Early Assessments of Dysphagia and Aspiration Risk in Acute Stroke Patients

Deborah J.C. Ramsey, MRCP; David G. Smithard, MD; Lalit Kalra, PhD

Background and Purpose—Dysphagia is common after stroke and is a marker of poor prognosis. Early identification is important. This article reviews the merits and limitations of various assessment methods available to clinicians.

Methods—An electronic database search was performed of MEDLINE, EMBASE, and the Cochrane database using such terms as stroke, aspiration, dysphagia, and assessment; extensive manual searching of articles was also conducted.

Results—Bedside tests are safe, relatively straightforward, and easily repeated but have variable sensitivity (42% to 92%), specificity (59% to 91%), and interrater reliability ($\kappa=0$ to 1.0). They are also poor at detecting silent aspiration. Videofluoroscopy gives anatomic and functional information and allows testing of therapeutic techniques. However, swallowing is assessed under ideal conditions that are different from clinical settings, and reliability is often poor ($\kappa=0$ to 0.75) in the absence of assessor training. Fiberoptic endoscopy allows swallow assessment and sensory testing but requires specialized staff and equipment. Oxygen desaturation during swallowing may be predictive of aspiration (sensitivity, 73% to 87%; specificity, 39% to 87%) but is more useful in combination with bedside testing than in isolation. Other methods of swallow testing are invasive and require specialized staff and equipment.

Conclusions—Although bedside tests remain an important early screening tool for dysphagia and aspiration risk, further refinements are needed to improve their accuracy. (Stroke. 2003;34:1252-1257.)

Key Words: aspiration ■ deglutition disorders ■ dysphagia ■ process assessment (health care) ■ stroke

Dysphagia after stroke is common, and its detection is an important part of acute stroke management. The literature suggests that swallowing difficulties can affect 22% to 65% of patients, depending on methods of assessment used,1-7 and may persist in some patients for many months.8,9 Dysphagia in acute stroke patients is a marker of poor prognosis, increasing the risks of chest infection, malnutrition, persistent disability, prolonged hospital stay, institutionalization on discharge, and mortality.1-5,7-9,10

In some patients with poorly coordinated swallowing, material subsequently enters the airway below the level of the vocal cords (aspiration), making oral feeding a significant risk. In some patients, aspiration causes no outward signs of distress. This is called silent aspiration,2-4,10,11 the long-term significance of which is unclear.4,10 The aim of this study was to identify the methods of swallow assessment available and to consider their relative merits and limitations, particularly with reference to management of acute stroke patients. An electronic database search was performed of MEDLINE, EMBASE, and the Cochrane Library using terms including dysphagia, aspiration, assessment methods, and stroke. The resultant information was supplemented by extensive manual searching of references.

Assessment of Swallowing

The most frequently used swallow test is the bedside swallow assessment, which covers a number of techniques used in a ward environment. For further assessment, videofluoroscopy (VF) is usually the next investigation of choice although other methods have been used.

Bedside Assessment of Swallow

Several forms of bedside swallow assessment are used to evaluate patients with an acute or recent cerebrovascular event. Some studies have involved patients with other neurological impairments, but the most common subgroup remains stroke disease.

Linden and Siebens12 looked for clinical factors correlating with aspiration on VF. They performed a sensorimotor examination, observed swallowing and related movements, making oral feeding a significant risk. In some patients, aspiration causes no outward signs of distress. This is called silent aspiration,2-4,10,11 the long-term significance of which is unclear.4,10 The aim of this study was to identify the methods of swallow assessment available and to consider their relative merits and limitations, particularly with reference to management of acute stroke patients. An electronic database search was performed of MEDLINE, EMBASE, and the Cochrane Library using terms including dysphagia, aspiration, assessment methods, and stroke. The resultant information was supplemented by extensive manual searching of references.

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a larger sample showed that abnormal voluntary cough and absent gag were independently associated with aspiration. Stanners et al also studied voluntary cough, gag reflex, and dysphonia but found an association only between weak voluntary cough and aspiration. These studies are limited by small patient numbers, variable times between stroke onset and assessment, and limited statistical analyses.

DePippo et al compared a 3-oz water swallow test with VF, showing that patients who coughed during or after swallowing or developed a wet or hoarse voice were at risk of aspiration. They proposed the Burke Dysphagia Screening Test, which also considered features such as stroke site and difficulty with meals. Timed tests of swallow capacity have noted the time and number of swallows required to swallow 150 mL water and have shown that delayed swallowing, coughing, or dysphonia indicated swallowing problems.

Linden et al used a clinical “Dysarthria/Dysphagia Battery”—a clinical battery of questions about respiration, anatomy, drooling, and parenteral feeding. Factors predictive of subglottic penetration on VF included recumbent posture, abnormal phonation, abnormal laryngeal elevation, abnormal palatal gag, wet spontaneous cough, and impaired swallowing of secretions, although these predicted only two thirds of cases of subglottic penetration in a discriminant analysis.

Daniels and colleagues performed an oropharyngeal examination and a clinical swallowing assessment using different volumes of water while monitoring laryngeal elevation, voice quality, and coughing. The presence of ≥2 of 6 features (dysphonia, dysarthria, abnormal volitional cough, cough after swallow, abnormal gag reflex, and voice change after swallow) predicted greater dysphagia severity on VF. Logistic regression identified abnormal volitional cough and cough with swallow as independent predictors of aspiration. McCullough et al used a similar assessment and found 2 reliable items for detection of aspiration: cough during swallowing and clinical estimate of the presence of aspiration.

Many researchers have assessed difficulty in drinking small volumes of water. Smithard and colleagues used 5-mL aliquots and then a larger volume (60 mL), looking for dribbling, laryngeal movement, cough, dysphonia, and the time taken to finish the drink. Logistic regression identified impaired consciousness level and weak voluntary cough as independent predictors for aspiration.

Addington et al used a reflex cough test that evaluated the laryngeal cough reflex with nebulized tartaric acid; a weak or absent cough was regarded as predictive of aspiration risk. Teramoto and Fukuchi studied patients with aspiration pneumonia and a nonrecent stroke. They developed a 2-step swallowing provocation test that involved injecting boluses (0.4 and 2 mL) of water into the suprapharynx of a supine patient and noting the latent time for swallowing. The test identified patients with aspiration pneumonia, but sample sizes were small.

**Gag Reflex and Laryngopharyngeal Sensation**

An absent gag reflex has been suggested as predictive of aspiration in some studies, but refuted in others. Acute and nonacute stroke patients were studied, as were patients dysphagic from other causes, and sample sizes varied considerably. Davies and colleagues have demonstrated that up to 30% of healthy younger adults and 44% of healthy older adults may have unilateral or bilateral absent gag reflexes.

Absence pharyngeal sensation appears rare in normal subjects, but Kidd et al found abnormal pharyngeal sensation (tested with an orange stick) in all stroke patients aspirating on VF. However, sensation was also abnormal in 40% of those not aspirating, and normal swallowing can occur with complete local anesthesia. Aviv and colleagues have developed a method of testing laryngopharyngeal sensation by stimulating the mucosa endoscopically with air pulses and determining sensory discrimination thresholds. Most dysphagic patients tested (predominantly stroke or chronic neurological disease) had sensory deficits, and aspiration or penetration was more common in those with severe deficits. Sensory deficits were also demonstrated in acute stroke patients without clinical dysphagia, and it has been suggested that silent sensory deficits may predispose to silent aspiration.

**Validity, Sensitivity, Specificity, and Reliability**

The validity for most swallow tests has been determined by comparison with VF. Detection of aspiration by bedside testing has been variable (Table 1), with sensitivities between 70% to 90% and specificities between 50% to 75%; negative predictive values range from 50% to 75%; positive predictive values range from 70% to 90%. Interobserver and intraobserver reliability levels for clinical examination vary considerably between studies, with variability in test performance ranging from 87% to 90%.

**TABLE 1. Sensitivity, Specificity, and Predictive Values for Bedside Swallow Tests Compared With VF**

<table>
<thead>
<tr>
<th>Researchers</th>
<th>Patients Studied, n</th>
<th>Sensitivity</th>
<th>Specificity</th>
<th>Positive Predictive Value</th>
<th>Negative Predictive Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smithard et al</td>
<td>83</td>
<td>47</td>
<td>86</td>
<td>50</td>
<td>85</td>
</tr>
<tr>
<td>DePippo et al</td>
<td>44</td>
<td>76</td>
<td>59</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Smith et al</td>
<td>53</td>
<td>80</td>
<td>68</td>
<td>50</td>
<td>90</td>
</tr>
<tr>
<td>Splaingard et al</td>
<td>107 (87 strokes)</td>
<td>42</td>
<td>91</td>
<td>75</td>
<td>70</td>
</tr>
<tr>
<td>Daniels et al</td>
<td>59</td>
<td>92</td>
<td>67</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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values of $\kappa=0$ to 1.0 quoted.\textsuperscript{4,29–31} Mann et al\textsuperscript{29} calculated values of $\kappa=0.82 \pm 0.09$ and $0.75 \pm 0.09$ for interobserver agreement on diagnosis of dysphagia or aspiration, respectively, by 2 speech pathologists. The study by Smithard et al\textsuperscript{4} found better agreement between assessments by speech therapists ($\kappa=0.79$; 95% CI, 0.55 to 1.0) than between doctors ($\kappa=0.5$; 95% CI, 0.26 to 0.73). Values for agreement between a doctor and a therapist ranged from only $\kappa=0.24$ to 0.42.

Ellul and Barer\textsuperscript{30} looked at interobserver reliability for a bedside swallow test performed predominantly by nursing staff and found more variable values ($\kappa=0.19$ to 1.0). McCullough et al\textsuperscript{31} studied reliability between speech pathologists performing a clinical swallow examination and again found wide-ranging values, from $\kappa=0$ to 1.0 for both interjudge and intrajudge reliability for the measures studied.

**Videofluoroscopy**

VF (or modified barium swallow) is often regarded as the assessment of choice in testing swallowing ability.\textsuperscript{32} The patient stands or sits at 45° to 90° and consumes foods or liquids of different consistencies impregnated with barium while their swallow is imaged in lateral and anteroposterior projections. VF provides a dynamic study in which the therapist or radiologist can examine the anatomic structures and the function of the oral and pharyngeal phases of swallowing, as well as testing potential compensatory techniques.

Although VF has been proposed as the gold standard for swallowing testing,\textsuperscript{11,32} this view is not accepted universally. It cannot be undertaken in patients unable to sit upright without the use of a specialized chair, which does not replicate physiological conditions. VF protocols vary, with some workers using a standardized protocol for all patients and others performing more functional, tailor-made studies.\textsuperscript{32} The radiation exposure for VF, although regarded as acceptable,\textsuperscript{32} makes frequent test repetition inappropriate. The limited procedure duration underestimates the time required for some patients to eat and makes patient fatigue less obvious. Test-retest variability has been found within normal subjects undergoing VF:\textsuperscript{31} the differences were nonsignificant, but repeated trials of each food consistency are advised.

VF is a relatively complex task to interpret, and interjudge agreement can be very variable. Smithard et al\textsuperscript{48} calculated percentage agreement between 2 radiologists for VF assessments as 76% ($\kappa=0.48$; 95% CI, 0.2 to 0.76), whereas Wilcox and colleagues\textsuperscript{34} found only limited agreement on VF features among 10 speech and language pathologists, possibly reflecting their variable experience. Mann et al\textsuperscript{29} looked at agreement between a speech pathologist and a radiologist and obtained statistics of $\kappa=0.75 \pm 0.09$ for VF diagnosis of dysphagia and $\kappa=0.41 \pm 0.09$ for aspiration.

McCullough et al\textsuperscript{31} examined common VF measures and found that statistics for interjudge reliability ranged from $\kappa=0$ to 0.478; percentage agreement (calculated when $\kappa$ was not possible) reached 92% on some variables. Intrajudge reliability has been greater in some studies but not in others.\textsuperscript{35,36} Reliability ratios in 1 study were highest for aspiration, particularly for solids, and lowest for functional swallowing components.\textsuperscript{36} Levels of agreement in ratings correlate with assessor experience\textsuperscript{37} and improve with group discussion among assessors\textsuperscript{38}; similar methods of training to criteria may form a way to improve reliability.\textsuperscript{35}

**Pulse Oximetry**

Pulse oximetry provides a noninvasive method of bedside swallow testing. Most studies have found a good correlation between oxygen saturations and arterial blood samples in higher saturation ranges, with correlation coefficients quoted at 0.82 to 0.99.\textsuperscript{39} The manufacturer’s accuracy for the monitors is $\approx$2% within the 50% to 100% saturation range. It has been suggested that aspiration causes reflex bronchoconstriction and therefore ventilation-perfusion imbalance, leading to hypoxia and desaturation.\textsuperscript{40} Others have suggested that abnormal swallowing leads to poor breathing and ventilation-perfusion mismatching because of reduced inspiratory volumes.\textsuperscript{41}

Initial reports of hypoxemia during oral feeding in neurologically disabled individuals noted associations with certain food textures, postulated to be secondary to aspiration of those foods.\textsuperscript{42,43} Zaidi et al\textsuperscript{40} subsequently found greater desaturation after swallowing water in acute stroke patients than in matched control subjects, and the degree of desaturation correlated with clinical assessment of aspiration risk, although statistical criticisms have been leveled at their analyses.\textsuperscript{44} Sherman et al\textsuperscript{45} performed pulse oximetry during VF and demonstrated significant desaturation in patients who suffered aspiration of material or penetration without clearing compared with those in whom penetration occurred with clearing or not at all, but patient numbers were small and age was very variable. Some studies have found no clear relationship between desaturation and aspiration,\textsuperscript{44,46} but 1 study demonstrated persistently lower saturations in aspirators than nonaspirators.\textsuperscript{44}

Other workers have found that desaturation of $>2\%$ from baseline predicted aspiration on VF.\textsuperscript{28,47} Sensitivity values ranged from 73% to 87%, and specificity values ranged from 39% to 87% (Table 2) with poor positive predictive values and possibly lower values in older subjects and those with lung disease.\textsuperscript{47} Using an end point of penetration or aspiration rather than aspiration alone gave higher specificity and positive predictive values.\textsuperscript{28} Another study compared oxygen saturation predictions with aspiration detected by fiberoptic endoscopy rather than VF and obtained better specificities and predictive values.\textsuperscript{48} Two studies combined predictions from bedside testing and saturation monitoring and achieved good sensitivity and specificity values, particularly with aspiration or penetration as end points.\textsuperscript{28,48}

**Fiberoptic Endoscopy**

Fiberoptic endoscopic evaluation of swallowing (FEES) can give information on anatomy, the swallow process, pharyngeal motility, and sensory deficits.\textsuperscript{26,49} Although aspiration cannot be seen directly, it can be inferred from residue left after swallowing or ejection of material out of the trachea after coughing.

On comparison with VF in a small sample of dysphagic patients, FEES gave sensitivity values of $\approx 0.88$ for 3 of 4 parameters\textsuperscript{49}, specificity ranged from 0.50 to 0.92, positive
predictive values were 0.69 to 0.88, and negative predictive values ranged from 0.63 to 1.00. One study found fewer aspiration pneumonias after a negative FEES result than a negative VF result although this was not statistically significant. The assessment can be conducted at bedside, can be videotaped if required, and is safe and well tolerated. It is, however, dependent on a skilled operator and specialized equipment, and limited information is available about the oral and esophageal stages.

**Other Methods**

Cervical auscultation of the mechanical and/or respiratory components of swallowing, combined with bedside testing, has been compared with VF and revealed significant agreement for detection of aspiration. It can be performed at bedside, but research into sound patterns is ongoing and technique reliability is unclear.

Lateral cervical soft tissue radiographs have been used after swallowing contrast, but poor head posture causes problems, and reporting is difficult for the inexperienced. Ultrasonography is safe and moderately portable, but most ultrasound probes are too small to visualize the whole swallow and are limited to nonbony areas.

Pharyngeal or esophageal manometry can provide useful information, particularly when combined with VF and other methods tried include scintigraphy and electromyography. These techniques cannot be used at bedside, are invasive, and require specialized staff and equipment, so they have principally remained research tools.

**Conclusions**

Dysphagia is common in acute stroke patients, but swallow recovers in >80% of patients within 2 to 4 weeks of stroke onset. The most important consideration initially is aspiration risk and suitability for oral feeding. Although a detailed examination of swallowing mechanisms may be desirable, it is usually difficult and often unnecessary to subject patients to such procedures, which may have greater relevance in patients with persistent dysphagia. The challenge is to develop simple bedside assessments that can be administered by a range of professionals in day-to-day clinical practice.

A variety of bedside assessments have been proposed that depend on the ability to swallow foods of various consistencies. The features most predictive of aspiration risk include a wet voice, weak voluntary cough, cough on swallowing, prolonged swallow, or some combination of these. Although abnormal gag reflex and reduced laryngopharyngeal sensation are associated with swallowing difficulties, they do not appear to predict aspiration risk in isolation. Bedside swallow tests are safe, therefore repeatable, and relatively straightforward to perform. However, sensitivities and specificities are very variable, with many methods missing silent aspiration, and assessments of reliability have been wide ranging.

All bedside swallow assessments have limitations, necessitating pragmatic dysphagia management that takes available facilities and user experience into consideration. In our unit, all acute stroke patients undergo swallow screening by trained nursing staff. The protocol assesses consciousness level, posture, ability to cooperate with the test, and gross oromotor function. Patients deemed safe are tested with sips of water while monitoring for coughing or respiratory distress, voice changes, and laryngeal movement. Those without obvious difficulties are offered a larger volume of water, yoghurt, and normal foods and again are monitored. Patients without problems receive a normal diet while we watch their oral intake and respiratory status for 48 hours. Patients who find eating effortful or with significant food residues are given a soft, smooth diet and referred to speech and language therapy. Any patient failing the test is kept nil by mouth and referred to a speech and language therapist for a detailed assessment, including VF if appropriate.

VF has advantages over bedside methods, especially in assessing swallow mechanics and testing compensatory techniques. However, the information provided is dependent on operating procedures and the training of assessors to interpret results. Limitations are imposed by patient cooperation, availability and timing of studies, and the ability to generalize to clinical settings. The radiation exposure involved makes it an inappropriate test to repeat frequently to monitor changes. The level of supervision and attention to posture during the examination (rarely possible on general wards) means that some patients considered safe on VF may remain at risk of aspiration in clinical settings.

Pulse oximetry is straightforward and noninvasive, and significant desaturation during feeding may correlate with aspiration in dysphagic individuals. Although specificity and

### TABLE 2. Sensitivity, Specificity, and Predictive Values for Desaturation Compared With Aspiration on VF or Fiberoptic Endoscopy

<table>
<thead>
<tr>
<th>Researchers</th>
<th>Patients Studied, n</th>
<th>Endpoint</th>
<th>Sensitivity, %</th>
<th>Specificity, %</th>
<th>Positive Predictive Value, %</th>
<th>Negative Predictive Value, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collins and Bakheit</td>
<td>54</td>
<td>Asp</td>
<td>73</td>
<td>87</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Smith et al</td>
<td>53</td>
<td>Asp</td>
<td>87</td>
<td>39</td>
<td>36</td>
<td>88</td>
</tr>
<tr>
<td>Combined with BSA</td>
<td>Asp/Pen</td>
<td>86</td>
<td>54</td>
<td>69</td>
<td>76</td>
<td></td>
</tr>
<tr>
<td>Combined with BSA</td>
<td>Asp</td>
<td>73</td>
<td>76</td>
<td>55</td>
<td>88</td>
<td></td>
</tr>
<tr>
<td>Lim et al</td>
<td>50</td>
<td>Asp</td>
<td>77</td>
<td>83</td>
<td>83</td>
<td>77</td>
</tr>
<tr>
<td>Combined with BSA</td>
<td>Asp</td>
<td>100</td>
<td>71</td>
<td>79</td>
<td>100</td>
<td></td>
</tr>
</tbody>
</table>

Asp indicates aspiration; Pen, penetration; and BSA, bedside swallow assessment.

*Compared with fiberoptic endoscopic assessment rather than VF.
predictive values for the technique are relatively poor in isolation, they appear better when used together with bedside swallow testing. Patients with significant dysphagia may be detected even if they do not aspirate; predictive values are better for aspiration or penetration than aspiration alone. FEES provides useful swallow information and is portable and safe, but specialized staff and equipment are required.

The limitations of the existing bedside tests that form the cornerstone of early assessment of aspiration risk in stroke must stimulate continued efforts to improve the accuracy and repeatability of swallow assessment methods. More reliable bedside tests would allow swallow screening by a range of professionals who may be in earlier contact with stroke patients than speech and language therapists. This should reduce the number of patients who are not fed or are fed inappropriately while awaiting assessment for dysphagia and are therefore at risk of aspiration pneumonia or malnutrition.

Acknowledgment
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References
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