Aspiration in Patients With Acute Stroke

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ABSTRACT. Daniels SK, Brailey K, Priestly DH, Herrington LR, Weisberg LA, Foundas AL. Aspiration in patients with acute stroke. Arch Phys Med Rehabil 1998;79:14-9.

Objectives: To determine the frequency and clinical predictors of aspiration within 5 days of acute stroke.

Design: Case series.

Setting: Tertiary care center.

Patients: Consecutive stroke patients (n = 55) with new neurologic deficit evaluated within 5 days of acute stroke.

Main Outcome Measures: Comparison of features identified on clinical swallowing and oromotor examinations and occurrence of aspiration (silent or overt) evident on videofluoroscopic swallow study (VSS).

Results: Aspiration occurred in 21 of 55 patients (38%). Whereas 7 of 21 patients (33%) aspirated overtly, 14 (67%) aspirated silently on VSS. Chi-square analyses revealed that dysphonia, dysarthria, abnormal gag reflex, abnormal volitional cough, cough after swallow, and voice change after swallow were significantly related to aspiration and were predictors of the subset of patients with silent aspiration. Logistic regression revealed that abnormal volitional cough and cough with swallow, in conjunction, predicted aspiration with 78% accuracy.

Conclusions: Silent aspiration appears to be a significant problem in acute stroke patients because silent aspiration occurred in two thirds of the patients who aspirated. The prediction of patients at risk for aspiration was significantly improved by the presence of concurrent findings of abnormal volitional cough and cough with swallow on clinical examination.

ASPIRATION, the subglottic penetration of liquid or food, is a frequent sequela of dysphagia and stroke. As identified by videofluoroscopic swallow study (VSS), aspiration occurs in 40% to 70% of stroke patients.[1,2] Silent aspiration, defined as the subglottic penetration of a bolus without elicitation of a cough reflex, occurs in approximately 40% of dysphagic patients who aspirate.[3,4] Dysphagic patients who aspirate are at increased risk of developing aspiration pneumonia. Specifically, the development of pneumonia is seven times greater in stroke patients who aspirate versus those who do not, and six times greater in patients who aspirate silently as compared with those who cough upon aspiration.[5,6] Johnson and colleagues[7] found that approximately 50% of stroke patients with dysphagia severe enough to warrant videofluoroscopic evaluation developed aspiration pneumonia. In addition, aspiration pneumonia, which is commonly associated with dysphagia, is the fourth most frequent cause of death in the elderly.[8] Given these data, it is imperative that acute stroke patients at risk for developing aspiration pneumonia be identified early in their clinical course to prevent increased morbidity and mortality. Furthermore, it is important to identify whether specific clinical features accurately predict aspiration.

Chronic stroke patients with persistent dysphagia and risk of developing aspiration have been studied using clinical and videofluoroscopic examinations. In a study of stroke patients 1 to 24 months after stroke, Horner and colleagues,[9] using VSS, found that aspiration occurred in half of their patients. Aspiration occurred more often in patients with bilateral cranial nerve signs (71%) as compared with patients with unilateral cortical signs (29%). Dysphonia was the most common clinical feature in patients with aspiration. In a subsequent study, Horner and Massey[1] studied stroke patients within 28 months of the acute stroke and found that 11 of 21 (52%) patients aspirated during VSS. Furthermore, 8 of these 11 patients were silent aspirators. On clinical examination, complaints of dysphagia, weak cough, and dysphonia distinguished the aspirating patients from nonaspirating patients. In addition, Horner's group[10,11] retrospectively studied patients with bilateral strokes and found that the coexistence of abnormal gag and voluntary cough were more highly predictive of aspiration than either of these clinical findings in isolation. Linden and Siebens[2] clinically and fluoroscopically examined 15 patients with unspecified central nervous system damage 1 to 46 months after onset. Either decreased gag reflex or a wet, hoarse vocal quality were evident in 90% of the patients who aspirated, and both occurred in 9 of the 11 aspirating patients. Furthermore, aspiration did not elicit a cough reflex in 82% of the patients. Linden and colleagues[12] studied 249 patients primarily with neurologic etiologies such as stroke, although time from onset to evaluation was not indicated. Nine clinical indicators were significantly associated with aspiration as identified by videofluoroscopy including: recumbent posture, dysphonia, wet phonation, decreased/absent laryngeal excursion, wet spontaneous cough, decreased ability to swallow secretions, decreased palatal gag, harsh phonation, and breathy phonation. Additional studies have used water swallow tests, measuring time and/or clinical indicators as predictors of dysphagia and aspiration, but as with studies by Horner and Linden, these investigations were not limited to acute stroke patients.[13-16]

Other investigators have studied dysphagia in acute stroke patients. Gordon and colleagues[17] identified dysphagia in 41 of 91 (45%) consecutive patients, half of whom were evaluated within 48 hours after onset. Elicitation of a cough during a water swallow test was used to identify and determine duration of dysphagia in this study. Using a water swallow test, Barer[18] also studied 357 stroke patients within 48 hours of onset and found that 30% of the patients had dysphagia acutely, but only 6% had persistent dysphagia 1 month after stroke. Odderson and coworkers[19] evaluated stroke patients within 1 day of admission and found that 39% failed the initial swallowing screen, and 19% required enteral nutrition before discharge from acute care. Although these three studies[17-19] evaluated acute stroke patients, videofluoroscopy was not used to confirm the occurrence of dysphagia and aspiration. In contrast, Kidd's group[20]

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used videofluoroscopy to evaluate 60 patients admitted with a presumed stroke, although only 50% had stroke confirmed by computed tomography (CT). Aspiration occurred in 42% of these patients, and clinical assessment within 3 days of admission revealed that decreased pharyngeal sensation, dysphagia on a water swallow test, and stroke severity significantly increased the risk of aspiration. Smithard and colleagues[21] studied the association between dysphagia and outcome and complications by using videofluoroscopy and clinical evaluations in acute stroke patients. Fifty percent of their patients were identified with an unsafe swallow on clinical examination, and 21% aspirated on VSS. VSS results, however, were not reported for 27 patients, which may have underestimated the incidence of aspiration. Patients diagnosed with an unsafe swallow on the clinical evaluation had a greater incidence of chest infection and increased mortality when compared with patients with aspiration during the VSS.

There is a consensus that swallowing difficulties are common in stroke patients, and it is well established that dysphagia puts these patients at increased risk of aspiration and developing aspiration pneumonia. Specifics regarding the incidence of dysphagia and aspiration have been more difficult to study in acute stroke patients, and more data are available on chronic stroke patients than on acute stroke patients. The prevalence of aspiration, particularly silent aspiration, in acute stroke patients has not been fully elucidated. Furthermore, clinical disorders of the oropharyngeal mechanism that may predict aspiration in acute stroke patients have not been previously investigated a priori. Therefore, the goals of this study were (1) to determine the incidence of dysphagia and aspiration in acute stroke patients, (2) to confirm aspiration by VSS and to record the occurrence of silent aspiration during VSS in acute stroke patients, (3) to determine whether specific clinical features of the oropharyngeal mechanism predict aspiration, and (4) to determine the clinical outcome from dysphagia by following patients throughout their hospitalization. We conducted a prospective study of consecutive stroke patients and performed a clinical evaluation and VSS within 5 days of hospitalization to answer these questions that relate to aspiration in acute stroke patients.

METHODS

Subjects

Fifty-five patients consecutively admitted to the Veterans Affairs (VA) Medical Center in New Orleans (LA) with a new neurologic deficit were recruited to participate in the study, which was approved by the Institutional Review Board at Tulane University School of Medicine and at the VA Medical Center. Mean patient age was 66 years (SD, 11; range, 41 to 93 yrs), and all patients were men. Stroke was confirmed by documentation of acute infarct by either CT or magnetic resonance imaging (MRI) in the patients studied. Fourteen patients presented with unilateral right hemispheric damage, 24 presented with unilateral left hemispheric damage, 13 presented with bilateral hemispheric damage, and 4 presented with brain stem infarcts. A complete mental status examination was not performed on all patients. Obtunded and agitated patients, however, were excluded from further study using VSS because these patients are at increased risk of complications related to the procedure. Obtunded mental status was operationally defined as brief arousal with vigorous verbal or tactile stimulation required to elicit a response, and agitation was defined as aggressive, uncooperative behavior. In addition, patients with a history of oropharyngeal dysphagia, oropharyngeal structural damage, or neurologic disease other than stroke that may produce dysphagia were excluded from the study. Using these exclusion criteria, only two patients were excluded from further study.

Procedures

All patients underwent evaluation of the oropharyngeal mechanism, clinical swallowing assessment, and VSS within 5 days of admission. Neuroimaging studies were obtained upon patient admission. CT or MRI was repeated within 2 weeks on patients with initial negative scan results.

Oromotor Examination

Assessment of oral musculature symmetry, strength, agility, and sensation was completed (appendix). Features of the oromotor examination included measurements of isolated movements as well as continual speech and nonspeech movements of the mandible, lips, tongue, velum, and larynx. Light touch of the face was examined, as well as production of a volitional cough and elicitation of a gag reflex. Identification of dysphonic voice quality was made and classified as wet hoarseness, strained, breathy, or nonspecific hoarseness. Assessment for dysarthria included evaluation of articulatory precision and agility, fluency, resonance, and intelligibility.

Clinical Swallowing Examination

The bedside swallowing assessment consisted of administering liquid, semisolid, and solid consistencies at varying calibrated volumes and assessing oral transition, oral retention, initiation of laryngeal elevation, laryngeal excursion, voice quality after swallow, and spontaneous cough. Assessments were initiated with a 5-mL liquid bolus and progressed to 10- and 20-mL volumes. All volumes were administered twice, for a total of 70mL. The evaluation for liquids was terminated if the patient coughed or demonstrated alterations in vocal quality immediately following or within 1 minute after swallowing. Semisolid and solid volumes were initiated at half-teaspoon volumes (2.5mL) and progressed to continuous ingestion. Administration of a consistency was terminated if a patient demonstrated either a cough or changes in voice quality after the swallow.

Fluoroscopic Examination

The VSS was performed by speech pathology in conjunction with radiology. VSS samples were recorded using a Super-VHS videocassette recorder, which was coupled to a counter timer that encoded digital time in hundredths of a second on each video frame. A video recording of the oral cavity (anterior to the lips) and the pharynx (inferior to the upper esophageal sphincter) was obtained in the lateral plane as the patient swallowed in duplicate liquid barium (81%wt/vol) at volumes of 3, 5, 10, and 20mL, and half-teaspoon barium paste (100%wt/vol). The examination was initiated with the 3-mL volume and advanced accordingly unless the patient exhibited significant aspiration that could not be eliminated with therapeutic intervention. In these cases the study was discontinued. Video recordings were analyzed using the slow motion and frame-by-frame capabilities of the recorder. Aspiration was identified as entry of barium inferior to the level of the true vocal folds. Aspiration was documented as overt or silent. Overt aspiration was defined as no elicitation of a cough reflex upon subglottic penetration, whereas silent aspiration was defined as no elicitation of a cough reflex following subglottic penetration.

In addition to aspiration, seven features of oropharyngeal dysmotility were evaluated. In the oral stage these features were: (1) anterior bolus loss, identified as spillage from the lips; (2) delayed initiation of movement, identified as inability to begin

oral transfer upon command to swallow; and (3) uncoordinated initiation of oral transfer, defined as groping and effortful labial, lingual, and mandibular movements. The pharyngeal stage dysmotility patterns evaluated were: delayed pharyngeal swallow, reduced laryngeal excursion, penetration into the laryngeal vestibule, and stasis. Delayed pharyngeal swallow was measured from the time the bolus head reached the point where the ramus of the mandible bisects the base of the tongue until the onset of laryngeal excursion.[22] The delay was rated as mild (.45- to 2-second delay), moderate (3- to 5-second delay), or severe (6-second or longer delay). Delays of less than .45second were considered within normal limits and were consistent with Tracy and colleagues,[23] who identified average delay time as .24sec for normal controls younger than age 60 and .36sec for those older than age 60. Vallecular and hypopharyngeal locations of the bolus before elicitation of the pharyngeal swallow were identified as pooling. Decreased laryngeal elevation was identified as reduced anteriosuperior hylolaryngeal excursion, which was not quantified temporally. Supraglottic penetration was identified as entry of barium into the laryngeal vestibule superior to the true vocal folds. Stasis was identified as pharyngeal residue after the swallow. The specific location of stasis (valleculae, pyriform sinus, or both areas) was noted and rated on a scale of 1 (coating) to 3 (complete filling of space).

Dysphagia was rated on a scale of 0 (normal) to 4 (severe). Mild dysphagia (score 1) was classified by evidence of decreased oral stage transition, inconsistent mild delay in the pharyngeal swallow (.45 to 2sec), inconsistent mild-moderate stasis, or intermittent evidence of trace penetration into the laryngeal vestibule with immediate clearing. Moderate dysphagia (score 2) was classified by mild to moderate delay in the pharyngeal swallow (.45 to 5sec), decreased laryngeal elevation, or moderate stasis resulting in laryngeal penetration with stasis and/or 2 or fewer instances of aspiration of a single consistency. Moderate-severe dysphagia (score 3) was classified by a moderate to severe delay in the pharyngeal swallow (3 to 5sec or greater) or moderate to severe pharyngeal stasis resulting in consistent aspiration of a single viscosity. Severe dysphagia (score 4) was identified by a severe delay in the pharyngeal swallow (longer than 5sec) or moderate to severe stasis with build-up on consecutive swallows resulting in aspiration of more than 1 consistency. Severity was determined before therapeutic intervention was initiated. Videofluoroscopic studies were reviewed without prior knowledge of the results of the clinical examinations.

All dysphagic patients in our study were treated with appropriate clinical measures (ie, swallowing therapy, compensatory strategies, diet alteration, nonoral intake). Follow-up VSS was not routinely performed and was completed on an individual basis as warranted. Patients' medical charts were reviewed at monthly intervals for 3 months to determine incidence of aspiration pneumonia and nutritional status following stroke onset.

Data Analyses

In this study, dysphagia and aspiration (silent or overt) identified on the VSS were the dependent variables, and characteristics of the clinical examinations were the independent variables. The data were analyzed comparing the results of the clinical evaluations with the results of the VSS. Chi-square analyses were performed to determine related clinical characteristics. Logistic regression was performed to identify significant combinations of predictor variables. The sensitivity and specificity of observance of a clinical feature as an indicator of aspiration were determined. Sensitivity and specificity are two standard measures of the accuracy of a diagnostic system. Sensitivity is the probability that a diagnostic sign will be positive given that a disease (in this case, aspiration) is truly present. Specificity is the probability that a diagnostic sign will not be positive given that a disease is truly not present.

To assess interrater reliability of dysphagia and aspiration identification, one third of the examinations were randomly selected for remeasurement. The second rater was a certified speech pathologist with experience reading VSS. To measure intrarater reliability, the speech pathologist responsible for making original measures completed blinded remeasurement of one third of the examinations. Interrater reliability for all dysphagia observations was 95%, and intrarater reliability was 98%. Interrater and intrarater agreements for overt and silent aspiration were 100%.

RESULTS

Dysphagia occurred in 36 of the 55 (65%) patients. Thirteen of the 36 (36%) had moderate-severe to severe dysphagia, 10 (28%) had moderate dysphagia, and 13 (36%) had mild dysphagia. Aspiration, identified by VSS, occurred in 21 of the 55 (38%) acute stroke patients. Whereas 7 of 21 (33%) patients aspirated overtly, 14 (67%) aspirated silently. Analyses revealed the following clinical indicators to be significantly related to aspiration ($p < .05$), as well as the subset of silent aspiration: dysphonia, dysarthria, abnormal gag reflex, abnormal volitional cough, cough after swallow, and vocal changes after swallow. Refer to table 1 for χ^2, sensitivity, and specificity data. Stepwise logistic regression produced a significant model involving two predictor variables ($\chi^2[2] = 21.89$, $p < .0001$): abnormal volitional cough ($p = .0035$) and cough with swallow ($p = .0055$). In conjunction, these variables predicted aspiration with 78% accuracy. Sensitivity (69.6%) and specificity (84.4%) were, in combination, superior to that obtained by any single predictor variable. All of the patients with aspiration presented with at least one of the clinical features of aspiration. Most (19 of 21, 90%) presented with 2 or more of the features on clinical oromotor and swallowing examinations. Bedside swallow testing, without the clinical features identified on oromotor examination, failed to identify 24% of the aspirating patients. Sixteen of the 21 aspirating patients coughed during the water swallow test, and only 1 coughed with ingestion of a more viscous bolus. Seven of the patients who coughed during the clinical swallowing examination aspirated silently during VSS. Post hoc follow-up review of patients records revealed that 1 of the 55 (1.8%) acute stroke patients developed aspiration pneumonia during the course of hospitalization. This patient presented with Broca's aphasia in addition to all of the clinical features of aspiration except abnormal volitional cough. Additional post hoc review revealed that of the 50 surviving patients, 94% returned to oral intake. Resolution of dysphagia was identified in 10 of 12 (83%) patients with silent aspiration and 5 of 6 (83%) patients with overt aspiration. Average time for resolution of dysphagia with return to a regular diet was 3 weeks with a range of 1 week to 2.5 months. The average length of hospitalization for this patient series was 20.62 days.

DISCUSSION

Our data show that acute stroke patients are at high risk for developing dysphagia and aspiration. Specifically, about two thirds (65%) of the acute stroke patients studied in the current investigation had videofluoroscopic evidence of dysphagia within 5 days of stroke onset. Furthermore, swallowing deficits were severe, such that more than half (21 of 36, 58%) of the patients with dysphagia aspirated with silent aspiration occurring in two thirds of the patients with videofluoroscopic evidence of dysphagia and aspiration. Our findings generally

Table 1: Analysis of Clinical Predictors of Aspiration

Variable	% Correct Classification	Sensitivity	Specificity	$\chi^2(1)$	p
Dysphonia	70.9	76.2	67.6	9.98	.0016
Dysarthria	61.8	76.2	52.9	4.53	.0333
Abnormal gag	74.5	61.9	82.4	11.25	.0008
Abnormal volitional cough	76.4	47.6	94.1	13.26	.0003
Cough with swallow	74.5	57.1	85.3	10.95	.0009
Voice change with swallow	67.3	38.1	85.3	3.93	.0473

support studies that have demonstrated a 30% to 50% incidence of dysphagia in stroke patients.[18-22] Using water swallow testing, Gordon and colleagues[17] found a 45% incidence of dysphagia in stroke patients, while Barer[18] found a 30% incidence of dysphagia, and Smithard et al[21] identified a 50% incidence. Using VSS, Kidd and coworkers[20] reported that 42% of their acute stroke patients aspirated, whereas Smithard[21] identified a 21% incidence. Unlike some of these other studies, we used VSS, which is more sensitive than water swallow tests in evaluating silent aspiration, and studied consecutive acute stroke patients, which may account for the increased incidence of dysphagia and aspiration in our sample. Our data extend previous studies that have demonstrated that dysphagia occurs commonly in stroke patients and suggests that aspiration, particularly silent aspiration, occurs more commonly than previously thought in acute stroke patients.

Our data also show that clinical tests performed at the bedside yield accurate measures of oropharyngeal functioning, and that impaired performance on specific clinical tests is a reliable predictor of patients at risk for aspiration. Specifically, the six clinical features of dysphonia, dysarthria, abnormal gag reflex, abnormal volitional cough, cough after swallow, and voice changes after swallow were all commonly associated with aspiration. Independently, these clinical features were predictive of aspiration, but the coexistence of abnormal volitional cough and cough with swallow predicted aspiration with 78% accuracy. Whereas all of the patients with aspiration presented with at least 1 of the 6 clinical oropharyngeal features, 90% of the patients presented with 2 or more features. These findings suggest that the presence of two or more clinical features of the oropharyngeal mechanism accurately predict the presence of aspiration in acute stroke patients, although this observation requires further study. Dysphonia, dysarthria, abnormal gag reflex, abnormal volitional cough, cough on the bedside examination, and vocal changes after swallowing have previously been associated with aspiration but only in groups of chronic stroke patients[1,2,10-13,16,17] or in acute unilateral stroke patients.[21] In the current investigation, these findings were expanded to include consecutive acute stroke patients with unilateral and multiple lesions, and VSS was performed on all patients. Our findings show that the presence of specific clinical oropharyngeal deficits on bedside examination accurately predicts patients at risk for the development of aspiration in the acute phase. In addition, the incorporation of water swallow testing may enhance the utility of these clinical predictors, but bedside swallow testing without the clinical features identified on oromotor examination is not as useful in identifying patients at risk for the development of aspiration. In our sample, all but one of the patients who coughed with clinical swallowing examination and aspirated on VSS were identified with ingestion of water versus semisolid and solid consistencies. In our water swallow test, swallowing assessments were initiated with a 5-mL bolus and progressed to 10- and 20-mL volumes. Testing was discontinued if the patient coughed or demonstrated alterations in vocal quality immediately following or within 1 minute after swallowing. Previous investigations have evaluated clinical swallowing with either extremely small volumes[21] or volumes ranging from 50 to 150mL.[14-18] Furthermore, these studies have not adjusted volume ingestion according to patient performance. Volumes of 5mL may be too small to identify dysfunction; however, volumes of 50mL or greater, with patients controlling the amount ingested, may risk aspiration of a large, uncontrolled amount of liquid and result in ensuing complications. Amounts of water administered during the examination should be calibrated and graded to prevent pulmonary complications, and the use of progressively larger volumes may enhance the utility of bedside water swallow testing. By testing the oropharyngeal mechanism as well as clinical swallowing, patients with aspiration, silent and overt, can be more accurately identified.

Our findings also have significant implications for the management of acute stroke patients. Although silent aspiration has previously been associated with stroke,[1-4] it has not been fully evaluated in acute stroke patients. Our data suggest that many stroke patients are at great risk for aspiration within the first few days following the acute stroke. The ensuing complications of aspiration, such as pneumonia, contribute to increased morbidity and mortality in the stroke population[6,8,9,24]; therefore, a complete and accurate assessment, including clinical oromotor and swallowing examinations within the first days of admission, is crucial to identify stroke patients at risk for aspiration to expedite the proper management of these patients. Although dysphagia may resolve in many stroke patients, proper initial management is essential to prevent the early complications of aspiration. In our study only 1 of the 21 patients who aspirated on VSS developed aspiration pneumonia during the course of hospitalization. Implementation of therapeutic maneuvers and diet alterations based on VSS results probably lowered this number. Given that the patients in our sample were treated for dysphagia, it is not possible to make predictions of the sensitivity of the six clinical parameters in the prediction of aspiration pneumonia, nor is it possible to determine the number of patients who would have developed pneumonia without therapeutic intervention.

Given that the incidence of dysphagia in our sample of acute stroke patients is higher than the incidence of dysphagia reported in chronic stroke patients, it is important to determine whether dysphagia and aspiration are transient in the acute stroke patient and to determine if specific clinical features predict recovery or persistent dysphagia. Follow-up review of patient records revealed that of the 18 surviving patients with initial aspiration, 83% returned to oral intake within 3 months, with only 2 of these patients (11%) requiring diet modification. Neither duration of dysphagia nor the factors associated with persistent dysphagia were prospectively studied in this investigation. Previous studies in the acute stroke population found that dysphagia generally resolved within 7 to 14 days of the stroke.[18,19] In the studies that reported recovery of function, however, dysphagia and aspiration were documented only with clinical examination and the findings were not confirmed with radiographic or endoscopic evaluations. Several studies investigated dysphagia in the subacute stroke population,[25-29] but given that patients were assessed at variable times from stroke onset, it is not possible to accurately relate these data to dysphagia recovery.

Longitudinal investigations are warranted in the study of dysphagia following stroke to identify the duration and clinical features that may predict transient versus long-term deglutition disorders.

The clinical examination is not designated to replace the VSS, as actual oropharyngeal dysfunction and effects of therapy can only be hypothesized at bedside. Odderson and colleagues[19] noted that diet and dysphagia precautions were defined according to clinical results. In our study, however, the incidence of increased silent aspiration with ingestion of thicker liquid viscosities (ie, barium) versus water indicates that an arbitrarily prescribed diet (ie, thickened liquids) or therapy based on overt clinical features may be contraindicated. Unsafe swallow on clinical examination was found to be a better predictor of patient outcome versus aspiration on VSS,[21] yet therapy based on the results of the two types of evaluation were not discussed. Not only does VSS specify dysphagia and aspiration in terms of oral, laryngeal, and pharyngeal dysfunction, specific therapeutic and diet considerations can be determined based on the physiologic findings of the VSS.

CONCLUSIONS

In our population of acute stroke patients evaluated within 5 days of stroke onset, silent aspiration occurred in two thirds of the patients who aspirated using VSS. On clinical examination, features of dysphonia, dysarthria, abnormal gag reflex, abnormal volitional cough, cough after swallow, and voice change after swallow were significantly related to aspiration and were predictors of the subset of silent aspiration. The prediction of patients at risk for aspiration was significantly improved by concurrent findings of abnormal volitional cough and cough with swallow on clinical examination. In addition, the presence of two or more of these clinical features may accurately predict aspiration. These data suggest that a detailed and accurate clinical assessment is essential for the early identification of acute stroke patients at risk of aspiration to ensure proper management, to prevent ensuing complications, and to determine which patients may need VSS. Improving sensitivity and specificity in the clinical examination should facilitate consistency in referral for VSS and may reduce unnecessary radiographic procedures. The clinical examination is not designed to replace VSS, because actual oropharyngeal dysfunction and effects of therapy can only be hypothesized at the bedside. Although dysphagia may resolve spontaneously following stroke, these data show that the proper identification and management of dysphagia and aspiration during the acute phase reduces the complications of aspiration.

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APPENDIX: EXAMINATION OF THE ORAL MECHANISM

Mandible (CN V)
- Symmetry on extension_____ Strength_____
- Nonspeech coordination: isolated movement_____ Repetitive movement_____
- Speech coordination: isolated movement (/a/)_____ Repetitive (/a/)_____

Lips (CN VII)
- Symmetry: Rest_____Retraction_____Protrusion_____
- Strength_____
- Nonspeech coordination: Repetitive movement_____ Alternating movement_____
- Speech coordination: Repetitive movement (/p, w/)_____ Alternating movement (/p-w/)_____

Tongue (CN XII)
- Symmetry: Rest_____Protrusion_____Lateralization_____
- Elevation: Yes/No Lateralization: Yes/No Fasciculations: Yes/No
- Strength_____
- Nonspeech coordination: Repetitive movement_____ Alternating movement_____
- Speech coordination: Repetitive movement (/t, k/)_____ Alternating movement (/p-t-k/)_____
- Alternating movement (p-t-k/)_____
- Multisyllabic word repetition (tip top, baseball player, several, caterpillar, emphasize)_____
- Laryngeal function: Isolated movement (/i-i-i/ on one breath)_____
- Alternating movement (/u-i/)_____
- Buccofacial apraxia: "Blow out a candle"_____ "Lick an ice cream cone"_____
- "Lick milk off your top lip"_____ "Sip through a straw"_____ "Kiss a baby"_____

Velum (CN IX, X, XI)
- Symmetry: Rest_____Elevation_____
- Speech coordination: Repetitive movement (/a/)_____
- Appearance of hard palate_____
- Dentition_____

Reflexes (CN IX, X, XI)
- Gag reflex_____
- Swallow_____

Additional Information
- c/o Facial numbness or tingling: Yes/No Light touch_____
- Dysphonia: Yes/No (mild, moderate, severe)_____
- Dysarthria: Yes/No (mild, moderate, severe)_____
- Breath support_____
- Resonance_____
- Volitional cough: Yes/No_____