The Toronto Bedside Swallowing Screening Test (TOR-BSST)  
Development and Validation of a Dysphagia Screening Tool for Patients With Stroke  
Rosemary Martino, PhD; Frank Silver, MD; Robert Teasell, MD; Mark Bayley, MD;  
Gordon Nicholson, MHSc; David L. Streiner, PhD; Nicholas E. Diamant, MD

**Background and Purpose**—Dysphagia occurs in 55% of all acute stroke patients. Early identification of dysphagia from screening can lead to earlier treatments and thereby reduce complications. We designed and validated a new bedside dysphagia screening tool—the Toronto Bedside Swallowing Screening Test (TOR-BSST) for stroke survivors in acute and rehabilitative settings.

**Methods**—The TOR-BSST initially contained 5 items with proven high predictive ability for dysphagia. Trained screeners administer and score the TOR-BSST in less than 10 minutes. Trained nurses from 2 acute and 2 rehabilitation facilities administered the TOR-BSST to consecutively admitted stroke inpatients. A positive screen identified patients at risk for dysphagia. Blinded repeat screenings were conducted within 24 hours. Test-retest reliability was established with the first 50 administrations at an ICC = 0.92 (CI, 0.85 to 0.96). Items were eliminated if they contributed ≤5% to the total score and were judged clinically impractical. 20% of all enrolled patients were randomly allocated to gold standard videofluoroscopic assessment of swallowing and findings rated independently by 4 blinded experts. Adequate validity was set at sensitivity ≥90% and negative predictive value ≥90%.

**Results**—311 stroke inpatients were enrolled; 103 acute and 208 rehabilitation. Screening was positive in 59.2% acute and 38.5% rehabilitation patients. The pharyngeal sensation item did not meet inclusion criteria and was eliminated. The TOR-BSST demonstrated excellent validity with sensitivity at 91.3% (CI, 71.9 to 98.7), and negative predictive values at 93.3% in acute and 89.5% in rehabilitation settings.

**Conclusion**—The TOR-BSST is a simple accurate tool to identify stroke patients with dysphagia regardless of severity and setting. (Stroke. 2009;40:555-561.)

**Key Words:** dysphagia ■ stroke ■ screening ■ assessment scale ■ validation

Dysphagia presents in approximately 55% of all acute stroke patients admitted to hospital. The presence of dysphagia can itself cause serious consequences. Patients with dysphagia, regardless of severity or presence of aspiration, are 3 times more likely to develop pneumonia than stroke patients without dysphagia. The risk of pneumonia is even higher, approximately 11 times more likely, for those patients with severe dysphagia marked by the presence of aspiration. Similarly, mortality is significantly higher for stroke patients with dysphagia, especially in the first 90 days after stroke. At later stages of recovery, stroke survivors continue to be at high risk for dysphagia, and the consequence of undetected dysphagia can lead to serious comorbidities. Fortunately, there is emerging evidence that early detection of dysphagia reduces not only pulmonary complications, but also reduces length of hospital stay and overall healthcare costs for acute patients.

Stroke guidelines are stressing early dysphagia detection using validated screening and assessment tools. In Canada, the United States, the United Kingdom, and Australia, stroke guidelines require that a trained clinician screen individuals admitted with stroke or suspicion of stroke for dysphagia as soon as they are alert and able. A standardized tool must be used. Those patients with a positive dysphagia screen result should be kept “nil by mouth” (NPO) and followed with a full assessment of swallowing within 24 hours. The premise is that earlier detection allows for earlier...
treatment which not only shortens the stroke recovery period, but also reduces the overall rehabilitation costs.\textsuperscript{6}

To date, the Burke Dysphagia Screening Test developed by DePippo and colleagues\textsuperscript{12} has been the instrument most commonly used to screen for dysphagia in clinical settings.\textsuperscript{5} Unfortunately, this tool was developed in only the rehabilitation setting with unblinded raters and no reported reliability—both necessary psychometric standards for proper tool validation.\textsuperscript{13} The purpose of the present study was to design and assess the reliability and validity of the TOR-BSST (the Toronto Bedside Swallowing Screening Test) as a screening instrument to identify dysphagia in stroke survivors across the continuum of care. The TOR-BSST was developed to include only items with potentially high predictive value\textsuperscript{6} to be simple, and to be readily administered by trained personnel who are not necessarily dysphagia experts. For the TOR-BSST to establish high clinical utility it must have high sensitivity (ability to detect those with dysphagia) and high negative predictive value (ability to rule out those without dysphagia) in both the acute and rehabilitation setting.\textsuperscript{14} Our study was designed to assess these factors.

Materials and Methods

Development

The items of the TOR-BSST were derived from an extensive systematic review by Martino and colleagues.\textsuperscript{5,15} This study was the first to systematically target item generation for a screening tool using the best available evidence, and the first to identify the combination of items included in the TOR-BSST. In this review, 49 individual clinical tests were identified but only 2 were found to have potential in accurately predicting dysphagia: dysphonia or coughing during the 50-ml water test by Kidd and colleagues\textsuperscript{16} and impaired pharyngeal sensation.\textsuperscript{16,17} Although the predictive ability for these individual tests was assessed with only aspiration on videofluoroscopy, their good predictive value is supported by good study design, including operational definitions for administration and interpretation.\textsuperscript{6} Two other clinical tests, impaired tongue movement and general dysphonia, showed promise with predictive ability but results were not consistent across different studies. The DePippo 3-oz water test was not included in the TOR-BSST because it was not as accurate a predictor as the Kidd water test with likelihood ratios of 2.5 and 5.0, respectively.\textsuperscript{6} The remaining tests, including weak voluntary cough without oral intake and gag reflex, were also not included because they did not rate as good predictors of dysphagia because of low likelihood ratios, wide 95\% confidence intervals, or inconsistent results from more than one study. Only the 4 clinical tests with highest likelihood ratios were carried forward as screening items, namely the Kidd water swallow test, pharyngeal sensation, tongue movement, and general dysphonia. General dysphonia was split into 2 items, “voice before” and “voice after,” in an attempt to secure screener attention to voice quality throughout screening. Therefore, initially a total of 5 items were selected to form the TOR-BSST. Our hypothesis was that in combination these 5 items would have the best predictive ability for increased dysphagia risk.

The response grid and layout were developed by a multi-professional group (3 speech-language pathologists, 2 gastroenterologists, 1 nurse, and 1 neurologist) that works full-time with the acute stroke population and that represents potential users and interpreters of the new screening tool. A pass/fail response was assigned to each item so that failure on any item constitutes a positive screen result and therefore an increased risk for dysphagia. The new form was pilot tested by speech-language pathologists with newly admitted acute stroke patients. Their responses indicated high ratings for ease in administration, scoring, and interpretation. The entire TOR-BSST could be administered, scored, and placed on the medical chart in approximately 10 minutes. Because administration continues only until the first TOR-BSST item is failed, patients with severe dysphagia typically fail an early item thereby reducing administration to less than 10 minutes. The TOR-BSST is intended for use by any health care professional trained in the clinical assessment of poststroke patients. It is designed so that it can be administered to stroke patients across all settings, including acute, rehabilitative, and chronic facilities. The primary purpose of the TOR-BSST is to predict dysphagia defined by aspiration or any physiological abnormality on videofluoroscopy, which is the accepted gold standard. More information about the TOR-BSST is available at http://swallowinglab.uhnres.utoronto.ca/torbsst.html.

Education

A 4-hour didactic session was developed to train screeners on administration and interpretation of the TOR-BSST using digitized real-life examples of 5 stroke patients. Training also included review of basic anatomy and physiology of swallowing as well as strategies to use when administering the TOR-BSST to patients with receptive or expressive aphasia. In addition, screeners were taught how to determine whether patients meet the criteria for dysphagia screening. According to published guidelines,\textsuperscript{7,8} patients should only be screened for dysphagia if they are alert, can be supported to sit upright, and can follow simple instruction. Patients without these 3 requirements are not to be screened because they are assumed to have dysphagia. Instead screeners are instructed to refer them directly for a swallowing assessment. Didactic training was followed by individual training where nurses independently administered the TOR-BSST to stroke patients. Didactic and individual training was facilitated by a speech-language pathologist with expertise in assessment and management of dysphagia poststroke.

Subjects

Dysphagia Screeners

All nurses working on participating stroke units were eligible to be screeners once they successfully completed the didactic training and 2 consecutive supervised TOR-BSST administrations. Selection of nurse participation was negotiated with hospital administrators to ensure availability of at least 1 trained TOR-BSST dysphagia screener across all shifts.

Stroke Patients

All consecutive patients newly admitted to hospital with the confirmed diagnosis of a brain stem stroke or cerebellar stroke and all other stroke patients with a National Institutes of Health Stroke Scale (NIH-SS) score greater than or equal to 4 were eligible and approached for participation. Stroke was confirmed from a physician’s clinical note or from CT scan or MRI findings. Nonbrain stem and noncerebellar stroke patients with low NIH-SS scores were considered by our stroke neurologist to have no swallowing difficulties; therefore, these patients were noted but excluded. Also excluded were patients with current respiratory compromise, a nonoral feeding regime, or a history of one of more of the following: nonstroke neurological disorder, surgery to the head or neck, a history of previous oropharyngeal dysphagia, dementia, or decreased level of consciousness. Patients were recruited from inpatient stroke units at 2 acute and 2 rehabilitation tertiary care hospitals in southern Ontario.

Procedure

As soon as possible after hospital admission, patients were identified, consented, and enrolled by a research assistant. The presence of aphasia did not exclude patients from participation. For those patients with communication impairment, the research coordinator obtained consent in 1 of 2 ways: (1) directly from the patient using the methods of Supported Conversation for Adults with Aphasia (SCA)\textsuperscript{18}; or (2) from the substitute decision maker in cases where SCA was not possible. After enrolment, 1 in 5 were randomized to receive the videofluoroscopic assessment of swallowing (VFS), the reference standard. The randomization list was generated a priori using SPSS software and kept off site with the central study coordinator. We used a 2-step randomization process to prevent advance
knowledge of a patient’s allocation. Each enrolled patient was assigned a study number, which was then matched to a randomization grid on a separate page. Regardless of VFS randomization, all patients were administered the TOR-BSST screen by 2 trained nurses. Nurses were blinded to each other’s screening results, patient medical information, and VFS randomization. As a safety check, 1 in 5 patients whose screen results were negative and all patients whose screen results were positive were referred for a clinical swallowing assessment by a speech-language pathologist. Patients who could not be administered the TOR-BSST were noted and excluded from analysis. All repeat TOR-BSST screenings and swallowing assessments were to be administered within 24 hours of each other. Patient demographic and stroke information was collected immediately after enrollment by the research assistant from review of the medical chart.

This research was conducted with approval of the institutional ethics review boards at each site and registered with www.clinical-trials.gov (ID NCT00141752). All participants, or substitute decision-makers, gave informed consent.

Reliability
Interrater reliability for administration of the TOR-BSST tool by trained nurse screeners was established with the first 50 patient screenings. The overall agreement between screeners was excellent with a total score intraclass correlation coefficient (ICC) = 0.92 (95% CI: 0.85 to 0.96) thereby achieving published standards for tools measuring individual status.19

Item Reduction
Items were eliminated if they singly contributed ≤5% to the total test score and were judged clinically impractical. Clinically impractical items were identified from independent judgements from 3 or more (of 5) speech-language pathologists with 5 years dysphagia experience.

Figure. Flow diagram for the TOR-BSST study. Examples of “other” = home hospital repatriation, uncooperative/combative patient, patient on comfort measures only/palliative care. Reasons for withdrawal: unable to complete study during SARS (n=2), Patient obtunded (n=3), patient discovered to be non-stroke (n=2), patient discovered to have premorbid dysphagia (n=1).
Table 1. Demographic and Diagnosis Profile of All Patients Across Sites

<table>
<thead>
<tr>
<th>Variable</th>
<th>All Sites (n=311)</th>
<th>Acute Sites (n=103)</th>
<th>Rehabilitation Sites (n=208)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean (SD) age, y</td>
<td>68.6 (14.3)</td>
<td>67.7 (13.9)</td>
<td>69.0 (14.5)</td>
<td>0.460</td>
</tr>
<tr>
<td>Male, n (%)</td>
<td>181 (58.2)</td>
<td>58 (56.3)</td>
<td>123 (59.1)</td>
<td>0.635</td>
</tr>
<tr>
<td>History of stroke, n (%)</td>
<td>62 (19.9)</td>
<td>17 (16.5)</td>
<td>45 (21.6)</td>
<td>0.287</td>
</tr>
<tr>
<td>Lesion site</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lt cortical, n (%)</td>
<td>104 (33.4)</td>
<td>25 (24.3)</td>
<td>79 (38.0)</td>
<td></td>
</tr>
<tr>
<td>Rt cortical, n (%)</td>
<td>108 (34.7)</td>
<td>35 (34.0)</td>
<td>73 (35.1)</td>
<td>0.023</td>
</tr>
<tr>
<td>Brainstem, n (%)</td>
<td>51 (16.4)</td>
<td>19 (18.4)</td>
<td>32 (15.4)</td>
<td></td>
</tr>
<tr>
<td>Cerebellum, n (%)</td>
<td>25 (8.0)</td>
<td>14 (13.6)</td>
<td>11 (5.3)</td>
<td></td>
</tr>
<tr>
<td>Mixed, n (%)</td>
<td>23 (7.4)</td>
<td>10 (9.7)</td>
<td>13 (6.3)</td>
<td></td>
</tr>
<tr>
<td>Infarct pathology, n (%)</td>
<td>269 (86.5)</td>
<td>89 (86.4)</td>
<td>180 (86.5)</td>
<td>0.975</td>
</tr>
<tr>
<td>Stroke severity</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean (SD) NIH*</td>
<td>7.1 (4.4)</td>
<td>6.8 (5.1)</td>
<td>7.2 (4.1)</td>
<td>0.530</td>
</tr>
<tr>
<td>Mean (SD) FIM†</td>
<td>78.3 (22.8)</td>
<td>82.5 (27.8)</td>
<td>76.8 (20.6)</td>
<td>0.113</td>
</tr>
<tr>
<td>Mean (SD) time, days</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LSN to admission</td>
<td>18.3 (38.5)</td>
<td>1.6 (3.6)</td>
<td>26.6 (44.8)</td>
<td>0.000</td>
</tr>
<tr>
<td>LSN to TOR-BSSST</td>
<td>23.2 (38.4)</td>
<td>6.1 (6.8)</td>
<td>31.6 (44.4)</td>
<td>0.000</td>
</tr>
<tr>
<td>LSN to discharge</td>
<td>54.6 (51.0)</td>
<td>15.7 (13.8)</td>
<td>73.8 (51.8)</td>
<td>0.000</td>
</tr>
<tr>
<td>TOR-BSSST positive finding, n (%)</td>
<td>141 (45.3%)</td>
<td>61 (59.2%)</td>
<td>80 (38.5%)</td>
<td>0.001</td>
</tr>
</tbody>
</table>

*Missing values: 14 acute patients.†Missing values: 29 acute patients; 2 rehab patients.

Dysphagia was defined to be any swallow-associated abnormal physiology in the upper aerodigestive tract, including aspiration, during intake of liquid or solid boluses. The presence of dysphagia was judged from the findings of videofluoroscopic swallowing (VFS) test. Despite being the accepted gold standard, reliability among experts remains low. Therefore we used 4 speech-language pathologists, each with more than 5 years experience with dysphagia and stroke, to make independent and blinded judgements of VFS findings using 3 measures: the Penetration Aspiration Scale (PAS),22 the MASA dysphagia subscore, and the MASA aspiration subscore. Latent class modeling was used first to assess reliability among experts and second to combine the 3 judgements from each of the 4 experts to determine the presence or absence of dysphagia on VFS for each patient. We report these statistical methods elsewhere.24

Data Analysis

For dysphagia, patient, and stroke information, univariate statistics were used to describe the data including frequencies, percentages, range, and mean. Accuracy of the TOR-BSSST was tested using sensitivity, specificity, likelihood ratios, and predictive values for overall TOR-BSSST score and for acute and rehabilitation patient subgroups. Because of the perceived increased risk to patients from radiation exposure, our hospital ethic boards mandated that we randomize to videofluoroscopic assessment with a subset of 60 patients (20% of the total) with power every estimate. A total sample of 300 patients allowed validity testing with a subset of 60 patients (20% of the total) with power at 80% and significance at 5%.

Results

Participants

Fifty-five nurses were trained, 28 from acute sites and 27 from rehabilitations sites. Of these, 41 (75%) were certi-
Negative predictive value.14 This fit is especially important for standards for screening tools to have high sensitivity and high sensitivity, and predictive of dysphagia in patients with stroke in both acute and rehabilitation settings. It fits with published sensitive, and predictive of dysphagia in patients with stroke. The TOR-BSST screening tool is a clinical tool that is simple, sensitive, and predictive of dysphagia in patients with stroke. A good screening test needs to have a high sensitivity and high negative predictive value.14 The TOR-BSST meets these criteria with an overall sensitivity of 91.3% (71.9 to 98.7) across all settings and negative predictive value.2

Validation
Gold standard VFS assessments were conducted on a random subset (n=68; 21.9%) of all enrolled patients.24 Characteristics of patients randomly selected to receive VFS assessment were the same as all other patients in the study. (Table 3) Nine patients were eliminated from accuracy statistics because their first screen and VFS assessments were administered more than 24 hours apart. Of the remaining patients assessed with VFS, 36 (61.0%) were judged by experts to have no dysphagia and 23 (39.0%) to have dysphagia. Separate accuracy statistics were calculated for all patients, the subset of acute patients, and the subset of rehabilitation patients. (Table 4) Predictive values are dependent on prevalence and thus were calculated separately for acute and rehabilitation patients. A good screening test needs to have a high sensitivity and high negative predictive value.14 The TOR-BSST meets these criteria with an overall sensitivity of 91.3% (71.9 to 98.7) across all settings and negative predictive values of 93.3% in acute patients and 89.5% in rehabilitation patients.

Discussion
The TOR-BSST screening tool is a clinical tool that is simple, sensitive, and predictive of dysphagia in patients with stroke. It fits with published standards for screening tools to have high sensitivity and high negative predictive value.14 This fit is especially important for diseases such as dysphagia where the risk of being undetected can lead to serious consequences of pneumonia,1 malnutrition26 and even death.2 Of particular importance, there is confidence that stroke patients with a negative TOR-BSST result will not have dysphagia, and that the TOR-BSST will miss few if any patients with dysphagia. The necessity for more extensive and specific assessments, and their associated costs in time and money, can be avoided in those patients with negative findings. Therefore, the TOR-BSST functions as a reliable and valid method by which to triage only patients with positive screen results to a more expensive and complicated full assessment by a speech-language pathologist dysphagia expert.

The main purpose of a screening test is to identify as many cases as possible before clinical signs occur.13,27 Hence, it is desirable that the sensitivity be high. For the TOR-BSST, this sensitivity is of prime importance because not identifying dysphagia can lead to the serious consequences of pneumonia24 and mortality.2 Because with any diagnostic test there is a trade-off with specificity, the result is an increased number of false-positives. However, because these can be identified later by an experienced speech-language pathologist professional before any intervention is started, it is preferable to increase the sensitivity at the first stage, to avoid an unacceptable number of false-negatives. Such is the case with the TOR-BSST.

At the time this study was initiated, there was only emerging evidence from a systematic review that screening for dysphagia in stroke patients has health benefits.6 Specifically, there was evidence across published studies for the reduction of both pneumonia and death events in patients who were screened for dysphagia, versus those who were not.
review also identified screening to be associated with a reduction in total patient charges by 14.6%. Shortly thereafter, a systematic review of the quality of existing tools reported few available dysphagia screening tools and of those published none were developed with proper study methodology. In 1999, the Agency for Health Care Policy and Research declared a need to develop such a tool. The Burke Dysphagia Screening tool had been developed and made available in 1994 but did not meet the published standards. Specifically, it was conducted without rater blinding and no assessment for reliability. It was limited to a rehabilitation setting and included a 3-oz water swallow test shown to be less effective than the Kidd 50-mL water swallow test included in the TOR-BSST. More recently, another swallowing screening tool was published—the Gugging Swallowing Screen. This tool was validated for use with nurse screeners with only 30 acute patients and assessed for its accuracy to detect only aspiration. This is in direct contrast to the common view that dysphagia is any abnormal physiology of the oropharyngeal swallow regardless of aspiration. In fact, we now have evidence that dysphagia, regardless of the presence of aspiration, increases the likelihood of pneumonia by three fold.

It is important to mention that the TOR-BSST was not assessed for accuracy with patients who were tube-fed or had comorbidities such as reduced level of alertness or pulmonary disease. From a clinical perspective, patients who are tube-fed have previously been identified to have dysphagia and thus would not require screening. From a research perspective, the presence of the feeding tube would have biased the screeners’ ratings. Likewise because swallowing requires a basic level of alertness, patients with reduced alertness are clinically considered to have dysphagia and hence do not require screening. Patients with pneumonia were excluded on an ethical basis, that is, to reduce any further risk of aspiration in a pulmonary system that was already seriously compromised. Finally, only patients with stroke were included in this study. Validation of the TOR-BSST with other neurological etiologies is now under separate research.

Table 4. Comparison of Diagnostic Accuracy Measures of the TOR-BSST Across Patient Groupings†

<table>
<thead>
<tr>
<th>VFS</th>
<th>Dysphagia</th>
<th>No Dysphagia</th>
<th>PPV</th>
<th>NPV</th>
</tr>
</thead>
<tbody>
<tr>
<td>TOR-BSST, all patients (n=59)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dysphagia</td>
<td>21</td>
<td>12</td>
<td>PPV=76.5%</td>
<td></td>
</tr>
<tr>
<td>No dysphagia</td>
<td>2</td>
<td>24</td>
<td>NPV=n/a</td>
<td></td>
</tr>
<tr>
<td>Sensitivity=91.3% (95% CI, 71.9–98.7)</td>
<td>Specificity=66.7% (95% CI, 49.0–81.4)</td>
<td>+LR=2.7 (95% CI, 1.7 to 4.4)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>False negative=8.7%</td>
<td>False positive=33.3%</td>
<td>-LR=0.1 (95% CI, 0 to 0.5) Prevalence=39.0%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

TOR-BSST, acute patients (n=24)

| VFS       | Dysphagia | No Dysphagia | PPV=76.5% |
|-----------|-----------|--------------|-----|-----|
| Dysphagia | 13        | 4            |     |     |
| No dysphagia | 0** | 7            |     |     |
| Sensitivity=96.3% (95% CI, 72.5 to 99.6) | Specificity=63.6% (95% CI, 35.4 to 84.8) |
| False negative=3.7% | False positive=36.4% |
| TOR-BSST, rehab patients (n=35) |            |              |     |     |
| Dysphagia | 8         | 8            | PPV=50.0% |
| No dysphagia | 2        | 17           |     |     |
| Sensitivity=80.0% (95% CI, 49.0 to 94.3) | Specificity=68.0% (95% CI, 48.4 to 82.8) |
| False negative=20.0% | False positive=32.0% |
| †Including only patients with a first screen and VFS assessments ≤24 hours apart. **Substituted 0.5 for calculations.
and tested for stability and accuracy. The added practical and economic value of a screening test that rules out dysphagia is obvious. To date and to accomplish these ends, the TOR-BSST is the only tool developed according to published standards31,32 and with a large stroke population across the continuum of care and with proven psychometric properties.

Summary
In an effort to standardize care for stroke patients across all settings, the Canadian Stroke Strategy7 and the U.S. Joint Commission33 have committed to ensure that every patient admitted to hospital with a suspicion of stroke be screened for dysphagia. The TOR-BSST offers an accurate method to identify stroke patients with dysphagia in the acute and rehabilitation setting with confidence that patients with a negative screen will not have dysphagia. Early positive identification of those stroke patients with dysphagia will allow for earlier referral to dysphagia experts for proper diagnosis and directed treatment, and a reduction in dysphagia-related complications such as pneumonia, malnutrition, and possibly even death.

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Disclosures
None.

References
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