Use of Temporary Enteral Access Devices in Hospitalized Neonatal and Pediatric Patients in the United States

Beth Lyman, MSN, RN, CNSC; Carol Kemper, PhD, RN, CPHQ; LaDonna Northington, DNS, RN; Jane Anne Yaworski, MSN, RN; Kerry Wilder, BSN, RN, MBA; Candice Moore, BSN, RN, CPN; Lori A. Duesing, MSN, RN, CPNP-AC; and Sharon Irving, PhD, RN

Abstract

Background: Temporary enteral access devices (EADs), such as nasogastric (NG), orogastric (OG), and postpyloric (PP), are used in pediatric and neonatal patients to administer nutrition, fluids, and medications. While the use of these temporary EADs is common in pediatric care, it is not known how often these devices are used, what inpatient locations have the highest usage, what size tube is used for a given weight or age of patient, and how placement is verified per hospital policy. Materials and Methods: This was a multicenter 1-day prevalence study. Participating hospitals counted the number of NG, OG, and PP tubes present in their pediatric and neonatal inpatient population. Additional data collected included age, weight and location of the patient, type of hospital, census for that day, and the method(s) used to verify initial tube placement. Results: Of the 63 participating hospitals, there was an overall prevalence of 1991 temporary EADs in a total pediatric and neonatal inpatient census of 8333 children (24% prevalence). There were 1316 NG (66%), 414 OG (21%), and 261 PP (17%) EADs. The neonatal intensive care unit (NICU) had the highest prevalence (61%), followed by a medical/surgical unit (21%) and pediatric intensive care unit (18%). Verification of EAD placement was reported to be aspiration from the tube (n = 21), auscultation (n = 18), measurement (n = 8), pH (n = 10), and X-ray (n = 6). Conclusion: The use of temporary EADs is common in pediatric care. There is wide variation in how placement of these tubes is verified. (JPEN J Parenter Enteral Nutr. XXXX;xx:xx–xx)

Keywords

pediatric; enteral access devices

Clinical Relevancy Statement

Although the use of temporary enteral access devices (EADs) is a frequent intervention in pediatric care, gaps remain in our knowledge related to the utilization of these devices and the incidence of complications associated with verification of temporary EAD placement. The percentage of pediatric patients with a temporary EAD has not been reported. While there is awareness among healthcare providers as to the risks associated with the placement and use of temporary EADs in children, the full scope is not well known. Complications related to a misplaced or dislodged temporary EAD have not been easily quantified, possibly due to a lack of standardized methods to capture such occurrences and the lack of national reporting. However, anecdotal reports of adverse events involving misplaced temporary EADs are compelling in their impact on patients, families, and healthcare professionals. Recognition of the frequency with which these temporary EADs are used and the methods used to verify placement may heighten awareness of the care necessary to maintain them and minimize any related risks. This study focuses on an important initial step in increasing our knowledge and understanding of the frequency of using temporary EADs and the practices used to verify placement in hospitalized children and neonates.

Background

The use of temporary enteral access devices (EADs) in children has provided a means to administer much-needed nutrition, fluids, and/or medications to children unable to orally consume adequate nutrition for growth. There are risks associated with the placement of temporary EADs. A 2005 article by Ellett et al reported nasogastric (NG) tube misplacement
occurred in 20.9%–43.5% of placements, with some of these tubes being in the lung, some in the esophagus, and some in the small bowel. Complications from placement of an NG tube in the pulmonary bed range from pneumothorax requiring chest tube placement to profound chemical pneumonitis and respiratory distress syndrome. In some patients, this can be a terminal event, as was reported in a Patient Safety Alert issued by the United Kingdom National Health Service in 2013. Even an experienced clinician may have difficulty recognizing pulmonary intubation when placing a temporary EAD. Although considered the “gold standard,” radiographs are not commonly obtained prior to initial or repeated use of the tube due to concerns of radiation exposure.

Methods used to verify NG and orogastric (OG) placement in this population have traditionally been bedside nursing techniques, including aspiration of contents from the tube, assessment of the color of fluid from the tube, auscultation for air insufflation using a stethoscope, or a combination of these techniques, of which none are a panacea or evidence based. Many studies using pH to confirm gastric placement of tubes in pediatric patients have provided evidence to guide practice. To date, there is no practice standard for location placement verification that is universally agreed upon. However, many acknowledge that when in doubt, a radiograph should be obtained. The American Association of Critical Care Nurses procedure manuals for critical care and the pediatric acute care both recommend pH measurement as part of the procedure to verify temporary EAD placement. Although commonly used, auscultation carries with it the human cost of error, which is deemed so high that a Patient Safety Alert was issued in 2012 by the Child Health Patient Safety Organization recommending hospitals stop using this method as a means of verifying NG or OG placement. The basis of this alert is that the lungs and stomach are both resonant organs that can transmit sounds, and the ability to discern the difference from one organ to the other is negligible, yielding misleading results with potentially unrecognized EAD misplacement.

This study was designed by the New Opportunities for Enteral Tube Location (NOVEL) project, which has been described previously. The specific aims of this point prevalence study were to (1) determine the number of neonatal and pediatric hospitalized children with a temporary EAD in place on 1 day to include NG, OG, and postpyloric (PP) tubes; (2) describe the population (by weight, age, and size of temporary EAD used), unit location within the hospital, and census of hospital on the day of data collection; and (3) discern the methods used to verify NG tube placement in participating centers.

Data Collection

Data collection focused on 3 areas: hospital demographics, patient characteristics, and the temporary EAD. Hospital specific data included hospital location, the census (number of patients actually occupying a bed) on the day of data collection (pediatric and neonatal only), and whether the hospital was exclusively pediatric (freestanding pediatric hospital), an adult hospital with a neonatal intensive care unit (NICU), or an adult, pediatric, and NICU center. Participating centers were asked to list the method(s) used to verify NG or OG placement and to rank order methods if more than one method is used. Patient characteristics included age, weight, and location in the hospital. For neonates younger than 30 days, age was determined by a percentage of a month (30 days) for day of life 29 or below. Specific feeding tube data collected included the size of the tube and the type of tube by location (NG, OG, or PP).

Data Analysis

Prevalence data were calculated using descriptive statistics for this study. Standard deviations were calculated for hospital prevalence percentages by census and by type of hospital. A correlation coefficient was calculated to evaluate the prevalence of tube use by size of the inpatient census. Mean, median, and modes were calculated to describe the patients and tube size by weight as the data were not normally distributed. Statistics were calculated using Excel (Microsoft Corp, Redmond, WA) spreadsheet programs.

Results

Participating Organizations

A total of 63 unique hospital organizations participated in the study from 29 states representing all regions of the United States. The largest percentage of participating organizations described themselves as pediatric hospitals (62%), followed by facilities with adult, pediatric, and neonatal populations (25%) and adult facilities with neonatal services (13%).

Organization and Individual Participant Characteristics by Temporary EAD Types

Across all 63 participating hospital sites, a total inpatient census of 8333 was reported, with 1991 (24%) of these patients...
having a temporary EAD. NG tubes were the most common device reported, with OG tubes and PP tubes representing smaller percentages (Table 1). Temporary EAD prevalence varied somewhat across hospital types and total census. Adult hospitals with neonatal services reported the highest percent prevalence of patients with temporary EADs (68%), while pediatric hospitals reported the lowest (22%). Variance in the prevalence of temporary EADs across sites based on pediatric and neonatal census was also evident. Sites with fewer than 50 patients had the highest percent prevalence (46%), while those with a census above 200 patients reported the lowest percent prevalence (22%). The relationship between inpatient census and temporary EAD percent prevalence was also explored. Figure 1 shows an inverse relationship between census and temporary EAD use. Most of the sites with fewer than 50 patients described themselves as adult/NICU hospitals or rehabilitation facilities.

The mean age and weight of individual participants with a temporary EAD was 14 months and 6.8 kg, respectively. The mean tube size across all individual participants was size 6 Fr. (Table 2). Some variance was noted in temporary EAD size by weight of individual participants, with the greatest variance seen with participants over 10 kg (Table 3).

**Methods Used to Verify Temporary EAD Placement**

Sites were asked to report the primary method used to verify temporary EAD placement. If more than one method was used, these were reported in order of use. Data were not collected to specify if multiple methods were used simultaneously to verify temporary EAD placement. The most common method of verification was identified as aspiration followed by auscultation (Table 4). Pediatric hospitals listed aspiration of gastric contents as the primary method used to verify placement, followed by abdominal radiograph and then measurement of the external length as the methods used to verify placement of the temporary EAD. Adult hospitals with a NICU listed auscultation for the first and second line placement verification methods, followed by aspiration of gastric contents. Those hospitals that admit adults, pediatrics, and neonates listed aspiration, auscultation, and then abdominal radiograph as their first, second, and third methods to verify placement. Not all participating centers listed 3 methods to verify placement. Interestingly, only 10 of the 63 participating centers listed pH as the first choice for verification of temporary EAD placement (7 pediatric, 1 NICU only, and 2 adult/pediatric/neonatal centers).

**Discussion**

This 1-day prevalence study was conducted to better understand issues surrounding temporary EAD use in hospitalized children and neonates. The fact that 24% of hospitalized children on the day of the study had a temporary EAD validates this as a high-use therapy. The literature is replete with reports of the risks associated with this intervention.8,18,20 While this is a convenience sample of hospitals, it includes 15% of the 256 pediatric hospitals in the United States. Also included are those centers that have a NICU only and university settings where a pediatric hospital is embedded within a larger adult center.

**Across-Hospital Type Differences**

The variation of NG, OG, and PP tube use by individual participant, unit type, and hospital census demonstrates some noteworthy trends. These trends may be related to the types of patients served in particular sites. Adult hospitals with a neonatal unit had a higher percentage of temporary EAD use compared with pediatric hospitals. This may reflect a predominant population of infants hospitalized for weight gain. These infants often receive early enteral nutrition (EN) via OG or NG tube feedings until they are able to tolerate adequate formula or human breast milk by mouth to demonstrate consistent weight gain and normal growth.21,22 While the largest number of participating organizations (39) were pediatric hospitals, these sites had the lowest temporary EAD prevalence at 23%. Hospitals exclusively caring for pediatric patients may have higher acuity neonates who require a more permanent EAD, accounting for their lower temporary EAD percentage. These pediatric hospitals may act as regional referral centers with medically complex patients who need longer term enteral feedings. The smaller centers, those with a census of fewer than 50 patients, comprise adult hospitals with a NICU and smaller rehabilitation facilities where temporary feeding tubes could be used for short-term enteral feedings. The finding that the higher the census, the lower the overall prevalence of temporary EAD use may reflect that fact that many of these centers transition patients to more permanent enteral tubes such as gastrostomy tubes.

**Individual Participant Variation**

The subject-specific data are highly variable, which would be expected since the population studied ranged from birth to 18 years of age. While the average age was 14 months, the mode and median were 1 month, indicating the younger the patient, the more likely a temporary EAD was used. Similarly, the average weight was reported to be 6.8 kg, but the mode was much lower.
Table 2. Individual Participant Characteristics.

<table>
<thead>
<tr>
<th>Participant Characteristic</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>Median</th>
<th>Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, mo</td>
<td>0.03</td>
<td>218</td>
<td>14.3</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Fr. tube size</td>
<td>4</td>
<td>18</td>
<td>6.5</td>
<td>6</td>
<td>5</td>
</tr>
<tr>
<td>Weight, kg</td>
<td>0.43</td>
<td>171</td>
<td>6.8</td>
<td>2.89</td>
<td>2.2</td>
</tr>
</tbody>
</table>

Table 3. Temporary Enteral Access Device Size by Individual Participant Weight Category.

<table>
<thead>
<tr>
<th>Weight, kg</th>
<th>No. of Participants by Weight Category</th>
<th>Average Fr. Tube Size</th>
<th>Smallest Fr. Tube Size</th>
<th>Largest Fr. Tube Size</th>
<th>Median Fr. Tube Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;5</td>
<td>1435</td>
<td>6</td>
<td>4</td>
<td>10</td>
<td>6</td>
</tr>
<tr>
<td>5 to &lt;10</td>
<td>233</td>
<td>7</td>
<td>5</td>
<td>12</td>
<td>8</td>
</tr>
<tr>
<td>10 to &lt;20</td>
<td>120</td>
<td>8</td>
<td>5</td>
<td>16</td>
<td>8</td>
</tr>
<tr>
<td>&gt;20</td>
<td>132</td>
<td>9</td>
<td>5</td>
<td>18</td>
<td>8</td>
</tr>
</tbody>
</table>

Table 4. Temporary Enteral Access Device (EAD) Verification Methods Used.

<table>
<thead>
<tr>
<th>Temporary EAD Verification Method</th>
<th>No. of Sites Reporting as Method 1</th>
<th>No. of Sites Reporting as Method 2</th>
<th>No. of Sites Reporting as Method 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aspiration</td>
<td>21</td>
<td>6</td>
<td>12</td>
</tr>
<tr>
<td>Auscultation</td>
<td>18</td>
<td>20</td>
<td>3</td>
</tr>
<tr>
<td>Measurement</td>
<td>8</td>
<td>4</td>
<td>9</td>
</tr>
<tr>
<td>pH</td>
<td>10</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>X-ray</td>
<td>6</td>
<td>19</td>
<td>13</td>
</tr>
<tr>
<td>Corttrak</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Fluoroscopy</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>63</td>
<td>55</td>
<td>39</td>
</tr>
</tbody>
</table>

Figure 1. Temporary enteral access device prevalence per inpatient census.
at 2.2 kg, with a median of 2.89 kg. The impetus to provide nutrition to fuel early growth and development is well reported in the literature, and these data reflect that practice trend. These data present a platform to focus future research, given that 61% of our study participants were located in a NICU.

**Temporary EAD Verification Practices**

Reports in the literature on various methods to verify placement of NG and OG EADs are conflicting. In our study, aspiration of tube contents was the most often reported method to verify placement. A study by Westhus found the color of enteral tube aspirates to be indicative of gastric placement in 41 of 49 samples (84%) and intestinal placement in 5 of 7 (71%). Gilbertson et al documented no difference in the color of gastric and endotracheal aspirates in the 645 patients studied. These researchers also reported that when it was not possible to aspirate from a smaller bore tube, an X-ray was obtained, with 8 of those tubes being misplaced—1 in the lung and 7 coiled in the esophagus. Smaller bore tubes often collapse, making any attempt to aspirate fluid problematic if not impossible. Given that gastric and esophageal fluids can be similar in color and small-bore tubes can be difficult to aspirate from, it is concerning that aspiration was used so often by participating centers. It is unclear from these data whether centers use aspiration as part of a multiprong approach to verify placement. The discrepancy in the literature and variability in the findings of the current study indicate a need for further evaluation of methods to assess temporary EAD placement.

Recommendations to use aspiration as one of a combination of methods appear in more than one publication. One quality improvement report documented a change in the use of aspiration over time from 51% to 71% but also noted that aspiration was combined with auscultation if an X-ray was not obtained. These authors recommended marking the tube at the nare and using this as confirmation for the first-line verification method, followed by aspiration of contents to visually inspect the color and then checking pH unless the child is receiving an acid suppressor. A similar study involving a NICU population recommended an X-ray to verify initial placement and subsequently to aspirate tube contents and assess color of the aspirate followed by observation for signs of respiratory symptoms. While both of these authors acknowledge the value of an X-ray, they also suggest X-ray is not always available and advocate using a combination of methods to verify placement.

Data from this study suggest centers are using a combination of methods as described, with aspiration being the most commonly reported method and auscultation the second most common. A recent review article by Irving et al. details the pitfalls of using auscultation to verify placement of a feeding tube. The accompanying commentary describes the human costs when a tube is placed inadvertently into the lung and a death occurs. The use of auscultation as a method of temporary EAD verification should cease, and a Patient Safety Alert with this same recommendation was published in 2012. Despite this, our data demonstrate widespread use of the auscultation method, indicating the need for further dissemination and implementation of evidence-based practices related to temporary EAD verification.

The use of pH to verify temporary EAD placement has been recommended as the preferred method. In 2006, a report from Boston Children’s Hospital outlined a change in practice to using pH as the primary method, with an X-ray to be done if the pH is >5. A report of children seen in an emergency department reported the ability to obtain a pH measurement from gastric aspirates was achieved in 84% of attempts with a median pH of 2. When the pH was >4, an X-ray was obtained. A study done by Gilbertson et al. reported a mean pH of 3.4 for children not receiving acid suppressors and 4.2 in children receiving acid suppression. In this large study of 4330 samples, the mean pH of endotracheal aspirates was 8.3. The Gilbertson study looked at infants older than 4 weeks. In our study, the use of pH to verify placement ranked number 3 as a first-line intervention, number 3 as a second-line intervention, and number 5 as a third-line method. To date, the best science available in the nursing literature is to measure pH to verify NG or OG placement.

**Study Limitations**

Limitations to this study must be acknowledged. This was a convenience sample of hospital organizations, with only those that expressed an interest and obtained IRB approval participating. Each participating organization selected its date to collect data, and it is likely the 1-day point prevalence study would vary from week to week or season to season. Data collection specifications were provided to each participating site. However, the data were self-reported and may contain errors in reporting unknown to the investigators.

**Future Direction**

Although it is clear that some methods of temporary EAD verification are more accurate than others, the ability to accurately verify placement with a variety of populations and in a multiple-care setting still remains a significant problem. Technology currently does not exist to meet this challenge. This study was conducted to provide industry and inventors with potential useful information to help drive the development of a safe, accurate, practical technology to verify temporary EAD placement without exposing a child to radiation. Data regarding how often the tubes are used, what sizes are typically used, and what size patients need temporary EADs were lacking. This 1-day study now provides direction for future research and education.

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References


