Dysphagia testing and aspiration status in medically stable infants requiring mechanical ventilation via tracheotomy*

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LEARNING OBJECTIVES

After participating in this educational activity, the participant should be better able to:

1. Plan an approach to the assessment of aspiration during feeding of stable infants who require mechanical ventilation via tracheotomy.
2. Plan an approach to feeding to minimize aspiration risk in stable infants who require mechanical ventilation via tracheotomy.
3. Distinguish differences in the use of a videofluoroscopic vs. fiberoptic endoscopic swallowing study in stable infants who require mechanical ventilation via tracheotomy.

Unless otherwise noted below, each faculty or staff’s spouse/life partner (if any) has nothing to disclose.

The authors have disclosed that they have no financial relationships with, or financial interests in, any commercial companies pertaining to this educational activity.

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Objective: To perform objective testing to determine aspiration status with the goal of initiating safe and timely oral alimentation in medically stable infants who require mechanical ventilation via tracheotomy. Medically compromised infants who require mechanical ventilation via tracheotomy and are nil by mouth are conventionally deemed as being at risk for aspiration and feeding difficulties. There is little information available in the literature regarding diagnostic testing and habilitation intervention to promote safe and timely initiation of oral alimentation when these infants are medically stable.

Design: Prospective, consecutive, referral-based sample.

Setting: Newborn, pediatric, and respiratory intensive care units in an urban, tertiary care, teaching hospital.

 Patients: Fourteen consecutive medically stable but mechanically ventilated infants (mean chronological age, 8.1 mos, range, 3–14 mos; mean gestational age, 28.4 wks, range, 24–39 wks) referred for swallow evaluation between April 2003 and May 2008.

Interventions: Videofluoroscopic and fiberoptic endoscopic evaluations of swallowing.

Measurements and Main Results: Aspiration status was determined by objective testing with videofluoroscopic and fiberoptic endoscopic evaluations of swallowing. Aspiration was defined as evidence of food material in the airway below the level of the true vocal folds. Eight infants exhibited a coordinated suck-swallow reflex, and six infants exhibited an oral dysphagia characterized by a weak, inconsistent, or absent suck. Nonetheless, 13 of 14 (93%) infants demonstrated a successful pharyngeal swallow with no evidence of aspiration and were started successfully on an oral diet.

Conclusions: Objective dysphagia testing is recommended for medically stable infants who are ventilator dependent via tracheotomy. The prevalence of aspiration in this group is low and a negative examination can promote safe and timely oral alimentation.

Key Words: deglutition; deglutition disorder; aspiration; mechanical ventilation tracheotomy; dysphagia diagnostics; fiberoptic endoscopy; videofluoroscopy
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fter completing this CME activity, readers will be able to perform objective dysphagia testing to determine aspiration status with the goal of initiating safe and timely oral alimentation in medically stable infants requiring mechanical ventilation via tracheotomy. Medically compromised infants with long-term tracheotomies and nil by mouth status, independent of the need for mechanical ventilation, are at risk for developing feeding difficulties (1). Dysphagia diagnostic testing to determine aspiration status and feeding intervention are integral components of the plan of care for these infants (2). Early feeding habilitation can potentially decrease development of resistance to oral feeding and behavioral feeding issues, i.e., oral aversion (3).

There is a paucity of data on the swallowing ability of individuals who are ventilator dependent via a tracheotomy. Only two studies, both dealing with adults, have been reported previously. When aspiration status in patients requiring long-term mechanical ventilation via a tracheotomy (mean, 112 days; range, 25–547 days) was investigated with videofluoroscopic swallowing studies (VFSS), it was found that 50% of patients swallowed successfully and 50% aspirated, with 77% of these aspiration events being silent (4). Prevalence and type of aspiration in acute care patients requiring short-term mechanical ventilation via a new tracheotomy (mean, 20 days; range, 1–62 days) was investigated with fiberoptic endoscopic evaluation of swallowing (FEES), and results indicated that 67% of patients swallowed successfully, 33% aspirated, and 87% of these aspiration events were silent (5).

The aspiration status of infants who require mechanical ventilation via a tracheotomy is unknown. It may be that the prevalence of aspiration for infants is different from those found in adults who required either short-term (5) or long-term (4) mechanical ventilation via a tracheotomy. The purpose of this study was to perform objective dysphagia testing to determine aspiration status with the goals of initiating safe and timely oral alimentation in medically stable infants requiring mechanical ventilation via a tracheotomy.

MATERIALS AND METHODS

Patients

The study was approved by the Human Investigation Committee, Yale University School of Medicine. All patients had physician referral and were in the newborn, pediatric, or respiratory intensive care units at the time of dysphagia testing. Inclusion criteria were infants (<2 yrs of age) who were medically stable at the time of testing, were nil by mouth with no feeding interventions, and who the referring physician felt were neurologically and developmentally appropriate to have a swallow evaluation. Medically stable infants were defined as those with stable ventilatory settings for 7 days to 14 days but who had ongoing tachypnea due to chronic lung disease with a respiratory rate of ≤40 breaths to 50 breaths per minute. In addition to initial diagnosis, all infants exhibited respiratory failure, resulting in tracheotomy and ventilator dependency. Neo-Shiley cuffless tracheotomy tubes in sizes 3.0 and 3.5 (Coridien, Mansfield, MA) were used. Table 1 shows descriptive statistics for the 14 consecutive participants. There were ten boys (mean chronological age, 8.0 mos, range, 3–14 mos; mean gestational age, 28.9 wks, range, 24–39 wks) and four girls (mean chronological age, 8.3 mos, range 3–13 mos; mean gestational age, 27.3 wks, range, 25–30 wks). No significant gender-related chronological or gestational age differences were observed (p > .05).

### Table 1. Participant characteristics

<table>
<thead>
<tr>
<th>Participant No./Gender/Chronological Age (mos)/Gestational Age (wks)</th>
<th>Diagnosis</th>
<th>Post Tracheotomy Days</th>
<th>Current Feeding</th>
<th>Aspiration Yes/No</th>
<th>Testing FEES/VFSS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/F/13 mos/25 wks</td>
<td>BPD</td>
<td>21</td>
<td>PEG</td>
<td>N</td>
<td>FEES/VFSS</td>
</tr>
<tr>
<td>2/M/12 mos/24 wks</td>
<td>BPD, PDA</td>
<td>275</td>
<td>PEG</td>
<td>Y</td>
<td>VFSS</td>
</tr>
<tr>
<td>3/F/13 mos/29 wks</td>
<td>BPD, PDA, subglottic stenosis</td>
<td>271</td>
<td>PEG</td>
<td>N</td>
<td>VFSS</td>
</tr>
<tr>
<td>4/M/8 mos/39 wks</td>
<td>Acute transverse myelitis</td>
<td>39</td>
<td>PEG</td>
<td>N</td>
<td>FEES/VFSS</td>
</tr>
<tr>
<td>5/F/4 mos/25 wks</td>
<td>Tracheomalacia</td>
<td>10</td>
<td>NGT</td>
<td>N</td>
<td>FEES/VFSS</td>
</tr>
<tr>
<td>6/M/14 mos/27 wks</td>
<td>PDA, BPD</td>
<td>386</td>
<td>PEG</td>
<td>N</td>
<td>FEES/VFSS</td>
</tr>
<tr>
<td>7/M/4 mos/24 wks</td>
<td>BPD</td>
<td>23</td>
<td>NGT</td>
<td>N</td>
<td>VFSS</td>
</tr>
<tr>
<td>8/M/3 mos/26 wks</td>
<td>Tracheomalacia</td>
<td>27</td>
<td>NGT</td>
<td>N</td>
<td>VFSS</td>
</tr>
<tr>
<td>9/F/5 mos/30 wks</td>
<td>Tracheomalacia</td>
<td>97</td>
<td>NGT</td>
<td>N</td>
<td>VFSS</td>
</tr>
<tr>
<td>10/M/5 mos/26 wks</td>
<td>BPD</td>
<td>90</td>
<td>NGT</td>
<td>N</td>
<td>VFSS</td>
</tr>
<tr>
<td>11/M/7 mos/28 wks</td>
<td>DiGeorge syndrome</td>
<td>182</td>
<td>PEG</td>
<td>N</td>
<td>VFSS</td>
</tr>
<tr>
<td>12/M/11 mos/29 wks</td>
<td>Intraventricular/cerebellar hemorrhages</td>
<td>175</td>
<td>NGT</td>
<td>N</td>
<td>VFSS</td>
</tr>
<tr>
<td>13/M/10 mos/27 wks</td>
<td>BPD</td>
<td>55</td>
<td>PEG</td>
<td>N</td>
<td>VFSS</td>
</tr>
</tbody>
</table>

**Totals**

| Mean, 120.4 days Range, 10–386 days |

FEES, fiberoptic endoscopic evaluation of swallowing; VFSS, videofluoroscopic swallow study; BPD, bronchopulmonary dysplasia; PEG, percutaneous endoscopic gastrostomy tube; PDA, patent ductus arteriosus; NGT, nasogastric tube; OGT, orogastric tube.

“No significant gender-related chronological or gestational age differences were observed (p > .05).

### Procedures

The standard FEES protocol (6, 7) was followed with slight modifications. Each naris was examined visually and the scope was passed through the most patent naris without administration of a topical anesthetic or vasoconstrictor to the nasal mucosa, thereby eliminating any potential adverse anesthetic reaction and assuring the endoscopist of a safe physiologic examination (8). The base of tongue, pharynx, and larynx were viewed, and swallowing was evaluated directly with the first 6 to 20 liquid boluses delivered via bottle. The food challenge consisted of liquid boluses (white milk/formula), as this color has excellent contrast with pharyngeal and laryngeal mucosa (9). The endoscopist (S.B.L.) who performed all FEES ratings in the present study participated in an investigation that determined intrarater reliability with FEES, using nonblue dyed food trials (9). Intrarater agreement in 66 trials was 100% for tracheal aspiration. FEES equipment consisted of a 3.6-mm diameter flexible fiberoptic rhinolaryngoscope (ENF-P3, Olympus, Center Valley, PA), light source (CLK-4, Olympus), camera (MN401E, ELMO, Plainview, NY), and color...
Thirteen (93%) of 14 infants exhibited a successful pharyngeal swallow and were without aspiration. No infant exhibited aspiration when a feeding tube was present. Only one infant (#3) exhibited aspiration, and a recommendation of nil-by-mouth status was made independently with both tests, i.e., due to aspiration on one of approximately 20 swallows during VFSS and laryngeal penetration and high aspiration risk during FEES.

**DISCUSSION**

The finding that 93% of infants who require mechanical ventilation via tracheotomy did not aspirate during dysphagia testing indicates that it is advantageous to evaluate swallowing function once medically stable. Timing of the swallow evaluation is, therefore, critical for success. Information on improving physical condition and medical progress, stable ventilatory settings for 7 days to 14 days, and ongoing tachypnea with a respiratory rate of 40 breaths to 50 breaths per minute are good prognostic indicators for recommending dysphagia testing with the goal of initiating timely oral alimentation.

The low prevalence (7%) of aspiration in infants requiring mechanical ventilation via tracheotomy in this study differed from both the 50% prevalence of aspiration reported in adult patients with long-term ventilatory needs (4) and 33% prevalence of aspiration reported in adult patients with short-term ventilatory needs (5). It may be that an infant’s swallowing physiology is more resilient than an adult’s swallowing physiology once improved health status occurs (11). Prompt consideration of dysphagia testing leading to safe initiation of oral alimentation may allow for improved suck-swallow behavior in those infants who exhibit an oral dysphagia characterized by weak or uncoordinated sucking skills.

When oral feeding trials were recommended, a regimen was established with the goal of transitioning from tube to oral nutrition delivery. Oral alimentation, via either breast or bottle, was always trialed first at each feeding when the infant was hungriest, followed by tube feeding to deliver the remainder of caloric needs. The volume of tube feedings decreased commensurate with increased oral intake.

The fact that neither nasogastric nor orogastric tubes influenced aspiration status is in agreement with findings from adults, i.e., aspiration status was not influenced by presence or absence of a nasogastric tube (12). A feeding tube, therefore, can remain in place both during dysphagia testing and to supplement oral alimentation without affecting aspiration status.

Use of VFSS or FEES changed during the course of this study (Table 1). Five (83%) of the first six infants were evaluated with both tests; whereas the remaining eight (100%) infants were evaluated only with VFSS. Reasons to use VFSS are less crying, allowing for a more normal swallow study (transnasal endoscopy invariably causes crying), and assessment of the oral and pharyngeal stage transitions of swallowing by speech-language pathology and pediatric radiology. Reasons to use FEES, especially with a 1.6-mm to 2.2-mm diameter pediatric scope, are if both pharyngeal swallowing and laryngeal functioning require examination concomitantly by speech-language pathology and pediatric otolaryngology (13) and to decrease irradiation exposure if frequent objective monitoring of swallowing function is required (14).

Research is needed to investigate both the diagnosis and rehabilitation of swallowing in medically stable infants who are ventilator dependent via tracheotomy. Areas of future interest include: 1) a larger sample size to corroborate the findings of the present study; 2) determination if fatigue influences aspiration status by increasing the duration of testing, thereby allowing for more swallows to be evaluated; 3) long-term follow-up to document success rate and timing of the transition from enteral tube feeding to oral alimentation; 4) investigation of pharyngeal stage structural movement patterns based on presence/absence of a nasogastric or orogastric feeding tube; 5) correlation of neurologic and developmental status with swallowing function; and 6) social and behavioral advantages associated with safe, successful, and timely oral feeding initiation once the infant is medically stable, e.g., improvement in socialization and infant-caregiver bonding, reduction in oral aversion behaviors, and discontinuation of nonoral nutrition.

**CONCLUSIONS**

Objective dysphagia testing to determine aspiration status is recommended for medically stable infants who are ventilator dependent and require a tracheotomy. The testing is advantageous in pro-
moting safe and timely oral alimentation. This article provides excellent evidence to aid the clinician in evaluating this situation and developing a treatment plan.

REFERENCES