Pulmonary Aspiration in Mechanically Ventilated Patients With Tracheostomies


The purpose of this descriptive study was to evaluate feeding aspirations in adult patients receiving long-term mechanical ventilatory support, including the incidence of aspirations, the frequency of silent (clinically inapparent) aspirations, and differences between aspirators and nonaspirators. Aspiration data were determined by review of videofluoroscopic (VF) tapes of modified barium swallow procedures performed on 83 medically stable patients admitted to a chronic ventilator unit. Demographic and clinical variables were obtained from review of subjects' medical records. Forty-two subjects (50 percent) aspirated during VF testing and 37 of 45 (77 percent) aspirations were silent. Subjects who aspirated were significantly older than those who did not aspirate (p = 0.007). Swallowing disorders were common, particularly disturbances of the pharyngeal phase. We conclude that feeding aspiration is seen frequently in patients with tracheostomies receiving prolonged positive pressure mechanical ventilation. Advanced age increases the risk of aspiration in this population. Episodes of aspiration are not consistently accompanied by clinical symptoms of distress to alert the bedside observer to their occurrence.

VF = videofluoroscopic; VSC = ventilator support center

Pulmonary aspiration is defined as penetration of material from the oropharynx into the larynx below the true vocal folds. Aspiration may occur in healthy individuals without deleterious consequences, particularly during sleep.1,2 Normal airway defenses are altered frequently in hospitalized patients, leaving them at risk for more frequent aspiration with more significant consequences. Harmful sequelae of aspiration can include transient hypoxemia, chemical pneumonitis, mechanical obstruction, bronchospasm, and pulmonary infection.

Patients with artificial airways, particularly those with tracheostomy tubes, are considered at high risk for aspiration. Aspiration is described as one of the most common complications from tracheal intubation.3 Occurrences of aspiration in patients with artificial airways have been documented frequently.4-12 Aspiration occurrences may be clinically silent, i.e., adverse symptoms (cough, choking, respiratory distress) do not occur.13

Investigators who studied aspiration in patients with artificial airways most often used bedside indicators to detect aspiration of enteral feedings. Methods included recovery of a dye marker from tracheal secretions or measurements of glucose concentrations in tracheal secretions. Although these techniques offer the advantages of economy, simplicity, and ready availability, questions have been raised about the accuracy and utility of these methods of aspiration detection.14,15

Videofluoroscopic (VF) visualization of swallowing trials is the preferred method for evaluating swallowing function and demonstrating aspiration. With VF technique, the structures of the oropharynx can be visualized and food boluses can be monitored in passage through and beyond the oropharynx. This allows direct visualization of aspirations and assessment of swallowing disturbances that may predispose to aspiration. Since patient transport to the radiology department is required for VF, this procedure is labor intensive, time consuming, and carries some risk. Videofluoroscopy is performed infrequently in patients who require mechanical ventilatory support.

In summary, the scope of the problem of aspiration in ventilator-dependent patients is unknown. Methodologic issues have hampered data acquisition in this area. The value of bedside assessment methods is questionable and VF evaluation is difficult and infrequently performed. We are unaware of any reported series of VF examination of swallowing trials in mechanically ventilated patients.

METHODS

Specific Aims

Our aim was to describe aspiration events in mechanically ventilated adult patients with tracheostomies. Specifically, we aimed to use VF examinations to determine the incidence of aspiration, the frequency of silent aspirations, and to compare demographic and clinical characteristics between subjects who aspirated and those who did not aspirate.

Subjects

Study subjects were adult patients admitted to the Ventilator Support Center (VSC) at Suburban Hospital in Hinsdale, Ill between April 1988 and March 1992. The VSC is a 28-bed unit designed specifically for rehabilitation and weaning of patients requiring prolonged mechanical ventilation. Ventilator-dependent patients are transferred to the VSC from short-term-care hospitals in the Chicago metropolitan area.

Videofluoroscopic swallowing examinations were performed on newly admitted patients for whom oral feedings were considered. Patients who did not undergo VF examination were those who were not

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alert enough to cooperate fully with the examination and those unable to tolerate an upright position long enough for transport to the radiology department and completion of the examination.

Methods

Swallowing ability and aspiration occurrences were determined by review of VF tapes of standardized modified barium swallow procedures. The procedure followed for VF examinations of study subjects is outlined in Table 1. Previously recorded tapes were reviewed by two licensed speech-language pathologists with expertise in swallowing disorders. Aspiration events were noted and scored. Aspiration was defined as penetration of any food or liquid substance into the airway below the true vocal folds. Aspiration events were scored according to an index developed for the present study: 1 = aspiration of less than 10 percent of food bolus/aspiration accompanied by cough/choking/distress; 2 = aspiration of less than 10 percent of food bolus/cough, distress absent; 3 = aspiration of greater than 10 percent of food bolus/cough, distress present; and 4 = aspiration of greater than 10 percent of food bolus/cough, distress absent. Silent aspiration was defined as any aspiration that occurred without accompanying cough, choking, and/or respiratory distress (scores of 2 or 4).

Patient records were reviewed to abstract demographic and clinical profiles for each subject. Variables studied included age, sex, diagnosis, duration of mechanical ventilation, time since tracheostomy placement, presence of enteral feeding tube, and serum albumin level. The study protocol was approved by the human investigations committee at Rush-Presbyterian-St. Luke's Medical Center.

Analysis

Data on aspiration frequencies were compiled using descriptive statistics. Differences between groups were tested for significance using Mann-Whitney U tests for discontinuous variables and t tests for continuous variables. A p value of 0.05 or less was accepted as significant.

RESULTS

Subjects

Videotapes were reviewed on 83 ventilator-dependent patients: 44 (53 percent) women and 39 (47 percent) men. Subjects ranged in age from 21 to 94 years, with a mean age of 68.7 years. Causes of respiratory failure included chronic obstructive pulmonary disease, pneumonia, sepsis, neuromuscular disorders, cardiovascular failure, postoperative respiratory insufficiency, and cancer.

Table 1—Videofluoroscopic (VF) Examination

| (1) Patients were transported to the Radiology Department via wheelchair accompanied by a respiratory therapist and speech pathologist. |
| (2) During VF examination, tracheostomy cuffs remained inflated to minimal occlusive volume. Continuous positive pressure mechanical ventilation was provided at patients' usual settings. |
| (3) Patients were positioned upright with the fluoroscopic tube directed laterally to encompass the oropharynx, larynx, tracheostomy tube, and upper esophagus. |
| (4) Various consistencies of barium were presented to subjects, usually in the following order: 1/2 tsp puree, 1/2 tsp thick liquid (by spoon), 1/4 tsp thick liquid (by spoon), 1/8 tsp thick liquid (by spoon), 1/25-cm cube solid. The sequence was altered at the therapist's discretion if aspiration was observed or a consistency was determined to be too difficult for the patient. |
| (5) If feeding residue was observed in the oropharynx postswallow or aspiration occurred, patients were given cues to "swallow again" or "cough" only after adequate time to observe whether these responses occurred spontaneously. |

Table 2—Aspiration Scores

<table>
<thead>
<tr>
<th>Descriptor</th>
<th>Incidence (%)</th>
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<tbody>
<tr>
<td>&lt;10% of bolus/with cough</td>
<td>5 (10)</td>
</tr>
<tr>
<td>&lt;10% of bolus/no cough</td>
<td>16 (33)</td>
</tr>
<tr>
<td>&gt;10% of bolus/with cough</td>
<td>6 (13)</td>
</tr>
<tr>
<td>&gt;10% of bolus/no cough</td>
<td>21 (44)</td>
</tr>
</tbody>
</table>

The mean duration of ventilator dependence was 112 days (range, 25 to 547 days). All patients had tracheostomy tubes, most commonly size 6 or size 8 French. Tracheostomy tubes had been in place for an average of 99 days (range, 15 to 727 days). Fifty-seven patients (69 percent) had small-bore enteral feeding tubes in place at the time of VF evaluation; 34 (41 percent) had nasogastric tubes, 18 (22 percent) had gastrostomy tubes, and 4 (5 percent) had jejunostomy tubes. Serum albumin levels were available as an indirect marker of nutritional status. Subjects' albumin levels ranged from 1.7 to 4.0 g/dl, with a mean of 2.8 g/dl (normal, 3.5 to 5.0 g/dl).

Aspiration Occurrences

Forty-two of 83 patients (50 percent) aspirated at least once and 6 patients (7 percent) aspirated more than once during VF examination. Of the total 48 aspiration events, 37 events (77 percent) were silent. Aspiration scores derived from VF evaluation were categorized in Table 2.

Subjects who aspirated during VF examination were significantly older than those who did not aspirate. The mean age of aspirators was 72.5 years compared with 64.8 years for nonaspirators (p = 0.007). A marginally significant difference was noted when serum albumin levels of aspirators and nonaspirators were compared. Average serum albumin levels for aspirators were 2.64 g/dl, compared with 2.89 g/dl for nonaspirators (p = 0.058). No significant differences were noted for other variables studied, including sex, size of tracheostomy tube, duration of tracheostomy, duration of ventilator support, or presence and type of feeding tube.

Silent aspirators were compared with subjects in whom aspiration was clinically apparent. No significant difference was found between silent and overt aspirators for any study variable.

Frequencies of aspiration for the various feeding substrates are listed in Table 3. Note that not all consistencies were presented to each subject. The consistency

Table 3—Aspiration Frequencies for Various Feeding Materials

<table>
<thead>
<tr>
<th>Substrate</th>
<th>No. of Patients Given Substrate</th>
<th>No. (%) of Patients Who Aspirated Substrate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thin liquid</td>
<td>68</td>
<td>25 (41)</td>
</tr>
<tr>
<td>Thick liquid</td>
<td>72</td>
<td>19 (26)</td>
</tr>
<tr>
<td>Pureed</td>
<td>77</td>
<td>12 (16)</td>
</tr>
<tr>
<td>Solid</td>
<td>47</td>
<td>1 (2)</td>
</tr>
</tbody>
</table>
aspirated most often was thin liquid. Most aspirations occurred during (55 percent) or after (42 percent) a swallow.

**Swallowing Disorders**

Disruptions in the oral and pharyngeal phases of swallowing were described among study subjects. Pharyngeal-phase disturbances occurred twice as often as did oral-phase disturbances. Oral-phase disturbances included poor bolus formation, poor bolus control, and diminished anteroposterior bolus propulsion. Disturbances in the pharyngeal phase of swallowing included slowed pharyngeal transit time, delayed initiation of swallowing reflex, laryngeal residue postswallow, and reduced laryngeal elevation during swallowing. With the exception of reduced laryngeal elevation, oral and pharyngeal disturbances occurred with equal frequency in aspirators and nonaspirators. Reductions in laryngeal elevation during swallowing were described in 55 percent of aspirators and in only 5 percent of nonaspirators.

**DISCUSSION**

A major finding of this study is the frequency of aspirations of oral feedings in long-term ventilator-dependent patients. The 50 percent aspiration rate in the current study compares with an aspiration frequency detected by VF of 0 in normal subjects and 40 percent in patients in a rehabilitation hospital. To our knowledge, no other study has used VF to study aspiration in a population of intubated, mechanically ventilated patients. Studies of aspirations in intubated patients using dye visualization or glucose monitoring methodologies have revealed aspiration frequencies anywhere from 0 to 95 percent. The variability in aspiration rates may reflect differing sensitivities of the various detection methods and/or differences in the types of aspiration detected by each method. Glucose oxide monitoring of tracheal secretions detects feeding aspirations specifically, as does adding blue dye to feeding formulas and examining secretions for blue discoloration. Instilling blue dye in the oropharynx and monitoring secretions for dye discoloration detect aspirated oropharyngeal secretions as well as aspirated feedings. The wide divergence of aspiration rates obtained in what appear to be similar patient populations underscores the need to standardize, compare, and establish the accuracy and utility of methods used currently for aspiration detection.

Our findings emphasize an association between aspiration and the presence of a tracheostomy. We found disturbances in laryngeal elevation and laryngeal closure, both of which have been described previously posttracheostomy. Aspirations due to pharyngeal-phase disturbances characteristically occur during and after swallowing, as was the case with our subjects.

Whether or how positive pressure ventilation may have contributed to aspiration is not clear. A normal swallow in a spontaneously breathing individual requires a brief period of breathholding after inspiration while the bolus passes through the pharynx and after which exhalation occurs. Synchronization of swallowing and breathing may be difficult for patients receiving volume-cycled mechanical ventilation where there is little patient control of the timing and duration of breaths.

The importance of age as a predictor of aspiration risk evidenced in the current study is not surprising given the recent findings of Robbins and coworkers who documented an increased incidence of dysphagia and total swallowing duration among the elderly. Although elderly subjects in the Robbins et al series swallowed more slowly, none of them aspirated. This suggests that age-related changes alone do not lead to aspiration, but aging in combination with other factors may be associated with aspiration. Given the reduced serum albumin values found in our patients, nutritional depletion deserves further study as a possible cofactor in the genesis of aspiration in the healthy elderly, as well as in those who are chronically ill.

The majority of aspirators in our study did not cough at the time of aspiration. This lack of reaction may be related to inflated tracheostomy cuffs. Inflated cuffs can limit, although not prevent, entry of aspirated material into the lower airways. Eventual penetration of aspirated material past inflated cuffs on artificial airways has been well documented. In the current study, fluoroscopy was not continued long enough to ascertain whether aspirated material eventually penetrated below the inflated cuffs and resulted in coughing. Airways desensitization from prolonged intratracheal intubation may also have contributed to the prevalence of silent aspirators. Whatever the mechanism(s), this study underscores problems in bedside identification of aspirators. A majority of aspiration events will not be immediately apparent to observers at the bedside. Herein, the most definitive diagnosis of aspiration remains the observation of food particles around the tracheostomy stoma or suctioned through the tracheostomy tube.

The present study is limited to describing the frequency and characteristics of aspirations of oral feedings in a particular population of ventilator-dependent patients. Caution should be exercised in generalizing our results. First, findings from this study do not necessarily apply to other populations of ventilator-dependent individuals. Our subjects received long-term ventilator support via tracheostomy, were medically stable, and were alert enough to be considered for weaning and rehabilitation. We can only speculate whether aspiration rates would have been even higher had more acutely ill patients been included as subjects. Second, our study was directed toward detecting feeding aspiration. We cannot comment about the occurrence of what has been called "microaspiration," i.e., aspiration of small quantities of oropharyngeal material. Finally, we did not at-
tempt to address the significance of aspiration events in study subjects. We are unable to comment if, how, or to what extent aspiration events may have affected clinical outcomes. Although there is some evidence for an association between aspiration and pulmonary complications, further study is sorely needed in this area.

REFERENCES