* test. Among the 49 patients enrolled, 1 patient did not receive videofluoroscopy for DSS and FOIS evaluation, and was therefore excluded for the subgroup analysis VF videofluoroscopy, DSS Dysphagia Severity Scale, FOIS Functional Oral Intake Scale, DM diabetes mellitus, mRS modified Rankin Scale

Table 2 Inter-rater reliability among the scales and VF-FOIS

Scales	κ (95% CI)	<i>p</i> value
^a Ohkuma questionnaire	0.016 (– 0.090, 0.122)	0.778
^a EAT-10	0.034 (– 0.084, 0.152)	0.590
^a RSST	0.187 (– 0.131, 0.504)	0.142
^b VE-FOIS	0.625 (0.300, 0.950)	< 0.001

For statistical analyses and comparisons, VF-FOIS is categorized into “tube-dependent group” and “tube-independent group” for analysis

^aScales of Ohkuma questionnaire, EAT-10, and RSST are individually categorized into “severe group” and “mild group” for analysis

^bVE-FOIS is categorized into “tube-dependent group” and “tube-independent group” for analysis

The inter-rater reliabilities among VF-FOIS and divergent measurements were further analyzed, and the results are presented as Table 2. The results turned out that VE-FOIS ($\kappa = 0.625$, 95% CI 0.300–0.950; $p < 0.001$), other than the rest of the scales and modalities, was the only measurement with a statistically substantial agreement with VF-FOIS. Other means including Ohkuma Questionnaire ($\kappa = 0.016$, 95% CI – 0.090 to 0.122; $p = 0.778$), EAT-10 ($\kappa = 0.034$, 95% CI – 0.084 to 0.152; $p = 0.590$), and RSST ($\kappa = 0.187$, 95% CI – 0.131 to 0.504; $p = 0.142$) possessed only slight agreement with VF-FOIS but without statistical significance.

As to the inter-rater reliabilities among VF-DSS and miscellaneous scales and methods (Table 3), we figured out that VE-DSS ($\kappa = 0.381$, 95% CI 0.127–0.636), EAT-10 ($\kappa = 0.269$, 95% CI – 0.006 to 0.543), and Ohkuma

Table 3 Inter-rater reliability among the scales and VF-DSS

Scales	κ (95% CI)	<i>p</i> value
^a Ohkuma questionnaire	0.213 (– 0.057, 0.484)	0.126
^a EAT-10	0.269 (– 0.006, 0.543)	0.060
^a RSST	0.198 (– 0.010, 0.406)	0.077
^b VE-DSS	0.381 (0.127, 0.636)	0.007
^b Nurse-DSS	0.105 (– 0.183, 0.393)	0.474

For statistical analyses and comparisons, VF-DSS is categorized into “choking/aspiration group” and “without choking/aspiration group” for analysis

^aScales of Ohkuma questionnaire, EAT-10, and RSST are individually categorized into “severe group” and “mild group” for analysis

^bScales of VE-DSS and Nurse-DSS are individually categorized into “choking/aspiration group” and “without choking/aspiration group” for analysis

Questionnaire ($\kappa = 0.213$, 95% CI – 0.057 to 0.484) were in fair agreement with VF-DSS. In addition, RSST ($\kappa = 0.198$, 95% CI – 0.010 to 0.406) and Nurse-DSS ($\kappa = 0.105$, 95% CI – 0.183 to 0.393) had slight agreement with VF-DSS. Nevertheless, VE-DSS was the only scale possessing a significant kappa value ($p = 0.007$) among all the analyzed scales.

Eventually, the consistencies between FOIS and DSS by means of VE (VE-FOIS versus VE-DSS) and VF (VF-FOIS versus VF-DSS), respectively, were analyzed for comparisons (Table 4). The results turned out that the weighted kappa of FOIS to DSS in VE (weighted $\kappa = 0.577$, 95% CI 0.414–0.740) was not lower than that in VF (weighted

Table 4 Comparison of VF and VE in analysis of the inter-rater reliability between FOIS and DSS

Methods	Weighted κ (95% CI)	<i>p</i> value	Agreement
^a VF	0.249 (0.136, 0.362)	<0.001	Fair
^b VE	0.577 (0.414, 0.740)	<0.001	Moderate

^aIn VF, the consistency between “VF-FOIS” and “VF-DSS” was analyzed

^bIn VE, the consistency between “VE-FOIS” and “VE-DSS” was analyzed

$\kappa = 0.249$, 95% CI 0.136–0.362), and both of the values were of statistical significance.

Discussion

The study aimed to investigate the consistency among various scales used to evaluate PSD. The findings demonstrated that only VE exhibited a statistically significant agreement with VF for both FOIS and DSS. Other bedside assessments were not significantly consistent with VF. As a result, VE may be considered the best alternative to VF.

Post-stroke dysphagia is a common and costly complication of acute stroke, which increases the risk of mortality, morbidity, and institutionalization partly due to the risks of aspiration, pneumonia, and malnutrition [6]. Conducting early assessments of dysphagia can help clinicians identify potential risks of complications in patients. Many literature researches have focused on specific bedside screening tools for dysphagia [12]. However, no prior research has utilized as many dysphagia screening methods as our prospective study, which aims to determine the consistency between these methods and VF in stroke patients. All the screening methods used in our study are commonly used in clinical practice in Asia and have been shown to possess reliability and validity in dysphagia detection [13–17]. Although bedside rating scales are convenient and cost-effective, a systematic review has concluded that none of the bedside screening protocols can adequately predict the presence of aspiration, except for maneuvers based on VF or VE [12]. Most bedside swallow examinations were deemed insufficiently sensitive to serve as a screening test for dysphagia [12]. Another review from the Cochrane Library also revealed that no bedside swallow screening tool with both high and precisely estimated sensitivity and specificity could be identified [18]. The result is consistent with our findings that none of the bedside assessment methods, including Ohkuma questionnaire, EAT-10, and RSST has significant consistency with VF. The result may be because VF and VE can precisely detect whether contrast enhancements have entered the airway or not during the examination process. This implies that silent aspiration can be effectively

observed and identified, making it easier to identify patients who are at risk of developing complications.

VF has been considered the traditional gold standard for dysphagia screening due to its high accuracy. However, some limitations, including radiation exposure, invasiveness, equipment dependent, and relative expensive hinder VF from being widely used. On the other hand, VE as a relatively novel instrument for dysphagia assessment has been promoted since 1990s [19]. Due to the portability of VE equipment, absence of ionizing radiation, and availability of testing materials, VE is particularly valuable in various situations, such as bedridden or immobilized patients, patients in the ICU or on monitors, repeated examinations, and patients who need to avoid ionizing radiation exposure [19]. There have been numerous comparisons between VF and VE, with studies claiming that VE is also an effective instrument for dysphagia evaluations and outcomes [19, 20]. These studies demonstrated that VE is more sensitive than VF when evaluating swallowing safety, as VE had a slight advantage in detecting aspiration, penetration, and residues compared to VF [19, 20]. In a research, PAS (Penetration–Aspiration Scale), pixel-based circumscribed area ratio, and Yale Pharyngeal Residue Severity were, respectively, applied in both VF and VE, and strong positive correlations and agreement were found between VF and VE [21]. Our research also revealed that VE has a statistically significant agreement with VF for both FOIS and DSS. Based on the above, it is plausible that VE is not inferior to VF in clinical practice. A recent review deemed VE a beneficial first-line examination, and they considered that using VF after VE could be advantageous in obtaining complete visualization and ensuring that no aspiration events are overlooked during the VE procedure [22]. VF is capable of providing real-time evaluation of all four phases of swallowing; whereas, VE might not capture the oral preparatory and esophageal phases. It is noteworthy that VF holds an advantage over VE in assessing the upper esophagus [23].

The study has some limitations. First, the small sample size of the study may have affected the results, as tools other than VE did not show statistical significance. This lack of power could be due to the limited number of participants. The small sample size also led to an uneven distribution of individuals among the groups. Specifically, the severe VF-FOIS group consisted of only 4 patients, which impacts the statistical power of the study. To confirm our findings, further research with a larger sample size is necessary. Second, the recruited patients' baseline functional severity and cognitive status were not examined, despite the fact that both of these factors can affect swallowing and should be considered in future studies. Third, the assessment tools employed in our study differ in their nature and function. The Ohkuma questionnaire and EAT-10 are questionnaire-based tools, reliant on personal judgments and primarily focused on the

patient's dysphagia-related life experiences. On the other hand, the RSST, DSS, and FOIS are evaluated by medical professionals, adding a more objective component to their assessments. The DSS and FOIS are designed to evaluate the severity of dysphagia based on clinical swallowing situations. Conversely, the Ohkuma questionnaire, EAT-10, and RSST are intended primarily for the screening of potential dysphagia patients, reflecting their different focus. Given that the dysphagia severity is still based on the patient's clinical swallowing status with differences in degree, the present study's comparisons overcome the restrictions and discriminations between the scales and make the results more reasonable. Last but not least, there are still many different bedside screening tools that were not included in this study. For a more comprehensive understanding, future studies could consider incorporating these additional screening tools.

Conclusion

In conclusion, the consistencies between bedside screening tools and VF are all statistically insignificant. Only VE has a statistically significant agreement with VF for assessing PSD. Due to the invasiveness, cost, and limited access of VF, it can be limited as an option for dysphagia evaluations. Therefore, VE can be considered a reliable alternative to VF, particularly when VF is unavailable or unsuitable.

Supplementary Information The online version contains supplementary material available at <https://doi.org/10.1007/s00405-023-08101-x>.

Acknowledgements This work was supported partially by the grants from the Kaohsiung Municipal Siaogang Hospital (KMSH S-108-08) and from the Ministry of Science and Technology (MOST 108-2218-E010-005, MOST 109-2224-E010-001, MOST-110-2221-E-008-048).

Funding This research did not receive any funding from agencies in the public, commercial, or not-for-profit sectors.

Availability of data and materials The data that support the findings of this study are not openly available due to reasons of sensitivity and are available from the corresponding author upon reasonable request. Data are located in controlled access data storage at Kaohsiung Municipal Siaogang Hospital.

Declarations

Conflict of interest The authors have no conflicts of interest to disclose.

References

1. US Department of Health and Human Services. Archived EPC Evidence Reports. 1999. Agency for Healthcare Research and Quality. Diagnosis and treatment of swallowing disorders (dysphagia) in acute-care stroke patients. Evidence report/technology assessment (Summary). pp. 1–6
2. Sura L, Madhavan A, Carnaby G, Crary MA (2012) Dysphagia in the elderly: management and nutritional considerations. *Clin Interv Aging* 7:287–298. <https://doi.org/10.2147/CIA.S23404>
3. Khan A, Carmona R, Traube M (2014) Dysphagia in the elderly. *Clin Geriatr Med* 30(1):43–53. <https://doi.org/10.1016/j.cger.2013.10.009>
4. Kumar S, Selim MH, Caplan LR (2010) Medical complications after stroke. *Lancet Neurol* 9(1):105–118. [https://doi.org/10.1016/S1474-4422\(09\)70266-2](https://doi.org/10.1016/S1474-4422(09)70266-2)
5. Wang Z, Song WQ, Wang L (2017) Application of noninvasive brain stimulation for post-stroke dysphagia rehabilitation. *Kaohsiung J Med Sci* 33(2):55–61. <https://doi.org/10.1016/j.kjms.2016.11.007>
6. Cohen DL, Roffe C, Beavan J et al (2016) Post-stroke dysphagia: a review and design considerations for future trials. *Int J Stroke* 11(4):399–411. <https://doi.org/10.1177/1747493016639057>
7. Wirth R, Dziejewski R, Beck AM et al (2016) Oropharyngeal dysphagia in older persons—from pathophysiology to adequate intervention: a review and summary of an international expert meeting. *Clin Interv Aging* 23(11):189–208. <https://doi.org/10.2147/CIA.S97481>
8. Lowery S (2001) Assessment and measurement tools used in the evaluation of swallowing. *Curr Opin Otolaryngol Head Neck Surg* 9:134–138. <https://doi.org/10.1097/00020840-200106000-00003>
9. Langmore SE, Schatz K, Olson N (1991) Endoscopic and videofluoroscopic evaluations of swallowing and aspiration. *Ann Otol Rhinol Laryngol* 100(8):678–681. <https://doi.org/10.1177/000348949110000815>
10. Ohkuma RFI, Kojima C, Hojo K, Takehara I, Motohashi Y (2002) Development of a questionnaire to screen dysphagia. *Jpn J Dysphagia Rehabil* 6:3–8
11. Landis JR, Koch GG (1977) The measurement of observer agreement for categorical data. *Biometrics* 33(1):159–174
12. O'Horo JC, Rogus-Pulia N, Garcia-Arguello L, Robbins J, Safdar N (2015) Bedside diagnosis of dysphagia: a systematic review. *J Hosp Med* 10(4):256–265. <https://doi.org/10.1002/jhm.2313>
13. Wilmskoetter J, Bonilha H, Hong I, Hazelwood RJ, Martin-Harris B, Velozo C (2019) Construct validity of the Eating Assessment Tool (EAT-10). *Disabil Rehabil* 41(5):549–559. <https://doi.org/10.1080/09638288.2017.1398787>
14. Zhou H, Zhu Y, Zhang X (2017) Validation of the Chinese version of the Functional Oral Intake Scale (FOIS) score in the assessment of acute stroke patients with dysphagia. *Stud Health Technol Inform* 245:1195–1199
15. Nishimura K, Kagaya H, Shibata S et al (2015) Accuracy of Dysphagia Severity Scale rating without using videoendoscopic evaluation of swallowing. *Jpn J Compr Rehabil Sci* 6:124–128. <https://doi.org/10.11336/jjcrs.6.124>
16. Kawashima K, Motohashi Y, Fujishima I (2004) Prevalence of dysphagia among community-dwelling elderly individuals as estimated using a questionnaire for dysphagia screening. *Dysphagia* 19(4):266–271. <https://doi.org/10.1007/s00455-004-0013-6>
17. Persson E, Wårdh I, Östberg P (2019) Repetitive saliva swallowing test: norms, clinical relevance and the impact of saliva secretion. *Dysphagia* 34(2):271–278. <https://doi.org/10.1007/s00455-018-9937-0>
18. Boaden E, Burnell J, Hives L et al (2021) Screening for aspiration risk associated with dysphagia in acute stroke. *Cochrane Database Syst Rev* 10(10):CD012679. <https://doi.org/10.1002/14651858.CD012679.pub2>
19. Wu CH, Hsiao TY, Chen JC, Chang YC, Lee SY (1997) Evaluation of swallowing safety with fiberoptic endoscope: comparison

- with videofluoroscopic technique. *Laryngoscope* 107(3):396–401. <https://doi.org/10.1097/00005537-199703000-00023>
20. Giraldo-Cadavid LF, Leal-Leaño LR, Leon-Basantés GA, Bastidas AR, García R, Ovalle S, Abondano-Garavito JE (2017) Accuracy of endoscopic and videofluoroscopic evaluations of swallowing for oropharyngeal dysphagia. *Laryngoscope* 127(9):2002–2010. <https://doi.org/10.1002/lary.26419>
 21. Yoon JA, Kim SH, Jang MH, Kim SD, Shin YB (2019) Correlations between aspiration and pharyngeal residue scale scores for fiberoptic endoscopic evaluation and videofluoroscopy. *Yonsei Med J* 60(12):1181–1186. <https://doi.org/10.3349/ymj.2019.60.12.1181>
 22. Helliwell K, Hughes VJ, Bennion CM, Manning-Stanley A (2023) The use of videofluoroscopy (VFS) and fibreoptic endoscopic evaluation of swallowing (FEES) in the investigation of oropharyngeal dysphagia in stroke patients: a narrative review. *Radiography (Lond)* 29(2):284–290. <https://doi.org/10.1016/j.radi.2022.12.007>
 23. Tutor JD, Gosa MM (2012) Dysphagia and aspiration in children. *Pediatr Pulmonol* 47(4):321–337. <https://doi.org/10.1002/ppul.21576>

Publisher's Note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Springer Nature or its licensor (e.g. a society or other partner) holds exclusive rights to this article under a publishing agreement with the author(s) or other rightsholder(s); author self-archiving of the accepted manuscript version of this article is solely governed by the terms of such publishing agreement and applicable law.