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Current Practices in Home Management of Nasogastric Tube Placement in Pediatric Patients: A Survey of Parents and Homecare Providers

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ABSTRACT

Enteral feeding tubes are used in pediatric patients to deliver nutrition, fluids or medications. The literature related to short-term feeding tube (nasogastric [NG], hereafter known as NGT, or orogastric [OGT],) use in pediatric homecare patients is sparse. This descriptive study sought to gather baseline information about these children and how their feeding tubes are managed at home. Specifically, we sought to better understand how the tubes are placed and the method(s) used for tube placement verification. Two surveys were distributed: one to parents and one to homecare providers who have direct patient contact.

Results: Responses were obtained from 144 parents and 66 homecare providers. Over half of the children were 12 months of age or younger and had a 6 Fr feeding tube. Over 75% (108) had an NGT for 1 year or less. Predominantly parents replaced the NGT but a few children self-inserted their tubes. Feeding tube placement was verified by auscultation (44%) or measurement of gastric pH (25%) in the parent's survey. Twenty-six percent of parents indicated they had misplaced an NGT at least once and 35 parents described symptoms of pulmonary misplacement. The homecare provider data indicated auscultation (39%) and pH measurement of gastric contents (28%) to verify NG tube placement location.

Study results confirms a need for consistency of practice among health care professionals and in parent education for those children who require NGTs at home. It is troubling that auscultation is still widely used for NGT location confirmation despite practice alerts that warn against its use.

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Background and Purpose

The incidence of inadvertent placement of an enteral tube into the lung of neonatal and pediatric patients is difficult to discern due to lack of required or standard reporting mechanisms. Additionally, one concern of institutions might be that of litigation or loss of reputation within the pediatric community, which may be one of the factors for the reluctance of reporting an adverse event involving an NGT by an institution. The language used to describe nasogastric tube (NGT) misplacement or dislodgement varies between institutions and providers, creating difficulty in quantifying the occurrence of these events. However, retrospective studies in hospitalized children have demonstrated the

incidence of NG tube misplacement is estimated to be 21–43% (Ellett, Croffie, Cohen, & Perkins, 2005; Quandt, Schraner, Bucher, & Mieth, 2009). It is unknown what the rate of misplacement of NGTs are in homecare as there are very few studies in the literature related to management of home NGT use and none regarding NGT misplacement.

Little is known about the use of enteral tubes in the homecare setting (Evan et al., 2010; Rosen et al., 2016; Sorokin & Gottlieb, 2006; Pedron-Gilner et al., 2012). Of these studies, only one addressed complications (Rosen et al., 2016). Evan et al. (2010) addressed use of home enteral feedings as a viable resource for children and studied the safety aspects of caregiver's enteral feeding tube placement technique in children with inherited metabolic disorders who required home enteral tube feeding. According to the authors, a questionnaire and practical assessment of the feeding process was completed by care givers, a dietitian and a nurse in the child's home. The feeding mode was evenly divided between gastrostomy and NGT. The main issues identified were poor compliance with sanitation issues, and a lack of appropriate implementation of the feeding regimen (Evan et al. (2010)). The

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researchers recommended regular updates on knowledge and technique to reduce risk of NGT misplacement in this population. There was no mention of enteral tube placement issues such as replacement or misplacement in the home.

Pedron-Gilner et al. (2012), reported a 10 year experience of 304 children requiring home enteral nutrition including 218 with NGTs. The major diagnoses were oncological disease (29.9%) and digestive diseases (27.6%). The authors noted that significant differences were related to age of the child at the onset of the home enteral feeding regimen, feeding infusion schedules and the formula prescribed. The researchers concluded that in their cohort enteral nutrition support with use of an NGT generally started at an early age, and varied depending on the disease of the child and medical treatment. Additionally, they found knowledge of the patient profile was important in designing the most effective strategy for home enteral feedings. There was no mention of complications or adverse effects related to enteral tube feedings.

In 2005, Daveluy, et al. published a study of an 11 year experience of 416 children with home enteral nutrition (Daveluy et al., 2005). Fifty three percent of the children were fed by nasogastric tube, with 41% by gastrostomy tube. An enteral feeding pump was used in 98% of the patients. The study concluded that home enteral nutrition can be used to treat children with chronic diseases, can be started early in life, and can be prolonged over several years. Complications or adverse events related to enteral tube use were not addressed.

In a recent retrospective chart review, Rosen et al. (2016) assessed post hospitalization feeding status and the impact on growth in children with chronic diseases discharged to home with NGT feedings. A total of 87 patients were included ranging in age from 3 months to 16 years of age with a variety of medical conditions. In the study 33% of the patients were discharged on continuous feedings and 44% were on a combination of bolus and continuous feedings. One hundred percent of the parents received NGT education prior to discharge and 94% had a homecare nurse. In 13% of the patients, parents discontinued feedings because of vomiting, inability to keep the tube in place, or because they felt the child was unable to tolerate the feeding tube. On average it took 4.8 months for children to successfully complete the prescribed treatment and progress to full oral feedings. This study suggests home enteral feedings requiring an NGT can be a prolonged arduous process for families to undertake (Rosen et al., 2016).

The lack of published research related to NGT placement and verification in the inpatient setting and recognizing that many children are discharged with NGTs for enteral feedings prompted the question to investigate what occurs in the homecare setting. The number of children at home using NGTs is unknown, as it is often a temporary measure for those children who are unable to take all feeding, hydration and medication orally. Decision making for a temporary NGT versus a percutaneous or surgically placed gastrostomy tube is multidisciplinary and multidimensional and beyond the scope of this paper. Given the complexity of the phenomena, the gap in the literature related to NGT misplacement, potential for complications, methods used for NGT location verification in the home, and the unknown as to how many children these issues affect, the current study was undertaken. The overarching purpose of this study was to collect data in the pediatric population to better describe the state of use, placement and management of displacement of nasogastric feeding tubes in pediatric homecare patients. The primary aim of the study is to address the data gap that exists related to placement, misplacement/complications of NGTs and to describe methods for placement and verification in the home when X-ray is not an option. In addition, this study may introduce questions to guide further research on NGT placement verification methods and help establish best practices for homecare settings. As a result of these findings there may be impetus for the development of new technologies related to enteral tube design, placement verification and securement.

Design and Methods

Design

This study used two voluntary surveys, one for parents/caregivers (called parents) and one for homecare providers, to better understand the incidence of enteral tube use in the homecare setting. The New Opportunities for Verification of Enteral Tube Location (NOVEL) project team members, comprised of nurses and physicians who care for pediatric patients in both the in-patient and homecare settings developed and reviewed the survey questions for content validity prior to distribution.

Sample

The populations of interest were parents and home healthcare providers caring for children in the home who required an NGT. Parents whose children were <18 years of age with an NGT in place at the time of survey completion were eligible. Any home healthcare company that employed home health nursing and supplied NGTs to pediatric patients were also eligible. Additionally, children with surgically inserted feeding tubes such as a gastrostomy tube were excluded from study participation. Both arms of this study were a convenience sample of persons who were contacted by email and voluntarily completed the online study survey. Some participants were referred by nurses who had knowledge of and/or had participated in the primary NOVEL study (Lyman et al., 2016). Other participants came from organizations associated with members of the NOVEL project, and companies with hospital affiliations or exceptional working relationships. Lastly, a web mail request of participating organizations in which members of the NOVEL project are affiliated were contacted for participation (Lyman et al., 2016).

Instrument

There were two separate survey tools composed of 13 items, one primarily directed toward parents and the other for health care providers. These tools were developed from a collection of questions compiled by the research team members, based on gaps in the literature and questions generated from clinical practice. The NOVEL team members reviewed the questions prior to implementation. The research team sought to have the survey be straightforward, easy to read, and short in length to encourage participants to complete all 13 questions. Descriptive information related to the patient population of interest including prevalence of NGT use, patient age, size of tube, frequency of NGT replacement and topics related to placement verification and misplacement in the home. Additional survey items included duration of NGT use, criteria used to determine need for tube change, identification of person (s) who change the NGT, identification of resources available for assistance with tube change, technique used to determine tube depth for placement, method for how NGT placement location is verified, and if adverse events have occurred during or immediately following NGT change, what actions parents or health care providers performed if such an adverse event arose. The questions were reviewed by the research team. Content validity was established for each instrument. Reliability was not tested prior to using either of the survey tools. The survey instruments are included as Fig. 1.

Procedure

The survey data instrument used the Survey Monkey® platform (<https://www.surveymonkey.com/>, n.d.) to house the web based questionnaires. Potential participants were given information about the survey and were encouraged to access the site and complete the survey. The researchers were only able to determine the number of participants based on the final count in the survey tally. There was no predetermined sample size due to the nature of the study and the solicitation of participants.

As caregiver, what measurement method were you taught to replace the tube?

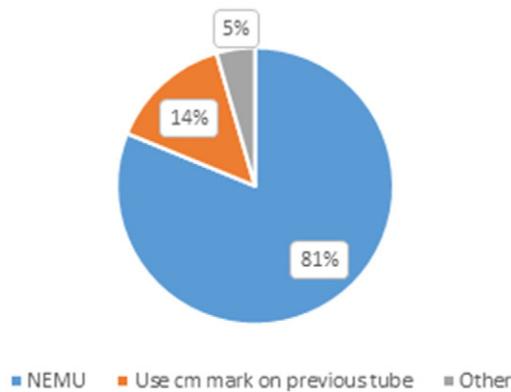


Fig. 1. Measurement Method – NEMU – Nose, ear, midway umbilicus.

Results

Simple descriptive statistics were used to analyze the data. These data were derived from the percentages provided by Survey Monkey. No statistical package was used. The study findings are reported in two cohorts, parents and homecare providers.

Parent Data

The parent data is from the parent group only. The data from the durable medical equipment (DME) companies is reported in the next section. There were 144 responses from parents who had a child in the home with an NGT. Parents were educated on NGT placement and verification prior to hospital discharge. The largest percentage of children (28%) were between 4 and 7 months of age with the second largest group (17%) between 8 and 12 months of age. Most of the children had an NGT in place (96%). The most common size tube was a 6F, (51%) however 23% of respondents did not know the size of the NGT. Forty seven (33%) of children had a tube in place for 0–3 months, while another 33% had a tube in place for 4–6 months.

Tube Replacement

When asked specific questions about tube placement, replacement and verification of the tube location, the responses reflect education that was assumed to have been received by the parents prior to leaving the hospital/agency. When asked who replaced a tube when it was dislodged, 102 respondents (71%) indicated that the primary caregiver, a parent, replaced the tube. Twenty (14%) of respondents took the child to a healthcare agency, and 17 (12%) indicated a health care professional replaced the tube.

When asked what measurement method they were taught to use when replacing the tube, ninety seven respondents (81%) measured from the nose to the earlobe to the xiphoid process to umbilicus and took the half-way point between the xiphoid process and umbilicus (NEMU) to determine tube depth. This NEMU procedure is described in the literature (Ellett et al., 2012). Fourteen percent of the respondents used the measurement from the previously placed tube (see Fig. 1).

Answers to questions related to verification of placement were varied. Verification through auscultation (listening with a stethoscope over the abdomen when air is pushed in) was approximately 44% of respondents; testing by pH was 25% of respondents; and 18% were taught to inspect return on stomach contents in the syringe. Other responses included a combination of auscultation and gastric aspirate inspection, a combination of pH testing and gastric aspirate inspection, or all

three methods. See Table 1 for results of methods of tube placement verification.

When asked how often the tube is routinely replaced, sixty seven (48%) percent of the respondents indicated that the NGT was routinely changed on a monthly basis. Twenty-five percent (35) changed the tube weekly and 11% (15) routinely changed the tube every two weeks. Other responses included daily, 2–3 times a week, every six weeks, every other month and every 3 months. Five respondents (4%) indicated the tube was replaced more than once a day.

When asked within the past month, how frequently a tube was replaced that was inadvertently removed, 33% of respondents (48) indicated that this had occurred at least monthly; 23% of respondents (33) indicated it occurred 2–4 times a week, 15% (22) indicated it occurred once per week, and 15% (22) indicated this occurred every two weeks.

When asked about complications for an NGT being incorrectly positioned, 74% (106) of respondents reported no known placement complications. Of the 25% (36) of respondents who indicated a complication, the reported signs and symptoms included: vomiting after feeding, high pH results, X-rays, no air in belly, coughing, gagging, “turning blue”, coiled in mouth, started making a funny noise, and “it didn’t feel right” when placed. Of this thirty six, 12 (33%), a full third indicated yes, a complication had occurred and reported additional symptoms of coughing, choking, gasping, crying, funny noise, and child irritability as symptoms noted. See Table 2 for list of comments related to complications.

Homecare Companies

Of the 66 homecare company respondents, 95% (63) had patients at home receiving NGT feedings. No questions in the survey asked who within the homecare company completed the survey. While the number of respondents was relatively low, they were geographically diverse from 21 states including 5 from the northeast, 6 from the south, 5 from the Midwest and 5 from the west. Agencies described their facilities as free standing, part of national homecare companies, or parts of a pediatric hospital. Of note, the majority of respondents', 64% (42) reported serving primarily a pediatric population. The others reported a mixed patient population, with a majority of those being pediatric patients. Yet the use of NGTs in the patients seen was low with two-thirds of the homecare providers indicating they had 0–5 patients at the time of the survey who required NGTs. Only one company had >50 patients at home with NGTs.

How the NGT was managed in the home showed wide diversity and was similar to the previously described findings above by parents. Routine tube replacement was documented as monthly by 11 respondents (17%) or weekly by 15 respondents (23%).

Table 1

If you as the caregiver replace the tube, how were you taught to make sure the tube is placed correctly?

Replacement measure you were taught	Number of respondents	% of respondents ^a
Total N = 136		
Auscultation	60	44%
Inspection of return of stomach contents in a syringe	25	18%
Testing with pH paper	34	25%
Combination of auscultation and inspection of contents	6	5%
Combination of inspection of contents and pH testing	5	4%
All three methods	3	2%
Other (8 responses removed as caregivers do not check tubes post replacement)	3	2%

^a Percentages rounded to whole number and may not equal 100%.

Table 2
If Yes, how did you know the tube was placed incorrectly?

Complication occurrence – how did you know?	Number of respondents Total N = 36	% of respondents ^a
X-rays	3	8%
Child coughing, choking, gasping, crying, funny noise breathing, irritable	12	33%
Took to the hospital	1	3%
Tube blocked	3	8%
pH incorrect	4	11%
Child vomiting	3	8%
Unable to auscultate air in abdomen	4	11%
Unable to aspirate stomach contents	3	8%
Tube in mouth	3	8%

^a Percentages rounded to whole number and may not equal 100%.

Respondents were asked to check all answers that apply to their practice for NGT placement confirmation. Auscultation was used by 39% (49) of respondents and inspection of aspirated gastric contents was used by 25% (32) of respondents. The use of pH to verify placement was listed by 28% (35) of respondents, some noted that they used pH when ordered by the tube feeding prescriber. See Table 3 for methods of placement used by respondents.

Discussion

Our study suggests the variability in practice related to placement and verification of NGTs in pediatric patients that is pervasive in the inpatient setting also exists in the home for this population. The lack of data regarding NGT placement, misplacement and/or complications, and how best to verify placement in settings where X-ray confirmation is not possible adds to the variability used when teaching families NGT care for home. The gold standard for NGT insertion is the abdominal X-ray and to date, no standards or guidelines exist that address the tube insertion or re-insertion which is often the case in the home setting. Additionally, guidelines or standards are lacking related to tube size, the use of pH to test for gastric aspirate or other alternatives that may facilitate identification of tube placement. This study is the first to report data from parents and homecare providers regarding practices related to NGT use in children in the homecare setting.

Nurses teach what they know, what they practice and what the institution procedures and policy dictate. When teaching a parent whose child is to be discharged with an NGT, the nurse must identify if the practice utilized in the inpatient setting will be consistent with that of the homecare provider. However, because there are no standards for best practice, policies/procedures and protocols for NGT placement and location verification, education for families will likely vary between institutions and homecare provider companies. This is confirmed in our survey responses and highlights the need to develop best practice guidelines for NGT placement and location verification in the pediatric population, particularly those in homecare.

Table 3
Verification methods identified by homecare agencies.

Method	Number and percent (respondents able to check all that apply, N = 126 responses) ^a
Auscultation	49 (39%)
Inspection of stomach contents	32 (25%)
Gastric pH assessment	35 (28%)
X-ray	2 (2%)
Not sure	8 (6%)
Other	3 (2%)

^a Percentages rounded to whole number and may not equal 100%.

Although the gold standard for NGT location verification remains the abdominal X-ray, many studies have demonstrated the use of gastric pH to be a secondary reliable indicator of NGT location when obtaining an X-ray is not practical (Gilbertson, Rogers, & Ukoumunne, 2011; Lyman et al., 2016; Methany et al., 1994; Ellett, 2004). This method of NGT location verification is not universally used, and has limitations, despite this, if testing gastric pH is consistently taught using correct pH value parameters, it could emerge as an initial step in establishing a standard of practice for NGT placement. Based on the study by Gilbertson et al. (2011), misplaced NGTs were identified with pH > 5.5, therefore the researchers concluded with reasonable confidence that gastric aspirate pH of ≤5.5 is safe, reliable, and indicative of tube placement in the gastric cavity in children.

The auscultation method, long used by nurses as a technique to assess NGT location is still being taught to families. Patient safety and practice alerts warning against the potential for patient harm associated with using the auscultation method to assess NGT location placement have been published since 2012. These publications should dissuade use and teaching auscultation as a method of tube placement verification, however studies show it (auscultation) is still often used in clinical practice (Lyman et al., 2016; Metheny, Stewart, & Mills, 2012; National Association of Children's Hospitals, 2012; American Association of Critical-Care Nurses, AACN, 2010; National Patient Safety Agency, 2012, <http://www.nrls.npsa.nhs.uk/resources/?EntryId45=129640>, Accessed 13 December 2016). Our data show auscultation continues to be taught to families and used by homecare agencies far more often than the use of gastric pH. Dissemination of the patient safety and practice alerts, paired with evidence based best practice guidelines to educate nurses, homecare agency personnel and families is necessary to change this practice.

NGT placement in the acute care, monitored environment can be alarming if the child develops symptoms of misplacement such as coughing, choking, and cyanosis. These symptoms can be even more foreboding for families in the home setting. Without prompt and appropriate intervention, an inappropriately placed tube can be life threatening, further emphasizing the need for standardization of care. Providing families and homecare personnel direction for safe NGT placement, identification of symptoms to be alert for that may indicate tube misplacement and what to do should misplacement with a complication occur are precautionary measures that each family should have readily available.

Patient and Tube Characteristics

Data from this study aligns with that of the NGT prevalence study in hospitalized children by Lyman et al. (2016), which reported an increased incidence of NGTs in younger children. The average age of a hospitalized child who required an NGT, OGT or post pyloric tube was 14 months, we report 51% of children <1 year of age in homecare require an NGT. Indicating that it may be our most vulnerable patients who are in need of an NGT for enteral feeding, medication and/or fluid administration and putting them at highest risk for misplacement and subsequent related complications. The adolescents identified in our data may reflect a growing trend toward using NGTs to optimize nutrition delivery for patients with chronic illnesses, such as Crohn's disease (Lyman et al., 2016; Abdelhadi, Rahe, & Lyman, 2016). Adolescent patients often self-insert their NGT and replace it daily to allow for school attendance, also putting them at increased risk due to number of times an NGT is removed and replaced. Evidenced based guidelines to direct NGT placement will help clinicians working with patients and families to monitor their practice and reinforce or reeducate as needed (Sevilla & McElhanon, 2016).

The sizes of feeding tubes reported were similar in our current study and the Lyman study (2016), size 6 French tubes being the most common diameter. In the Lyman et al. (2016), the author's report 65% of the children required an NG tube for <6 months duration, indicating it

to be a short term intervention. While Lyman et al. (2016), documented an overall prevalence of temporary enteral access device use at 24% in a pediatric in-patient population from the 63 participating centers, suggesting home NGT use to be less common. Of the homecare providers, ($n = 66$), 66% indicated they have 0–5 children at any given time receiving NGT feeding. These findings demonstrate a longer length of use than the findings of Rosen, where NGT use was on average 4.8 months. (Rosen et al., 2016)

An area that has not been previously described for children receiving NGT feedings at home is the feeding schedule. The use of continuous feedings, nocturnal continuous feedings or intermittent bolus feedings combined with continuous feedings suggests efforts by the family and healthcare team to customize the feeding regimen to meet the nutritional goals for the child and needs of the family. Variation and flexibility in the feeding schedule mimicking family established meal times allows the child freedom from a feeding pump and encourages interaction with their environment and family. For children in homecare who require NGTs, feeding schedules may also be created around school to enable the child to attend and participate in school learning and activities. There is a dearth of information on the long-term effects of these types of feeding regimens on development of oral feeding skills, and the effects of these types of feeding regimens on the social maturity of the child, an area for inquiry that can help establish a baseline for development of guidelines for practice for children at home on NGT feedings.

The homecare provider represents a diverse group of respondents representing both nursing agencies and/or branches of a national company. It is important to note the majority of respondents served a primarily pediatric population and therefore reflect the broad array of practices in this population. The differences in feeding tube management between homecare providers and parents further exhibits different practices and adaptations made by the parent to manage a child with an NGT at home.

Feeding Tube Replacement

Sixty seven percent of parents responded overwhelmingly that they replace the NGT when necessary. In contrast, the homecare provider survey indicated either the parent or a healthcare professional typically replace NGTs in the home as a shared responsibility. Parents reported transport to a hospital or clinic approximately 14% of the time for NGT replacement. Similarly, 10% of the homecare providers indicated the child must be transported to an outside facility for NGT replacement. This data relative to the need to transport to an outside facility after a misplaced tube has not previously been reported and raises concerns about resource allocation, delays in feeding and principles related to family-centered care. However, the responses from the homecare survey indicates there are some hospital based programs with a population of home patients requiring NGT feedings. In these programs, there are professionals who believe the safest approach to NGT replacement is to have the procedure performed by a trained healthcare professional and use of an abdominal radiograph for verification of NGT placement (Northington, 2014). It is likely some of the parents have been instructed to seek care at an outside facility for a misplaced tube by their managing healthcare team. With concerns about radiation exposure and the added burden of taking a child out of the home to place the tube, here is an identified need for technology to allow for accurate NGT placement verification in the home, which has yet to be developed and tested.

The technique of tube depth placement had similar responses from both the parent and homecare provider surveys. Both parents and homecare providers identified the NEMU technique as the most common method used in clinical practice to determine tube depth. Due to its widespread use among nurses, this data suggests that NEMU is a common method taught for use in the home. It is important to note, this technique grossly identifies desired tube depth, but may not be descriptive of tube tip location (Ellett, 2004; Farrington, Lang, Cullen,

& Stewart, 2009). Errors in external measurement using the NEMU technique risks tube placement being more distal or proximal than intended and again raising another concern regarding the need for a more reliable method for NGT placement to avoid the risk of tube misplacement. The second most common method listed by parents was use of the previous centimeter mark identified on the tube, presumed to be accurate during the hospital stay. It is not known who the respondents were on the homecare provider survey, therefore we are unable to accurately interpret responses on this item.

How often tubes are replaced in the home has not been previously reported. Frequency of NGT replacement varied in our study. Critch et al., 2012, identified that a prolonged interval for NGT change, 6–12 weeks, raises concern for retrograde bacteria movement up the NG tube. However, the prevalence of this in the homecare patients has yet to be determined. Without an evidenced based, clinical standard for duration of NGT placement, current practice in the home setting may be reflective of third party payer reimbursement over clinical judgement.

The frequency of unplanned, inadvertent NGT removal in our study ranged from daily to between 2 and 4 times per week. We are unaware of previously published data on this aspect of home NGT use in pediatric patients. Inadvertent tube removal may be unavoidable, family education for home NGT use should include techniques to prevent or minimize unintentional tube removal. In a retrospective chart review, Rosen et al. (2016) note inability to keep the tube in place as a reason parents used to discontinue enteral feedings for their child. Methods and devices for securing and NGT are an important aspect of NGT use and care and considerable variability currently exists. Our data suggests NGT securement to be an area for product development, healthcare provider, patient and family education. A review of the literature in adult intensive care patients found five studies addressing NGT securement methods. Although the use of tape to secure NGTs was the most common method used, use of nasal bridling to secure the NGT across the nasal septum reduced the rate of unintentional tube removal (Brugonilli, Ambrosi, Canzan, & Saiani, 2014). Further inquiry into NGT securement in children is needed.

Feeding Tube Placement Verification

While there was agreement in our results between parents and healthcare providers regarding NGT placement verification, current data suggests many methods used are inconsistent (Irving, Lyman, Northington, Bartlett, & Kemper, 2014; Longo, 2011; Ellett et al., 2012). The majority of both survey respondents indicated auscultation to be the most common method used to verify NGT placement followed by inspection of gastric contents. This translates to parents being educated to use the auscultation method for NGT placement. Auscultation is unreliable and potentially dangerous due to the proximity of the lungs and gastric cavity, both being resonant organs that allow air instilled in one area to be heard in another (Metheny et al., 2012). The use of auscultation for NGT placement verification has been the subject of a Child Health Patient Safety Alert both in this country and in the United Kingdom (Safety alert, 2012; National Patient Safety Agency, UK, 2011). In a practice alert issued in 2012, The American Association of Critical Care Nurses describes the auscultation method as unreliable. Despite this, a survey of adult critical care nurses indicates poor adherence to hospital policies, by using the auscultation method for NGT placement even with knowledge that the auscultation method should not be used (Metheny et al., 2012). While it is suggested to use more than one method to verify the accuracy of any procedure, the use of multiple unreliable methods leaves uncertainty in the accuracy of placement verification. However, in the absence of X-ray for confirmation, a combination of these methods along with patient assessment and observation are currently what families and healthcare providers use in the homecare environment. To date, this is the base we can offer, short of a transport in for X-ray verification.

Testing of gastric pH is another commonly used method for verification of NGT location. In the study by Gilbertson et al. (2011), researchers examined >4000 samples of gastric aspirate in children, compared to endotracheal aspirates and determined gastric pH of <5 provides a 90% confirmation rate for a correctly placed NGT (77% when antacid medications are in use, (Gilbertson et al., 2011)). Testing of gastric pH was the second most common method used in our study to verify NGT placement. Use of gastric pH is identified currently as the best evidence based practice for bedside verification of NGT placement when abdominal X-ray is not desirable or not available (Irving et al., 2014; Taylor, 2013). No parents and only 2% of the homecare providers listed the use of an abdominal radiograph to verify placement of the NGT. This aligns with pediatric inpatient practice where use of X-ray to determine NGT placement is used judiciously as it is unknown if there is a cumulative effect of radiation exposure (Hart, 2006; Leinerman, 2006). However, a radiograph considered the 'gold standard' for NGT placement, as identified by a 2012 Patient Safety Alert and by the American Society for Parenteral and Enteral Nutrition (Safety Alert, 2012; Bankhead et al., 2009), is none-the-less impractical for the homecare patient.

In addition to use of gastric pH, inspection of gastric contents is also widely used to determine NGT location. The same study by Gilbertson et al. (2011) found nurses in the inpatient environment had difficulty discerning gastric contents from endotracheal aspirate. It is therefore likely that parents and healthcare providers working in the home may have the same difficulty determining the source of body fluids.

Misplaced NG Tubes

Studies of neonatal patients document misplaced tubes in nearly 50% of infants (Quandt et al., 2009; deBoer, Smit, & Mainous, 2009). Misplaced tubes are those in a location other than what is originally intended (Quandt et al., 2009; Gilbertson et al., 2011; Creel & Winkler, 2007). While the child may not be harmed, there is potential for harm if a child aspirates from an NGT in the esophagus or has diarrhea after an intermittent feeding is delivered into the small bowel instead of stomach. It is often challenging for clinicians to discern tube misplacement, yet this decision-making is placed on families in the home setting (Quandt et al., 2009; deBoer et al., 2009). Quandt et al. (2009) reported only 41% optimal positioning in their review of 381 consecutive radiographs in neonates for placement of oral or nasogastric feeding tubes, more than half, 59% had been placed incorrectly. Creel and Winkler (2007) reported five cases of errors in placement of oral/nasal enteral tubes in a pediatric intensive care unit. All five cases resulted in placement of the feeding tube in the respiratory tract, with three of the five children experiencing worsening of their respiratory status. Although there are additional risk factors to consider for ill hospitalized children, these studies highlight the challenges of NGT placements by highly trained healthcare providers. Families will perform as taught and emulate the practice of nurses from the in-patient setting. Homecare providers may have varied techniques related to determination of correct NGT placement, creating an inconsistency in ongoing family education and support. Simply stated, if highly trained professionals have varied methods and techniques that cause error in placement, the burden for family providers is even greater. Recognizing the implications for patient safety and standardization of practice, investigators have called for more accurate measures to determine NGT placement depth (Quandt et al., 2009; Metheny et al., 2012; Anderson, Buckle, & Hanna, 2012).

NGT misplacement is not limited to pediatric patients. In a study of >2000 NGT placements in adult patients, investigators found between 1.3 and 2.4% misplaced tubes, with 68% of these in the pulmonary bed and resulting in complications (Sorokin & Gottlieb, 2006). In another adult study comparing X-ray verification of feeding tubes in 729 patients, 1822 of which were NGTs, investigators identified 3.2% of the tubes in the pulmonary bed causing pneumothorax in nine (1.2%) of subjects and four deaths (de Aguilar-Nascimento & Kudsk, 2007).

Evidence based, standardization of practice across the lifespan may help minimize such incidents.

Other parent comments equally concerning included "child hysterical", "incorrect pH", and "inability to breathe properly". The presence of these symptoms are highly suggestive of pulmonary placement of the NGT, which can be a life threatening event. The high percentage of parents responding affirmatively that NGT misplacement has happened in the home has not been previously reported.

Misplaced feeding tubes in a home setting are challenging as the signs of tube misplacement can initially be subtle, but quickly escalate, or signs of an acute change in the child can present immediately. Whether the outcome for the child is no harm, serious morbidity or death, the guilt incurred by the parent is apt to be lifelong. A commentary by Kemper details the guilt felt by a mother who did not place the NGT but asked a number of questions of a nurse and still her son suffered inadvertent pulmonary placement which proved to be fatal (Kemper, Northington, Wilder, & Visscher, 2014). A second victim in this same statement is a nurse who accidentally misplaced an NGT, verifying placement using auscultation, the hospital endorsed method. It is incumbent upon all healthcare agencies to assure NGT management and placement verification procedures are developed based on current evidence.

Future Directions

Placement of NGT is a skilled nursing competency. While medically necessary, this is a big responsibility to ask parents to perform in the home, it is incumbent on healthcare providers to continually evaluate the policies and procedures employed related to the use of NGTs. The results from this study, stimulate many questions about NGT placement, use and management in the home. These include:

- Are NGT replacements safe to be done in the home by healthcare professionals and/or parents?
- How do we identify and achieve best practices for NGT placement and verification?
- How can methods of verification become consistent across the lifespan in all healthcare delivery settings?
- Does the homecare provider have an obligation to re-educate families on appropriate placement verification procedures? With what frequency?
- Who is responsible for verifying the competence of parents who are performing essentially a nursing skill at home?
- What should be the standard of care for patients in the home?
- Should there be more diligence by hospital based nurses regarding teaching parents about NGT placement?
- Is there a role for Enteral Access Safety Team nurses in homecare?
- What is the culture of safety for the home setting where there is a child with medical/nursing care needs?
- How do nurses and other health care providers assist with ongoing safety measures that are realistic and cost effective?
- How do nurses and other health care providers support the family and child in case of an emergency?
- Is there follow-up for the parent after such an occurrence (i.e., misplaced tube that cause an adverse event)?

Additional questions related to infectious risks and potential for skin injury related to prolonged use of NGTs, particularly in homecare are unaddressed. To date there is no clinical standard for how long an NGT should remain in place. The unanswered questions related to the study of NGT placement verification in the acute care and homecare setting provides numerous opportunity for inquiry to expand our knowledge and understanding surrounding use of NGTs in homecare pediatric patients and to provide data on which to base best practice guidelines.

Limitations of the Study

There are limitations to this study that should be acknowledged. The surveys used in this study were developed by the research team. Although vetted by the study team and members of the larger NOVEL project team, we have not tested and established their reliability however, content validity was established prior to distribution. Use of the Survey Monkey platform and recruitment in the manner done, we are unable to determine a response rate. The researchers had no way to determine how many people were contacted to complete the survey. We only have the data for those surveys that were completed. There were no phone calls or email follow up for potential participants. There was a reminder sent monthly to the participants of the original study to remind them to ask for volunteers to complete the survey. We did not collect demographic data related to those who completed the homecare provider survey, therefore the responses may vary depending on the professional responsibilities of the individual completing the survey on behalf of the agency. The surveys did not and were not designed to link a particular child to a particular homecare provider/agency. We were most interested in NGT placement and methods used for verification, therefore, we did not collect data on type of pH testing or on the value used, only that pH testing was a method used for NGT location verification. The participants represent a very small sample of the population of interest, therefore our results cannot be generalized to the larger pediatric homecare community that utilize NGTs, however these data provide a snapshot of the challenges related to NGT use with children in the home setting.

Practice Implications

The results of the two surveys used in this study (one for the parents and one for the homecare companies) highlight inconsistencies in practice surrounding the care of pediatric patients with NGTs in the home, in particular, methods used to verify NGT placement. This study clearly demonstrates the need for and development of standardization of best practice guidelines and widespread education of nurses, parents and homecare providers regarding reliable and appropriate method(s) to verify NGT placement. Many parents use auscultation as they were taught, however, based on safety alerts and current literature, this practice should be immediately discontinued. Pediatric guidelines and practice alerts warn against use of auscultation to test NGT placement in children; therefore, it is troubling that it was used by 44% of the parents and 39% of the caregivers in our survey. An evidenced based procedure for verification of NGT placement that can be used by home healthcare professionals and parents is needed. Our study showed evidence that pH testing for NGT placement is growing in acceptance in practice settings.

Conclusion

This study demonstrates a knowledge deficit regarding NGT management in homecare patients, with particular challenges surrounding replacement of NGTs, and methods used to verify NGT placement. While it is unclear how often NGTs are used in the home, respondents were geographically diverse making it likely that this is a common therapeutic intervention in pediatric patients. The responses provide exposure to the experience of parents and homecare providers, while identifying variations in practice. These results address a gap in both practice and the literature not previously recognized, and serves as a mandate for clinicians in all healthcare settings to develop and provide consistent and evidence based practice for children who require NGTs in the home.

Conflict of Interest

There was no funding for this study or conflicts of interest to report.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <http://dx.doi.org/10.1016/j.pedn.2017.01.005>.

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