Aspiration and Relative Risk of Medical Complications Following Stroke

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Objective: To determine the relative risk of pneumonia, dehydration, and death associated with videofluoroscopic evidence of aspiration, silent aspiration, aspiration of 10% or greater on one or more barium test swallows, and aspiration of thick liquid or more solid consistencies in the subacute phase after stroke.

Design: Prospective, longitudinal cohort study.

Setting: Inpatient stroke rehabilitation unit.

Patients: There were 114 consecutive patients who met the following criteria: (1) stroke as defined by clinical history and neurological examination with compatible computed tomographic or magnetic resonance imaging scan; (2) age 20 to 90 years, inclusive; (3) no known history of significant oropharyngeal anomaly; and (4) videofluoroscopic evidence of dysphagia. Of 122 eligible patients, eight refused participation.

Main Outcome Measures: Development of pneumonia, dehydration, and death.

Results: The relative risk for developing pneumonia was 6.95 times greater (P=.027) for those patients who aspirated compared with those who did not, 5.57 times greater (P=.012) for those who aspirated silently compared with those who coughed when aspirating or who did not aspirate, and 8.36 times greater (P=.002) for those who aspirated 10% or greater on one or more barium test swallows compared with those who aspirated less than 10% or did not aspirate.

Conclusion: Aspiration, silent aspiration, and aspiration of 10% or greater on one or more barium test swallows during videofluoroscopic evaluation are associated with an increased risk of pneumonia, but not dehydration or death, during the subacute phase after stroke.

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DYSPHAGIA and aspiration following stroke have been well documented in the literature. In patients with stroke, the prevalence of dysphagia ranges from 25% to 32%. For patients with dysphagia following stroke, the frequency of aspiration ranges from 51% to 73%.

The modified barium swallow (MBS) technique is widely used to document dysphagia and aspiration. In addition, the MBS evaluation is used to observe the patient’s response to aspiration of test material. In normal individuals, entry of material into the larynx that touches the false or true vocal folds should elicit a cough response. Patients with stroke who aspirate during MBS often do so without any overt signs. These patients are commonly referred to as “silent aspirators.” Linden and Siebens reported that nine of 11 patients who aspirated did not cough when aspiration occurred. The MBS can also be used to document the consistency and amount of test material aspirated.

Dysphagia and aspiration may result in various medical complications—pneumonia, dehydration, or death. Modified barium swallow evidence of aspiration has been shown in a retrospective study to be associated with an increased risk of medical complications. Schmidt et al. from our institution, studied 59 patients follow-

See Patients and Methods on next page
PATIENTS AND METHODS

All patients admitted to an inpatient stroke rehabilitation unit during a 24-month interval were screened for signs and symptoms of dysphagia using the Burke Dysphagia Screening Test. This test has been found useful for identifying patients at risk for developing medical complications associated with dysphagia following stroke. Patients who failed the screening test were referred for MBS evaluation. There were 114 patients who met the following inclusion criteria: (1) stroke as defined by clinical history and neurological examination with compatible computed tomography or magnetic resonance imaging; (2) age 20 to 90 years, inclusive; (3) no history of significant oral or pharyngeal anomaly; and (4) videofluoroscopic evidence of dysphagia. All patients or their next of kin gave informed consent for participation in the study.

The MBS evaluation consisted of the presentation of 5 mL of thin liquid barium, 5 mL of thick liquid barium, 5 mL of barium-impregnated pudding, one fourth of a cookie coated with barium paste, 20 mL of thin liquid barium to be taken in one swallow, and 30 mL of thin liquid barium to be taken in successive swallows. All patients were seated upright and were viewed in the lateral projection, then they were viewed in the anteroposterior projection for one 5-mL thin liquid barium swallow. Studies were recorded on a videotape recorder with a video-counter timer. Tapes were reviewed by two speech-language pathologists to determine the presence or absence of aspiration, the presence or absence of cough following aspiration of test material, amount of material aspirated, and consistency of material aspirated. Aspiration was defined as any test material passing through the true vocal folds. Amount of material aspirated was estimated and recorded as less than 10% or 10% or greater on one or more test swallows.

Pneumonia, dehydration, and death were recorded for the patient's hospital stay. Biweekly laboratory analyses and medical chart review were conducted to determine the occurrence of study end points.

The diagnosis of pneumonia was based on the presence of either chest roentgenographic evidence of pneumonia or three or more of the following: (1) sustained febrile illness with temperature higher than 37.8°C; (2) presence of rales or rhonchi; (3) drop in arterial PaO2 greater than 10 mm Hg compared with baseline values; (4) Gram's stain of sputum sample showing many leukocytes; or (5) sputum culture showing respiratory pathogen. Dehydration was defined as serum sodium level greater than 145 mmol/L or serum urea nitrogen level greater than 17.8 mmol/L of urea not caused by primary renal insufficiency or the use of diuretics.

Death was also recorded after hospital discharge to 1 year after stroke. Follow-up was conducted by telephone interview with the patient's next of kin at 3, 6, and 12 months after stroke. Categorical outcome results were compared using chi² analyses. Fisher's Exact Test was used when chi² analysis resulted in three or less expected events in any cell. Because this was a prospective study, RR rather than odds ratio was the chosen strength of association index. Statistical analyses with observed probabilities (P≤.05) were defined as significant.

RESULTS

The mean±SD age of all patients studied was 71.6±10.6 years. Sixty-seven were men and 47 women. Thirty-seven had right-hemisphere strokes; 38, left-hemisphere strokes; 11, bilateral strokes; 16, brainstem strokes; and 12, other combinations of lesion location. The median time after stroke to time of videofluoroscopic evaluation was 4 weeks (interquartile range, 3 to 6 weeks).

Results of the MBS evaluation showed that 61 patients aspirated, 44 aspirated silently, 22 aspirated greater than 10% on one or more barium test swallows, and 14 aspirated thick liquid or more solid consistencies.

The RR for developing pneumonia were 6.95 times greater (95% confidence interval [CI], 1.24 to 21.34) for those patients who aspirated compared with those who did not (P=.027); 5.57 times greater (95% CI, 1.45 to 21.34) for those who aspirated silently compared with those who coughed when aspiration occurred or did not aspirate (P=.012); and 8.36 times greater (95% CI, 2.74 to 25.49) for those who aspirated 10% or greater on one or more barium test swallows compared with those who aspirated less than 10% or did not aspirate (P=.002) (table).

The RR of developing pneumonia was 3.57 times greater for those who aspirated thick liquid or more solid consistencies compared with those who aspirated thin liquid only or who did not aspirate (P=.08).
Table. Frequency of Pneumonia Associated With Videofluoroscopic Evidence of Aspiration

<table>
<thead>
<tr>
<th></th>
<th>Pneumonia</th>
<th>No Pneumonia</th>
</tr>
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<tbody>
<tr>
<td>Patients who aspirate, No.</td>
<td>8</td>
<td>53</td>
</tr>
<tr>
<td>Patients who do not aspirate, No.</td>
<td>1</td>
<td>52</td>
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</table>

Silent Aspiration†

| Patients who aspirate and do not cough, No. | 7 | 37 |
| Patients who cough when aspirating or do not aspirate, No. | 2 | 68 |

Aspiration≥10% on 1 or More Barium Test Swallows‡

| Patients who aspirate ≥10% on ≥1 test swallow or do not aspirate, No. | 6 | 16 |
| Patients who aspirate <10% on ≥1 test swallow or do not aspirate, No. | 3 | 89 |

*χ²=4.92; P=.027.
†χ²=6.33; P=.012.
‡Fisher’s Exact Test, P=.002.

No statistically significant increase was noted in the occurrence of dehydration or death for the presence of aspiration or any of the specific characteristics of aspiration studied.

**COMMENT**

The MBS is a frequently used dynamic imaging technique for the identification of dysphagia and aspiration. In this study, 61 (53.5%) of 114 patients with videofluoroscopic evidence of dysphagia following stroke aspirated during the evaluation. This is similar to results presented by others.† Relative few patients reached a study end point. This may be because patients were studied during the subacute phase following stroke or because patients participated in a dysphagia management program throughout their rehabilitation hospital stay. Treatment strategies included diet modification, patient-family counseling, and use of compensatory swallowing techniques. All treatment plans were individualized and were based on the results of the MBS evaluation.

The prospective design of this study allows us to estimate the RR of pneumonia, dehydration, and death for patients who aspirate, aspirate silently, aspirate 10% or greater on one or more barium test swallows, or aspirate thick liquids or more solid consistencies during MBS evaluation. To our knowledge, our results are unique and there are no other prospective studies with which to compare our data.

The RR for developing pneumonia was 6.95 times greater for those who aspirated during MBS. This supports the retrospective study by Schmidt et al.8 which found the odds ratio for developing pneumonia to be 7.6 times greater for those who aspirated during MBS. Schmidt et al did not identify a relationship between pneumonia and the amount of test material aspirated. Our prospective study found the RR of pneumonia to be 8.36 times greater for those who aspirated 10% or greater on any given barium test swallow. This difference may be due to the retrospective nature and smaller sample size of their study.

The RR for developing pneumonia was 5.57 times greater for patients who aspirated silently compared with patients who did not aspirate or who coughed when aspirating. This result supports the clinical significance of silent aspiration and the value of the MBS evaluation to detect its occurrence.

The RRs for dehydration and death were unrelated to the presence of aspiration or any of the specific characteristics of aspiration studied. This suggests that other factors not identified in this study are responsible for the development of these two study end points.

Our results show that patients with aspiration, silent aspiration, or aspiration of 10% or greater on one or more barium test swallows are at an increased risk for developing pneumonia. This information may prove to be useful in identifying a subset of patients who need dysphagia therapy and monitoring for early signs and symptoms of pneumonia.

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**REFERENCES**