Valid Items for Screening Dysphagia Risk in Patients With Stroke
A Systematic Review

Stephanie K. Daniels, PhD; Jane A. Anderson, PhD; Pamela C. Willson, PhD

Background and Purpose—Screening for dysphagia is essential to the implementation of preventive therapies for patients with stroke. A systematic review was undertaken to determine the evidence-based validity of dysphagia screening items using instrumental evaluation as the reference standard.

Methods—Four databases from 1985 through March 2011 were searched using the terms cerebrovascular disease, stroke deglutition disorders, and dysphagia. Eligibility criteria were: homogeneous stroke population, comparison to instrumental examination, clinical examination without equipment, outcome measures of dysphagia or aspiration, and validity of screening items reported or able to be calculated. Articles meeting inclusion criteria were evaluated for methodological rigor. Sensitivity, specificity, and predictive capabilities were calculated for each item.

Results—Total source documents numbered 832; 86 were reviewed in full and 16 met inclusion criteria. Study quality was variable. Testing swallowing, generally with water, was the most commonly administered item across studies. Both swallowing and nonswallowing items were identified as predictive of aspiration. Neither swallowing protocols nor validity were consistent across studies.

Conclusions—Numerous behaviors were found to be associated with aspiration. The best combination of nonswallowing and swallowing items as well as the best swallowing protocol remains unclear. Findings of this review will assist in development of valid clinical screening instruments. (Stroke. 2012;43:00-00.)

Key Words: dysphagia □ screening □ stroke □ validity

Dysphagia commonly occurs in association with stroke contributing to an increased risk for aspiration and pneumonia.1 Swallowing screening is the essential first step in identifying risk of dysphagia (abnormality in the oropharyngeal swallowing system) and aspiration (subglottic penetration of food or liquid) and is a quick and minimally invasive procedure that expedites referral to speech pathology for evaluation and treatment. Improved outcomes after swallowing screening have been documented. Early detection of dysphagia allows for immediate intervention thereby reducing morbidity, length of stay, and healthcare costs.2–4

Screening of swallowing before the administration of food, liquid, or medication in patients with stroke is an initial step of the American Heart Association/American Stroke Association guidelines for early stroke management.5 Recently, the Joint Commission excluded swallowing screening as a performance measure for Primary Stroke Center certification due to a lack of systematically defined standards for what constitutes a valid swallowing screening tool (SST).6 Consequently, the Joint Commission retired dysphagia screening as a Primary Stroke Center performance measure in 2010. Despite variability of SSTs, screening swallowing after stroke remains critical to ensure patient safety and quality care.

All screening tools strive to be valid, reliable, and feasible. Validity encompasses sensitivity and specificity. An effective SST should be sensitive to accurately identify patients with risk of swallowing impairment and specific to not falsely include patients without risk of dysphagia. Many SSTs focus primarily on high sensitivity due to increased morbidity and mortality associated with aspiration, which necessitates requirements for low false-negative results. Specificity is frequently used to achieve high sensitivity; however, low specificity cannot be ignored. At a minimum, it delays administration of medication and nutrition and leads to overreferral to speech pathology, and at its most severe, it results in placement of unwarranted nasogastric feeding tubes, which are associated with medical complications in patients with acute stroke.7 Hence, accuracy in identification of individuals with dysphagia is enhanced when using a SST with both high sensitivity and specificity. Likelihood ratios

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combine sensitivity and specificity to determine the relative risk of someone with a positive SST actually having dysphagia. Thus, the development of a valid SST is a balancing act between sensitivity and specificity. Also, reliability of administration and interpretation of findings as well as feasibility in implementation need to be considered.

Stroke SSTs have recently been developed, each with varying degrees of validity, reliability, and feasibility. Currently, no single tool has achieved consensus as a standard screen, and many facilities continue to construct their own SST. Previous literature reviews concerning swallowing screening and stroke have been completed; however, systematic reviews must be updated to include current literature. In an effort to facilitate the evaluation of the quality of items used in SSTs, and to identify items to include in the development of a stroke SST, a systematic review of the literature was undertaken.

**Methods**

Electronic databases (PubMed, CINAHL Plus, ProQuest Nursing and Allied Health, PsychoINFO) were searched from 1985 through March 2011 using search terms: cerebrovascular disease, stroke, deglutition disorders, and dysphagia. Searches of relevant journals and article references were also completed from January 2005 through March 2011. Searches were limited to English language articles involving adult humans. Review articles and nonpeer-reviewed articles were excluded. Abstracts were reviewed by the first author.

Articles were submitted for full review if they fulfilled the established eligibility for this review. The criteria were: (1) publications reporting on homogeneous stroke populations (acute and/or chronic); (2) clinical features were compared with instrumental examination results (videofluoroscopic swallow study or videendoscopic evaluation of swallowing) for all or a random sample; (3) clinical examination without equipment (ie, stethoscope, pulse oximetry) unless separate analysis without equipment was included; (4) outcome of instrumental examination findings were dysphagia and/or aspiration; and (5) report of sensitivity and specificity for individual items or appropriate raw data available for calculation. Cervical auscultation and pulse oximetry were excluded due to questionable feasibility and contradictory validity findings for both. Full article reviews were conducted independently by the first 2 authors to verify inclusion. If multiple articles used the same or partial study samples, the report that best represented our review focus was included.

Articles meeting inclusion criteria were submitted for evaluation of methodological rigor. This step involved independent evaluations by the first and third author using criteria from Cochrane guidelines, the Quality Assessment for Diagnostic Accuracy of Studies tool, and work by Sackett. These criteria were modified to address the specific focus for patients with stroke using clinical features associated with risk of dysphagia/aspiration and an instrumental evaluation (online-only Supplemental Table I; http://stroke.ahajournals.org).

<table>
<thead>
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</tbody>
</table>

1 indicates yes, met criteria; 0, no, criteria unmet; ?, criteria unclear/not stated, scored as 0.
Results

Systematic Literature Review
A total of 808 articles were initially identified through database and manual searches and were reviewed in abstract form (Table 1). After applying inclusion criteria, 62 articles remained with an additional 24 articles identified through manual searches. The resulting 86 articles were reviewed and assessed for eligibility based on the eligibility criteria. Sixteen articles met inclusion criteria and underwent methodological appraisal.21–36

Quality of the Studies Evaluated
The 14 quality analysis measures applied to the 16 articles are shown in Table 2. None of the 16 articles met all 14 measures. No study reported on uninterpretable results and only 2 discussed patient withdrawal.22,24 With this in mind, 2 studies achieved a high score of 12,21,22 and 1 had the lowest score of 4.36 Seven studies reported testing consecutive patients with stroke,21–25,28,30 the remaining studied a subsample or particular type of patient with stroke. A wide range of bolus volumes and viscosities was used in the instrumental examinations. Seven studies tested clinical features and completed the instrumental examination within rapid succession21,23,26–28,30; 3 reported >1-day delay between the clinical examination and instrumental assessment,22,25,35 and the remaining 6 studies did not report the timeframe between the assessments.29,31–34,36 Thirteen studies used videofluoroscopic swallow study as the reference standard,21,22,24–27,30–36 and 2 studies used videoendoscopic evaluation of swallowing23,29; only 1 used both tests.28 Generally the clinical swallowing test was completed before the instrumental examination. Blinding of clinical results from the person completing the instrumental was reported in 7 studies.21–25,27,29 The remaining studies did not report blinding. Eleven studies described clinical test protocols and interpretation methods with adequate clarity for replication,21–26,28,30,33,35 whereas 13 studies did so for the instrumental examination.21,23,25–29,31–35

Five main categories of screening items were identified: demographics, history, functional assessment, oral mechanism assessment, and swallowing test (online-only Supplemental Table II). Direct testing of swallowing was, by far, the most frequent category identified; however, protocols varied with each study. Ten studies tested swallowing with only water,21–26,28,29,31,32 whereas 1 study used various consistencies.27 All but 1 administered calibrated volumes.28 Seven studies started with or maintained small volumes (3–5 mL) of ingestion,21,22,24,25,27,31 whereas 4 studies evaluated swallowing with only large volumes.23,26,28,32

Validity of Items for the 16 Studies
Table 3 details the outcome measures of validity for each item. Only 1 study used dysphagia as the outcome measure.22 Aspiration or risk of aspiration (laryngeal penetration with residue) was the outcome measure in the remaining studies. Items generally achieved either high specificity or high sensitivity (>80%). Only 1 item, the water swallow test (WST) administered in 10 5-mL volumes,32 achieved both high sensitivity and specificity; however, this study did not achieve a high score for methodological rigor. Most studies reported only validity for single items; however, 1 study reported that the presence of any 2 of 6 clinical items (abnormal volitional cough, abnormal gag reflex, dysarthria, dysphonia, cough or throat clear after swallowing, voice change after swallowing) improved validity over single items (sensitivity 92%, specificity 67%) in determining risk of
Table 3. Validity of Items for the 16 Studies

<table>
<thead>
<tr>
<th>Study</th>
<th>Outcome</th>
<th>Items</th>
<th>Sensitivity</th>
<th>Specificity</th>
<th>+LR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>McCullough, 2005</td>
<td>Aspiration</td>
<td>Weak unilateral jaw</td>
<td>0.2558</td>
<td>0.9590</td>
<td>6.242 (2.30–16.94)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Dysphonia</td>
<td>0.5349</td>
<td>0.8607</td>
<td>3.839 (2.28–6.47)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cough, throat clear, voice change—3-oz WST</td>
<td>0.4844</td>
<td>0.9508</td>
<td>9.930 (4.29–22.96)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cough, throat clear, voice change—10-mL WST</td>
<td>0.3721</td>
<td>0.9590</td>
<td>9.079 (3.54–23.29)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cough, throat clear, voice change—5-mL WST</td>
<td>0.4419</td>
<td>0.9426</td>
<td>7.701 (3.48–17.03)</td>
</tr>
<tr>
<td>Mann, 2001</td>
<td>Dysphagia</td>
<td>Male gender</td>
<td>0.7195</td>
<td>0.5217</td>
<td>1.504 (1.08–2.09)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Age &gt;65 y</td>
<td>0.7683</td>
<td>0.4130</td>
<td>1.309 (0.99–1.71)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Barthel index &lt;60</td>
<td>0.4268</td>
<td>0.9111</td>
<td>4.802 (1.82–12.63)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Weak/asymmetrical palatal movement</td>
<td>0.8537</td>
<td>0.5652</td>
<td>1.963 (1.39–2.76)</td>
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<tr>
<td></td>
<td></td>
<td>Incomplete oral clearance</td>
<td>0.5244</td>
<td>0.9130</td>
<td>6.030 (2.31–15.73)</td>
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<tr>
<td></td>
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<td>Impaired pharyngeal response (cough, voice change—5–10-mL WST)</td>
<td>0.4512</td>
<td>0.9565</td>
<td>10.378 (2.62–41.10)</td>
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<tr>
<td>Lim, 2001</td>
<td>Aspiration</td>
<td>Cough, voice change—50-mL WST</td>
<td>0.8462</td>
<td>0.7500</td>
<td>3.385 (1.66–6.90)</td>
</tr>
<tr>
<td>Smithard, 1998</td>
<td>Aspiration</td>
<td>↓ LOC</td>
<td>0.5000</td>
<td>0.9198</td>
<td>6.167 (2.55–14.92)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Weak/absent volitional cough</td>
<td>0.4500</td>
<td>0.9054</td>
<td>4.757 (2.02–11.19)</td>
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<td></td>
<td></td>
<td>Cough—5-mL WST</td>
<td>0.4000</td>
<td>0.9324</td>
<td>5.920 (2.17–16.13)</td>
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<tr>
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<td></td>
<td>Weak, wet voice—5-mL WST</td>
<td>0.4500</td>
<td>0.7432</td>
<td>1.753 (0.94–3.26)</td>
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<tr>
<td>Daniels, 1997</td>
<td>Risk of aspiration</td>
<td>Abnormal volitional cough</td>
<td>0.4231</td>
<td>0.8485</td>
<td>2.792 (1.11–7.03)</td>
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<tr>
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<td>Dysarthria</td>
<td>0.8462</td>
<td>0.5455</td>
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<tr>
<td></td>
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<td>Dysphonia</td>
<td>0.7308</td>
<td>0.7273</td>
<td>2.679 (1.46–4.09)</td>
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<tr>
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<td>Cough, throat clear—5–10, 20-mL WST</td>
<td>0.6538</td>
<td>0.7879</td>
<td>3.082 (1.51–6.30)</td>
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<td>Nishiwaki, 2005</td>
<td>Aspiration</td>
<td>Cough, voice change—30-mL WST</td>
<td>0.7222</td>
<td>0.6744</td>
<td>2.218 (1.32–3.72)</td>
</tr>
<tr>
<td>McCullough, 2001</td>
<td>Aspiration</td>
<td>History of pneumonia</td>
<td>0.3182</td>
<td>0.9211</td>
<td>4.030 (1.16–14.02)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Poor nutrition</td>
<td>0.5000</td>
<td>0.7632</td>
<td>2.111 (1.04–4.28)</td>
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<tr>
<td></td>
<td></td>
<td>Dysarthria</td>
<td>0.7727</td>
<td>0.5526</td>
<td>1.727 (1.13–2.63)</td>
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<tr>
<td></td>
<td></td>
<td>↓ Secretion management</td>
<td>0.5000</td>
<td>0.8421</td>
<td>3.167 (1.36–7.37)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Dysphonia</td>
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<td>0.2632</td>
<td>1.357 (1.12–1.64)</td>
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<tr>
<td></td>
<td></td>
<td>Cough—5-mL various consistencies</td>
<td>0.6818</td>
<td>0.8158</td>
<td>3.701 (1.79–7.66)</td>
</tr>
<tr>
<td></td>
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<td>Clinical estimate of aspiration—5-mL various consistencies</td>
<td>0.7727</td>
<td>0.6316</td>
<td>2.097 (1.31–3.69)</td>
</tr>
<tr>
<td>Smith Hammond, 1988</td>
<td>Aspiration</td>
<td>Clinical sign of aspiration WST (cough, absent swallow, ↓ secretion control)</td>
<td>0.5748</td>
<td>0.8254</td>
<td>3.298 (1.79–6.08)</td>
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<td>Chong, 2003</td>
<td>Aspiration</td>
<td>Cough, voice change—WST (10 mL×5 trials)</td>
<td>0.7941</td>
<td>0.6250</td>
<td>2.118 (1.10–4.08)</td>
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<tr>
<td>Horner, 1991</td>
<td>Aspiration</td>
<td>Cranial nerve IX abnormality</td>
<td>0.4667</td>
<td>0.8571</td>
<td>3.267 (0.49–21.70)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Vocal fold paralysis</td>
<td>0.4667</td>
<td>1.0000</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>Severe dysarthria</td>
<td>0.4667</td>
<td>1.0000</td>
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</tr>
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<td>Kidd, 1993</td>
<td>Aspiration</td>
<td>Abnormal pharyngeal sensation</td>
<td>1.0000</td>
<td>0.6000</td>
<td>2.500 (1.67–3.75)</td>
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<tr>
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<td>Cough, voice change—WST (5 mL administered 10 times)</td>
<td>0.8000</td>
<td>0.8571</td>
<td>5.600 (2.43–12.91)</td>
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<td>DePippo, 1992</td>
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<td>0.8000</td>
<td>0.5417</td>
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<td>Abnormal gag reflex</td>
<td>0.6667</td>
<td>0.7308</td>
<td>2.476 (1.24–4.96)</td>
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<td>Aspiration</td>
<td>Right hemiplegia</td>
<td>0.5500</td>
<td>0.8235</td>
<td>3.117 (1.04–9.37)</td>
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<td>Abnormal volitional cough</td>
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<td>0.3636</td>
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<td>Abnormal gag reflex</td>
<td>0.7407</td>
<td>0.6364</td>
<td>2.037 (0.90–4.59)</td>
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<tr>
<td>Horner, 1988</td>
<td>Aspiration</td>
<td>Abnormal voice</td>
<td>0.9130</td>
<td>0.3182</td>
<td>1.339 (0.98–1.83)</td>
</tr>
</tbody>
</table>

+LR indicates positive likelihood ratio; ↓, decreased; WST, water swallow test; LOC, level of consciousness.
aspiration. Another study found that a combination of 4 of these same features achieved better validity. Using logistic regression, unilateral jaw weakness, dysphonia, and global judgment of aspiration on the 3-oz WST were identified as the best combination of features to identify aspiration.

Discussion

The intent of this literature review was to objectively identify articles that demonstrated the highest methodological rigor as well as items that demonstrated high validity and redundancy across studies to promote development and validation of a stroke SST that is both highly sensitive and specific. Specific criteria were used to identify studies that would facilitate development of a SST. Included in the analysis were studies that used an instrumental reference test (VFSS, VEEG) to objectively determine dysphagia or aspiration. Published stroke SSTs were excluded because data were not available to calculate validity of the individual items comprising the tool.

The 16 articles analyzed were not equal in quality (Table 2). Although all 14 guidelines are important, some may be more relevant than others. Factors such as blinding of examiners, ability to replicate administration and interpretation of the screening items, and minimal delay between the screen and the instrumental examination would appear to be high priority; however, the exact relevancy of specific guidelines is dependent on the needs of the institution developing the SST. Nevertheless, article quality must be considered before selecting items to be included in the SST. Aspiration was the primary outcome in the majority of studies with only 1 study using dysphagia as the outcome. Concerns exist with focusing specifically on aspiration because a person may have severe dysphagia without aspiration. Although aspiration can lead to pneumonia, significant dysphagia without aspiration may lead to decreased nutrition, hydration, and quality of life. Thus, it would appear that the SST that can identify risk of dysphagia as well as aspiration is compelling and relevant. How screening features associated with aspiration translate to accuracy in identification of dysphagia is unclear and requires continued study.

Through this review process, we identified 5 principle categories included in screening: demographics, medical history, global assessment, oral mechanism examination, and swallowing assessment. Demographic features, that is, males, >65 years, history of pneumonia, and reduced nutrition were associated with dysphagia and aspiration. Although highly feasible, it is unclear if these items would reduce specificity.

Three global assessment measures were identified, level of consciousness, Barthel Index score, and hemiplegia. The ability to maintain alertness for a sustained period should be a prerequisite for attempting a swallowing screen. The Barthel Index measures independence in activities of daily living and can serve as an indicator of stroke severity. Although it seems logical to assume that increased stroke severity may be associated with increased risk of dysphagia or aspiration and research has supported this notion with the National Institutes of Health Stroke Scale, the feasibility of completing and reliably interpreting these types of scales in a busy emergency department or hospital unit would appear restricted. Hemiplegia was also identified as associated with risk of aspiration; however, the quality of research is reduced secondary to limited methodological detail.

Most of the 16 articles identified oral, laryngeal, or pharyngeal features associated with aspiration not included in the swallowing assessment. For example, dysphonia has high interrater reliability when judged by a speech pathologist to provide insight into laryngeal functioning; however, high interrater reliability may not be reached if assessment is completed by other medical personnel. Interrater reliability is warranted for all screening items and requires application of clear operational definitions with training in interpretation.

Direct assessment of swallowing was used in 11 of 16 identified articles. Direct assessment was associated with high-quality studies; therefore, having a patient actually swallow should be included in a SST. The method of evaluating swallowing varied for each study, but the majority (10 of 11) used some type of WST. The use of water may make the test feasible and easier to administer. Water volumes administered ranged from 5 to 90 mL and the number of trials also varied. Inclusion of the WST demands a balance of feasibility and safety. That is, is it realistic that clinicians will administer 10 trials of measured water volumes? Moreover, is it safe to have a patient with acute stroke self-administer 90 mL of water when research has shown that many patients with stroke are unaware of their swallowing deficits and continue to drink even when choking? Continued research is required to determine which water swallow protocol is the most valid and if the consideration of nonswallowing features improves sensitivity and specificity.

A primary objective in completing this review was to provide clinicians an evidence-based for identifying valid items for SST development and use in clinical practice. The next step in the screening process is the use of these articles and information to develop a valid, reliable, and feasible stroke SST. Based on results of this review, cough and wet voice in response to a WST appear to be essential predictors of aspiration and should be part of a stroke SST. Other items identified from this review may further increase validity of the SST. Future research should identify if the WST is an independent screening measure or if nonswallowing items are also required to yield maximum validity. How predictive these features are to identification of dysphagia, not just aspiration, must be determined.

Conclusions

Numerous studies over the past 10 years sought to identify clinical features associated with dysphagia in patients with stroke. The quality of these studies is variable; however, many imposed adequate control. A WST appears to be an important part of screening; however, the most valid protocol remains to be determined. Given inconsistent validity for most items, it appears that a cluster of swallowing and nonswallowing features may achieve both high sensitivity and specificity.

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Disclosures

None.

References


Valid Items for Screening Dysphagia Risk in Patients With Stroke: A Systematic Review
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Supplemental Material

Supplemental Table 1: Cochrane, QUADAS, and Sackett Criteria to Assess Quality of Articles

1. Was the sample representative of patients with stroke (e.g. includes mild, moderate, and severe stroke) who will receive a swallowing screening test in clinical practice?
2. Is the instrumental swallowing examination and/or protocol likely to correctly identify dysphagia and/or aspiration?
3. Is the time period between administration of the clinical items and the instrumental swallowing examination short enough to be reasonably sure that dysphagia/aspiration does not change between the two tests (24 hours acute stroke, 1 week chronic stroke)?
4. Did the whole sample or a random selection of the sample receive verification of dysphagia/aspiration using an instrumental swallowing examination?
5. Did all patients receive the same instrumental swallowing examination regardless of the results of the clinical test results?
6. Did the instrumental swallowing examination not include items from the clinical test and vice versa?
7. Was the instrumental swallowing examination results interpreted without knowledge of results from the clinical test?
8. Was the clinical test results interpreted without knowledge of results from the instrumental swallowing examination?
9. Was the same patient/clinical data available that is typically available in routine clinical practice?
10. Were uninterpretable test results reported?
11. Were withdrawals from the study explained?
12. Is execution and scoring of the clinical items described in sufficient detail for replication?
13. Is execution and scoring of the instrumental swallowing examination described in sufficient detail for replication?
14. Was patient selection criteria sufficiently described including inclusion and exclusion criteria?
Supplemental Table 2. Categories of Clinical Items

Demographic Items
  Age
  Gender

History Information
  Pneumonia
  Reduced nutrition

Functional Assessments
  Level of Consciousness
  Barthel < 60
  Right hemiparesis

Oral Mechanism Assessments
  Dysarthria
  Dysphonia
  Weak volitional cough
  Unilateral jaw weakness
  Weak/Asymmetrical palatal movement
  Reduced secretion management
  Reduced pharyngeal sensation
  Abnormal gag reflex
  CN IX abnormality

Swallow Tests
  Cough after swallow
  Throat clear after swallow
  Voice change after swallow
  Incomplete oral clearance
  Absent swallow
  Reduced secretion control

References