Predictive value of clinical indices in detecting aspiration in patients with neurological disorders

Fabiola Mari, Monica Matei, Maria Gabriella Ceravolo, Anna Pisani, Alfeo Montesi, Leandro Provinciali

Abstract

Objectives—(1) To evaluate the predictive value of a detailed clinical screening of aspiration in patients with neurological diseases, both with and without symptoms of dysphagia taking videofluoroscopy as the gold standard; (2) to assess the existence of risk factors for silent aspiration, measuring the cost-benefit ratio of radiological examination.

Methods—93 consecutive patients meeting the diagnostic criteria for a neurological disease with a risk of swallowing dysfunctions (cerebrovascular accidents, brain injury, Parkinson's disease, multiple sclerosis, ataxia, myotonic dystrophy, and abiotrophic diseases) underwent a detailed clinical assessment using a 25 item form to check for symptoms of dysphagia and impairment of the oropharyngeal swallowing mechanism. The 3 oz water swallow test was also performed to assess the aspiration risk. Sensitivity, specificity, positive predictive, and negative predictive values (NPV) of dysphagia, history of cough on swallowing, and 3 oz test positivity, versus videofluoroscopy documented aspiration, taken as the gold standard, were measured in all the patients and in subgroups with different neurological disorders.

Results—Non-specific complaints of dysphagia showed a very poor predictive value, whereas the symptom “cough on swallowing” proved to be the most reliable in predicting the risk of aspiration, with 74% sensitivity and specificity, 71% positive predictive, and 77% negative predictive value. The standardised 3-oz test had a higher predictive potential than the clinical signs, but had low sensitivity. The association of cough on swallowing with the 3 oz test gave a positive predictive of 84%, and an negative predictive value of 78%. In cases where the clinical tests failed to detect any impairment, videofluoroscopy documented only a low risk (20%) for mild aspiration.

Conclusions—The association of two clinical items (such as history of cough on swallowing and 3 oz test positivity) provides a useful screening tool, the cost:benefit ratio of which seems very competitive in comparison with videofluoroscopy in aspiration risk evaluation.

Keywords: dysphagia; aspiration risk; bedside clinical assessment

Food aspiration is a frequent consequence of dysphagia, causing a strong risk of pneumonia1 and diet alterations.7 In some neurological diseases, dysphagia can persist for a long period, without being complained of by patients.3 Therefore, a screening of swallowing alterations in such conditions is suggested, if lung infections are to be prevented.

A prospective, longitudinal cohort study, carried out on patients during the subacute phase after stroke, documented that even silent aspiration is associated with a 5.57-fold increase in risk of pneumonia.4 Videofluoroscopy showed the occurrence of a swallowing impairment in many different neurological disorders, such as cerebrovascular accidents,5 brain injury,6 Parkinson's disease,7 multiple sclerosis,9 ataxia, myotonic dystrophy,10 and dementia.13

Although videofluoroscopy is, so far, the most accurate instrumental investigation to check the passage of food below the vocal folds,14 it is an invasive test that requires a specialised diagnostic laboratory with trained staff and a specific set of expensive instruments not available in all centres.15

Several clinical approaches have been proposed to make the diagnostic process easier and to measure the severity of dysphagia.16−18 In particular, clinical scales were associated with either non-specific19 or specific pathology tests20 to predict aspiration.

The aim of this study was to evaluate the predictive value of a detailed clinical screening of aspiration in patients with neurological diseases, both with and without symptoms of dysphagia taking videofluoroscopy as the gold standard.21

Furthermore the cost:benefit ratio of the radiological examination was evaluated on the basis of such results and risk factors for silent aspiration were investigated.

Methods

PATIENTS

Ninety three consecutive patients (61 in-patients and 32 outpatients; 59 men, 34 women; mean age 59.8 (SD 16), range 18-80) admitted to the rehabilitation clinic over an 18 month period, were screened to evaluate the presence of aspiration. Inclusion criteria were as follows:

(1) presence of a neurological disorder with a documented risk of swallowing dysfunctions5−11;
(2) informed consent to the investigation; (3) ability to cooperate. Unconscious and de-
mented subjects, as well as bedridden patients, were excluded.

The case mix was represented by 28 acute or subacute stroke (cerebrovascular accident)
(five total anterior circulation infarct, 10 partial anterior circulation infarct, four posterior
circulation infarct, nine lacunar infarct, as classified according to Bamford et al2), seven
recent traumatic brain injury, seven multiple sclerosis (expanded disability status scale rang-
ing between 2.0 and 6.0, median: 3.5), 27 Par-
kinson’s disease (Hoehn and Yahr stage ranging from 2.0 to 4.0, median: 3.0), six
amyotrophic lateral sclerosis, five myotonic dystrophy, 13 abiotrophic diseases (four Alzhe-
imer’s disease, two multisystemic atrophy, two olivopontocerebellar atrophy, three Friedrich dis-
eases).

Patients with cerebrovascular accident and traumatic brain injury were examined at least
one month after the clinical state had stabilised.

Twenty patients (21%) were free from
symptoms of swallowing impairment. Among
the others, 17 (18%) complained of dysphagia
for liquids, 30 (32%) of dysphagia for solids,
and 26 of both.

PROCEDURE
The investigation protocol was approved by the
local ethics committee.

Patients underwent a detailed clinical examina-
tion based on collection of symptoms and
evaluation of the oropharyngeal swallowing
mechanism.

A 25 item form, drawn up on the basis of
both personal experience and previous re-
ports,16 23–25 checked for:
(1) past or present dysphagia for either
liquids or solids; (2) “knot in throat” sensation;
(3) odynophagia; (4) nasal regurgitation; (5)
daily episodes of cough on swallowing during
the past week; (6) dysphonia; (7) dysarthria;
(8) need for either feeding orthosis or nasoga-
stric tube; (9) history of coma or pneumo-
nia;(10) tracheostomy. The checklist also
included in the 25 item checklist was also
value associated with each clinical item in-
cluded in the 25 item checklist was also

The radiological examination was to assess
the four phases of bolus deglutition: (1) oral
containment; (2) horizontal progression (the
transport from the oral cavity to the pharynx);
(3) pharyngeal containment (containment,
morphological and volumetrical adaptation of
the pharynx, closure of the nasal, oral, and
laryngeal cavities); (4) vertical progression
(transport of bolus from the pharynx to the
esophagus) (table 1). Aspiration was accurately
assessed checking for the entry of bolus below
the vocal folds. With respect to the volume of
the aspirated bolus (<10%, 10%-30%, or
>30% of the total) aspiration was classified as
mild, moderate, or severe respectively.

DATA ANALYSIS
Sensitivity, specificity, positive predictive, and
negative predictive values of: (1) the patient’s
complaint of dysphagia(2); a history of cough
on swallowing, and (3) positivity of the 3 oz test
versus radiologically documented aspiration
taken as the gold standard, were measured in
all the patients and in subgroups with different
neurological disorders. The positive predictive
value associated with each clinical item in-
cluded in the 25 item checklist was also
assessed.

Factor analysis was employed to measure the
covariance of indices used to build the
checklist. To compute the costs of both clinical
and radiological approaches the time spent on
performing the investigations and the materials
employed were considered.

Results
Table 2 shows the prevalence of symptoms and
signs checked for during the clinical examina-
tion and of 3 oz test positive findings.

Videofluoroscopy documented the occur-
rence of aspiration in 43 (46%) patients; it was
mild in 25, moderate in seven, and severe in 11.
Among the remaining patients, 45 showed an
impairment in at least one swallowing mech-
anism.

Table 2 shows the positive predictive values
associated with each clinical item with respect
to radiologically documented aspiration.

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Variables considered by videofluoroscopy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Swallowing phase</td>
<td>Radiological issues</td>
</tr>
<tr>
<td>Oral containment</td>
<td>Anterior leakage</td>
</tr>
<tr>
<td>Horizontal progression</td>
<td>Deficit of horizontal transport</td>
</tr>
<tr>
<td>Vertical progression</td>
<td>Valleycular stasis</td>
</tr>
<tr>
<td>Horizontal progression</td>
<td>Deficit of lingual piston</td>
</tr>
<tr>
<td>Vertical progression</td>
<td>Deficit of UES opening</td>
</tr>
<tr>
<td>Vertical progression</td>
<td>Deficit of closure of nasal cavity</td>
</tr>
<tr>
<td>Vertical progression</td>
<td>Deficit of pharyngeal peristalsis</td>
</tr>
<tr>
<td>Vertical progression</td>
<td>Deficit of pharyngeal movement</td>
</tr>
<tr>
<td>Vertical progression</td>
<td>Deficit of laryngeal closure</td>
</tr>
<tr>
<td>Vertical progression</td>
<td>Deficit of epiglottis movements</td>
</tr>
</tbody>
</table>

Penetration
Aspiration severity
Mild <10%
Moderate <30%
Severe >30%
Table 2 Prevalence and positive predictive value (PPV) of positive findings on the 25 item clinical assessment and of 3 oz test, used to check for aspiration risk in neurological patients

<table>
<thead>
<tr>
<th>Index</th>
<th>Prevalence (%)</th>
<th>PPV (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>History collection:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dysphagia</td>
<td>78</td>
<td>52</td>
</tr>
<tr>
<td>Dysarthria</td>
<td>44</td>
<td>58</td>
</tr>
<tr>
<td>Dysphonia</td>
<td>57</td>
<td>60</td>
</tr>
<tr>
<td>Knot/lump in throat</td>
<td>32</td>
<td>47</td>
</tr>
<tr>
<td>Nasal regurgitation</td>
<td>26</td>
<td>75</td>
</tr>
<tr>
<td>Cough during swallowing</td>
<td>48</td>
<td>71</td>
</tr>
<tr>
<td>Odynophagia</td>
<td>6</td>
<td>33</td>
</tr>
<tr>
<td>Coma</td>
<td>10</td>
<td>67</td>
</tr>
<tr>
<td>Nasogastric tube</td>
<td>12</td>
<td>54</td>
</tr>
<tr>
<td>Tracheostomy</td>
<td>4</td>
<td>75</td>
</tr>
<tr>
<td>Pneumonia</td>
<td>18</td>
<td>82</td>
</tr>
<tr>
<td>Clinical evaluation:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oral phase</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corner deviation</td>
<td>30</td>
<td>68</td>
</tr>
<tr>
<td>Anterior leakage</td>
<td>29</td>
<td>71</td>
</tr>
<tr>
<td>Protrusion deficit</td>
<td>42</td>
<td>54</td>
</tr>
<tr>
<td>Drooling</td>
<td>28</td>
<td>66</td>
</tr>
<tr>
<td>Tongue motility impairment</td>
<td>42</td>
<td>64</td>
</tr>
<tr>
<td>Bulus formation deficit</td>
<td>35</td>
<td>55</td>
</tr>
<tr>
<td>Oral clearance impairment</td>
<td>41</td>
<td>63</td>
</tr>
<tr>
<td>Mandible movement deficit</td>
<td>19</td>
<td>61</td>
</tr>
<tr>
<td>Massester muscle strength deficit</td>
<td>31</td>
<td>66</td>
</tr>
<tr>
<td>Oral sensitivity deficit</td>
<td>17</td>
<td>57</td>
</tr>
<tr>
<td>Pharyngeal phase</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Swallow reflex impairment</td>
<td>60</td>
<td>54</td>
</tr>
<tr>
<td>Soft palate motility deficit</td>
<td>38</td>
<td>63</td>
</tr>
<tr>
<td>Hyoid-laryngeal motility</td>
<td>40</td>
<td>60</td>
</tr>
<tr>
<td>Pharyngeal reflex impairment</td>
<td>26</td>
<td>57</td>
</tr>
<tr>
<td>3 oz test positivity</td>
<td>34</td>
<td>76</td>
</tr>
</tbody>
</table>

Symptoms of dysphagia showed a very poor predictive value. Silent aspiration occurred in four of 20 (20%) patients who did not complain of any swallowing difficulty and in 49% of dysphagic patients. Among the indices in which the positive predictive value was higher than 70%, history of pneumonia, tracheostomy, evidence of anterior leakage, and nasal regurgitation showed a low occurrence rate (less than 30%).

The symptom cough on swallowing proved to be the most reliable in predicting the risk of aspiration, showing high sensitivity, specificity, positive predictive value, and negative predictive value (table 3). The standardised 3 oz test had a higher predictive potential than the clinical signs, but had a low sensitivity. In particular, subjects with silent aspiration gave negative findings in the 3 oz test. For the whole population, the association of cough on swallowing with the 3 oz test gave a positive predictive value of 84%, and a negative predictive value of 78%.

The analysis of subgroups showed how the correlation between symptoms of dysphagia, 3 oz test positivity, and aspiration differed according to the underlying neurological disease (figure), the positive predictive value of the 3 oz test ranging from 50% in patients with traumatic brain injury to 78% in patients with a cerebrovascular accident. Silent aspiration occurred more often in patients with Parkinson's disease than in other cases.

The analysis of patients with negativity of clinical criteria produced the following “identikit”:

(1) complaint of dysphagia in 30% of patients; (2) higher prevalence of Parkinson's disease (48%) than other neurological diseases; (3) low occurrence of pneumonia, tracheostomy, coma, or feeding through nasogastric tube in the medical history (about 2%); (4) impairment in one or more mechanisms of either oral or pharyngeal swallowing phases in 8% to 25% of patients, without any definite pattern; (5) low frequency of positive findings on videofluoroscopy; aspiration occurred in 21% patients, mostly (18%) of a mild type and always associated with evidence of alteration in gag reflex, penetration, and vallecular stasis.

Factor analysis applied to the 25 item check list allowed the detection of seven domains, each depending on one or more clinical indices: (1) dysarthria, dysphonia, and knot or lump in the throat (2); history of coma, nasotracheal tube application, tracheostomy (3); odynophagia (4); lip corner deviation (5); dyskinesia; (6) impairment of mandible movement (7); the association of complaints of dysphagia, nasal regurgitation, and cough on swallowing, history of pneumonia, and evidence of impairment in the oral and pharyngeal phases as detected by the checklist (anterior leakage, protrusion deficit, drooling, tongue motility deficit, bulus formation and clearance deficit, masseter strength deficit, oral sensitivity deficit, swallow and pharyngeal reflex impairment, and soft palate and hyoid-larynx motility deficit).

For the cost/benefit ratio evaluation, the bedside clinical assessment did not employ any expensive equipment and took 20 minutes on average to complete compared with the 55 minutes required by videofluoroscopy including a global radiation exposure time of up to 5.8 minutes (average 3.6 (SD 0.87) min). Both investigations were well tolerated by patients.

Discussion
The role of clinical tests in evaluating swallowing dysfunction and checking aspiration has often been discussed. Logeman et al took the amount of oral intake and the time of feeding as relevant clinical indicators of dysphagia. DePippo et al formulated the Burke dysphagia screening test, associating the 3 oz test with other clinical signs, and administered it to 139 inpatients with stroke, concluding that the test is worthwhile in identifying patients at risk of pneumonia or airway obstruction and death. By contrast, Garon et al found the opposite in 100 patients affected by different diseases and argued that the 3 oz test, which uses the cough reflex as the sole indicator of aspiration, is not a replacement for the precision and accuracy of videofluoroscopic evaluation

In agreement with Fleming et al and Garon et al, the checklist employed in this study included both history and clinical indices,
selected on the basis of knowledge of the anatomical structures and functional mechanisms involved in swallowing. Factor analysis allowed us to assess how some indices seem poorly related to impairment in swallowing mechanisms. In particular, items such as dysphonia, dysarthria, oral dyskinesiae, mandible movement deficit, and lip corner deviation, may indicate the presence of brainstem lesions, often responsible for, but not necessarily associated with swallowing impairment. Both sensation of a knot or lump in the throat and odynophagia may occur in neurotic syndromes and be detected in neurological patients with depressive reactions, hence being dissociated from the detection of an aspiration risk. History of coma, tracheostomy, and use of a nasogastric tube were highly correlated with each other, leading to the identification of a subgroup of patients who had severe brain lesions. Although such a condition is associated with a high risk of aspiration, the inclusion of the aforementioned indices in a screening assessment is not advisable, owing to their poor sensitivity.

The choice of videofluoroscopic examination as a gold standard for the detection of aspiration was made in accordance with previous investigations; the pattern of swallowing mechanisms was assessed using a procedure already described by other authors.

Patients included in this research were selected on the basis of the risk of aspiration associated with the neurological disease. The occurrence of aspiration in our patients is similar to that described in the literature for patients with cerebrovascular accident, traumatic brain injury and multiple sclerosis. No definite data are available on the incidence of swallowing alterations in Parkinson’s disease (rates ranging between 0% to 100% are reported), amyotrophic lateral sclerosis, myotonic dystrophy, and abiotrophic diseases. The few cases examined in this study does not allow us to draw any conclusions about the disease specific incidence rates or the higher prevalence of silent aspiration in Parkinson’s disease than in other neurological groups.

The evaluation of the predictive value of the clinical examination showed that the complaint of dysphagia by the patients should be considered a non-specific feature, whatever the underlying neurological disease. Despite a prevalence of symptoms ranging from 56% to 100%, true aspiration has been documented in less than one half of dysphagic patients. Although apparently low, such a percentage is still higher than those reported by Johnson et al and Perlman et al who found a prevalence of aspiration of 30% and 39% respectively, in different categories of dysphagic patients undergoing videofluoroscopy. The dissociation between severity of symptoms and swallowing alterations may partially reflect the influence of either neurological deficits (for example, post-stroke facial paresis may cause oral stage dysphagia without affecting the pharyngeal stage of swallowing) or psychic problems (anxious patients may complain of swallowing alterations in the absence of any detectable deficit).

Among all the clinical signs considered, only a history of cough on swallowing proved to be really accurate in predicting aspiration, both in the total population and in subgroups with different diseases. Other conditions such as recurrent pneumonia, or previous tracheostomy, although being highly correlated with the risk of aspiration, have no clinical usefulness, owing to their low occurrence rate, as they only affect patients in severe conditions.

The 3 oz test was confirmed as a valuable tool in the evaluation of dysphagic patients, with a positive predictive value of 76% versus risk of aspiration. These findings almost overlap those described by DePippo et al in patients with stroke, by Garon et al in multiple neurological pathology groups, and by Splaingard et al in patients with stroke or brain injury.

The association of history collection with objective assessment (cough plus 3 oz test) gives an increase in both positive and negative predictive values. A similar conclusion was provided by DePippo et al who analysed the predictive significance of items included in the
Burke dysphagia screening test and found that, in patients with stroke, "coughing associated with feeding or during a 3 oz water swallow test could identify 92% of patients developing pneumonia or recurrent upper airway obstruction.

However, the diagnostic accuracy of the clinical evaluation depends on the preservation of the cough reflex and pharynx sensitivity; all pathological conditions which cause either an impairment in pharynx innervation or silent aspiration are unlikely to be detected by the bedside assessment and need radiological screening.

In our experience, the failure of the clinical evaluation prevented prediction of the aspiration risk in a very low percentage of patients, in whom, moreover, aspiration was always mild (<10% bolus) and never associated with a history of lung infections. According to a recent prospective study, only aspiration of more than 10% on barium test swallows during videoproctivestudy, only aspiration of more than theory of lung infections. According to a recent whom, moreover, aspiration was always mild risk in a very low percentage of patients, in

screening.

impairment in pharynx innervation or silent pathological conditions which cause either an pneumonia or recurrent upper airway obstruction.

could identify 92% of patients developing aspiration and needed radiological

In conclusion, the association of the 3 oz test with the clinical index cough on swallowing provides a useful screening tool, the cost:bene

te of which seems very competitive with videofluoroscopy in evaluation of risk of aspiration.

Although videofluoroscopy keeps its diagnostic importance in evaluating disability after different failures of the swallowing mechanism, to plan an appropriate treatment, the use of a detailed bedside examination, based on a multiple item checklist, is advisable for tailoring the rehabilitation approach to each patient’s needs in patients in whom radiological examination is not available.

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