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Lose the Whoosh: An Evidence-Based Project to Improve NG Tube Placement Verification in Infants and Children in the Hospital Setting

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ABSTRACT

Purpose: The purpose of this EBP project was to align NG and OG tube placement and verification practices with evidence-based recommendations for children.
Practice change: An evidence-based NG/OG Tube Placement Algorithm was developed. The algorithm provided an individualized approach based on patient condition as well as a tiered approach that incorporated radiographs, tube measurement and marking, and pH testing.
Methods: A systematic appraisal of literature identified 40 studies supporting the development of the practice change. A 9-item questionnaire was administered to nurses across five pediatric units to assess current tube verification practices. Education was provided in participating units through a Competency Fair. Post-implementation evaluation included re-administering the practice survey and conducting a chart audit of NG/OG events occurring in the year following the practice change.
Results: Seventy-one nurses completed the pre-implementation survey; 64 nurses completed the post-implementation survey. Strategies for checking NG/OG placement varied across units prior to implementation; however, auscultation was the most likely to be used strategy and assessing pH was the least likely to be used strategy across units. Post-implementation, aspiration and checking pH were the most frequently endorsed assessment strategy, and auscultation was the least endorsed strategy. The post-implementation chart audit revealed that 73% of NG/OG tubes were checked for placement on insertion with radiograph or aspirate pH.
Conclusions: Implementation of an NG/OG Tube Placement Algorithm standardized NG/OG care across five pediatric units. Additional efforts are underway to further improve adherence to protocol in order to ensure safe, evidence-based practice for children with NG/OG tubes.

Problem description

Placement of pediatric nasogastric (NG) and orogastric (OG) tubes occurs commonly in the inpatient and outpatient areas, as well as in the home setting. The access provided by NG or OG tubes allows enteral nutrition and medication administration in children unable to swallow, suck, or manage oral feeding and/or medications. Though critical for growth and development and medication administration for disease management and health maintenance in some children, the procedure is not without risk. The primary concern is accurate placement and maintenance of the appropriate location for the duration of therapy. Greatest risks come from accidental pulmonary insertion with consequent instillation of feeding or medication (Creel & Winkler, 2007).

The most definitive method of verifying placement is through radiographic studies. However, many tubes are inserted without x-ray verification due to the cumulative effects of exposure for infants and children. The reported rate of incorrect placement in the literature ranges from 20% to 59% in infants and children (Ellett, Maahs, & Forsee, 1998; Quandt, Schraner, Bucher, & Mieth, 2009). Although the number may be low, the consequence of NG/OG misplacement with infusion of fluids or medications into the pulmonary track can be fatal. Tubes placed incorrectly have been reported to cause pneumothorax, hydropneumothorax, esophageal perforation, urinary bladder perforation, and death (Metheny & Titler, 2001).

Although the conclusive method for assessment and verification of location of NG and OG tubes is the x-ray, a variety of approaches are discussed in the literature (Dias et al., 2017; Huffman, Jarczyk, O'Brien, Pieper, & Bayne, 2004; Metheny & Titler, 2001). Practice varies from nurse to nurse and institution to institution. Historically, when radiographs were not available, nurses injected air into the tube while

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auscultating over the abdomen. The potential for referred sound has led to incorrect assumptions of appropriate placement, resulting in events ranging from temporary respiratory distress to death. Recognizing significant risks and implications, the Children's Hospital Association released a Patient Safety Action Alert regarding blind NG tube placements in 2012 (National Association of Children's Hospitals). In 2009 and again in 2016, the American Association of Critical Care Nurses echoed these grave concerns and issued a practice alert regarding blind placement of feeding tubes, noting the high frequency of use and the potential serious complications—leading to and including death.

Parents and caregivers face an even greater challenge in caring for children with NG or OG tubes, often utilizing the Emergency Departments for support and management when clinics are unavailable. In addition, families often receive their initial education on tube placement and verification in the hospital or clinic setting. Nurses in a Pediatric Subspecialty Clinic observed that parents often lacked comfort and competence with the maintenance of tubes and management of accidental removal. In addition, through their consultations to pediatric units (including nursery, neonatal intensive care, pediatrics and pediatric intensive care) for tube placement, these nurses identified variation in both nursing practice and patient education for children with NG and OG tubes. These observations prompted nurses in the Pediatric Subspecialty Clinic to apply for an Evidence-based Fellowship within a tertiary care facility to address this practice problem.

Through this fellowship, a clinical expert nurse with over 30 years inpatient and outpatient pediatric experience, a pediatric Clinical Nurse Specialist, and a Nurse Researcher undertook the assignment to determine specific, reasonable, evidence-based guidelines for frontline nurses. The purpose of this EBP project was threefold: First, to determine the safest methods for assessing placement of NG tubes in infants and children; second, to measure current practices in the placement and verification of location prior to NG tube feedings in infants and children; and lastly, to align nursing care with evidence-based recommendations.

Methods

Setting/Context

The setting for this Evidence-based Practice project was a 587-bed teaching hospital located in the upper Midwestern United States; it is a level one-trauma center with Magnet designation. The Children's Center includes a 45-bed regional neonatal intensive care unit, a nursery with 6000 births per year, a 30-bed pediatric unit, a 12-bed pediatric intensive care unit, and a pediatric outpatient surgery unit with approximately 3000 cases per year.

Development, description, and implementation of the practice change

A systematic review of the literature from 1995 to 2014 provided the evidence for development of an algorithm to ensure the safest strategy for placing NG/OG tubes in infants and children. The literature search was driven by the following PICO statement: What is the safest strategy for verifying NGT placement in hospitalized infants and children. This search strategy yielded 40 studies, ranging in level of evidence from 1 to 7 and representing a variety of practice settings including urban and community hospitals, tertiary care centers, children's hospitals, and outpatient pediatric settings.

The Child Health Patient Safety Organization (PSO) provided a critical piece of evidence by recommending the immediate discontinuation of auscultation for assessment and verification of NG and OG tube placement (National Association Children's Hospitals ECRI Institute, 2012). The recommendations from the Child Health PSO, American Association of Critical-Care Nurses (2009, 2016), Society of Pediatric Nurses, American Society for Parenteral and Enteral Nutrition (ASPEN), and several others, prompted the formation of The New Opportunities for Verification of Enteral Tube Location (NOVEL) Project. Through the NOVEL Project Work Group, Irving et al. (2014) identified the long-standing challenges for placement and verification of NG tubes in the pediatric inpatient and outpatient settings. Metheny and Meert (2004) and Metheny, Stewart, and Mills (2012) have identified similar issues in the adult population. In working for practical, reliable, and effective methods to assess placement, Meert, Caverly, Kelm, and Metheny (2015) focused on the use of gastric pH in infants. In the absence of radiograph, evaluating pH of gastric aspirate is the first line for assessing tube placement (Ellett, 2004; Farrington, Lang, Cullen, & Stewart, 2009; Metheny, Aud, & Ignatiavicius, 1998; Patient Safety Alert, 2011; Peter & Gill, 2009).

Together, this evidence in addition to the protocol development work of Wilkes-Holmes (2006) provided the foundation for the development of the Evidence-based Algorithm for Management of Naso/Orogastric Tubes in Infants and Children (see Fig. 1), which included steps for assessing placement on initial insertion, as well as when the tube is in place. Guidance also addressed children with neurologic deficits or altered reflexes. The algorithm was designed to 1) guide nurses in evidence-based placement assessment and verification strategies for NG and OG tubes, and 2) guide teaching for families of infants and children discharged home with feeding tubes.

Concurrent with the synthesis of evidence, a baseline audit of knowledge and practice provided a starting point for designing the algorithm and staff education. A nine-item questionnaire was distributed to nurses in the Neonatal Intensive Care Unit, Nursery, Pediatrics, Pediatric Intensive Care, and Pediatric Outpatient Surgery. The goal of the baseline audit was to measure current practice in placing NG/OG tubes for feedings, as well as methods used to verify NG/OG tube placement at insertion and during use. Knowledge of when to check placement, signs and symptoms of misplaced or displaced NG/OG tube, and documentation patterns were also assessed. The responses reflected the difficulties with verification of tube placement and, most importantly, the lack of one set, practical method for determining correct tube placement. Nurses used auscultation, x-ray (when ordered), pH of aspirate, tube measurement, and visualizing secretions. Even though 74% of respondents correctly recognized the limitation of auscultation, 88.7% indicated that auscultation was their primary method of checking placement. Pre-implementation, only 11% of respondents indicated that they used pH for checking correct tube placement.

These data were used to plan subsequent educational strategies and to engage caregivers and key stakeholders early in the change process. The baseline survey results and education on evidence-based practice for NGT placement verification were provided to unit representatives, including frontline nurses, nursing administration, and physicians from all involved units. The algorithm was refined with input from each unit to assist nurses in selecting the most appropriate tube verification strategy. Staff determined the best way to operationalize assessing pH (where to place pH paper, how to maintain quality assurance process). Staff education focused on two areas: 1) NGT placement using an anatomical measure from nose to earlobe to mid-umbilicus [NEMU] (Ellett, Perkin, Croffie, Lane, & Austin, 2012) and 2) tube placement assessment using pH measurement with gastric pH ranges of 1–5 (Khair, 2005). The staff education was provided for each unit at Competency and Skills fairs that achieved 97–100% staff attendance from the five units. In addition, NGT champions were recruited from each unit. Changes in the electronic medical record were implemented to allow easy documentation of evidence-based tube verification strategies. Specifically, auscultation was removed as a verification method and rows were added to allow documentation of gastric pH and tube depth every eight hours.

Evaluation plan

Both process and outcome indicators were measured to evaluate the impact of this practice change implementation. A summary of these indicators follows:

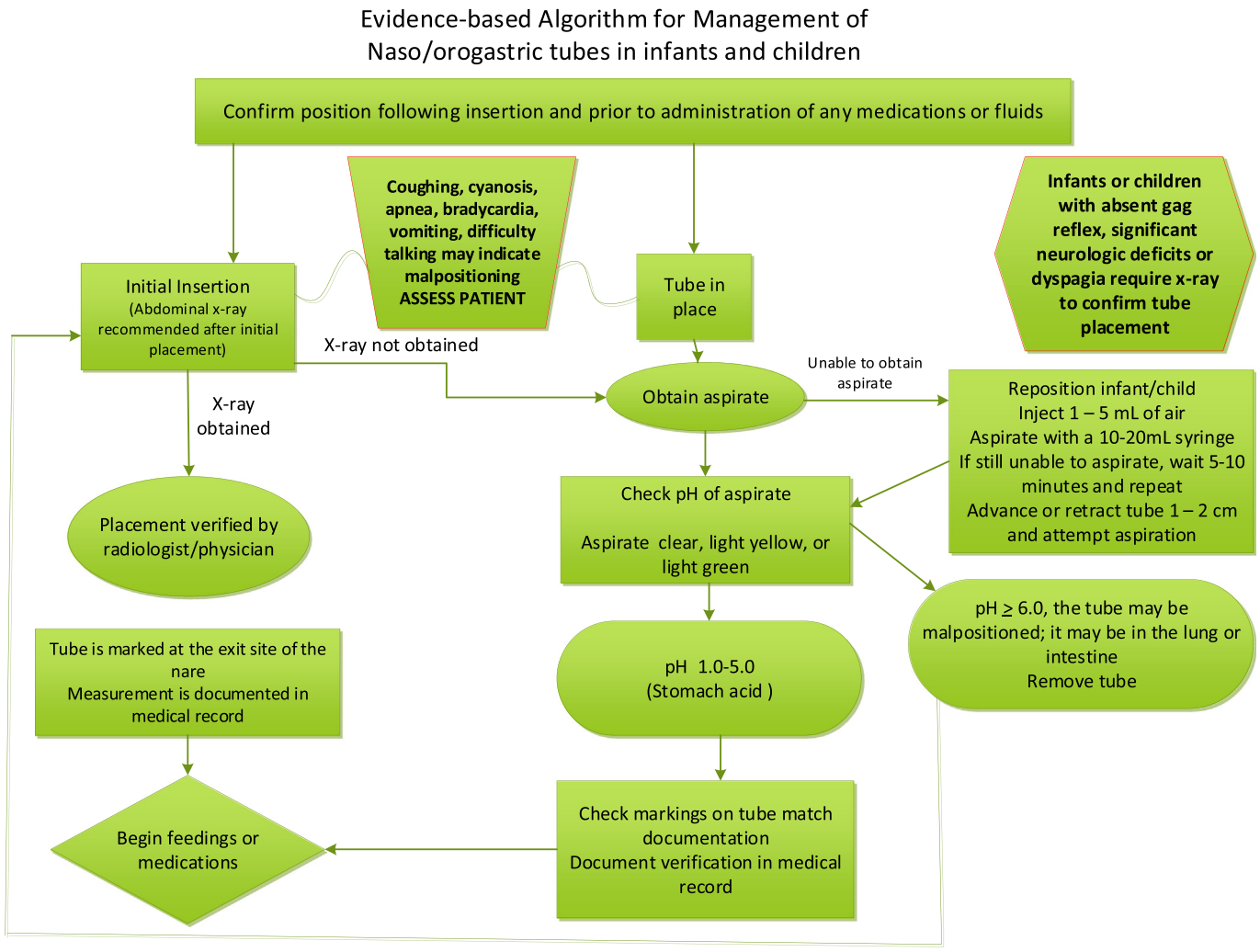

Fig. 1. Evidence-based Algorithm for Management of Naso/Orogastric Tubes in Infants and Children.

Staff knowledge and current practice

Staff knowledge and practice were measured using an EBP team-developed survey modeled after the work of Bourgault et al. (2014). The 9-item multiple-choice, pre-assessment tool measured staff perceptions of their usual strategy for verifying placement. The 11-item post-assessment included two additional questions to measure: 1) the extent to which staff were able to locate pH paper on their unit, and 2) their overall perception of whether their practice has changed. The knowledge and practice assessment was re-administered 6 months following the practice change.

Staff participation in training

Percent of staff attending the competency fairs were monitored as a process measure of protocol implementation. From the *five* clinical areas, participation ranged from 97 to 100% of all frontline registered nurses.

Adherence to protocol

Adherence to protocol was measured through chart audits over a four-month period of time post protocol implementation. This audit identified 99 infants and children with 231 NG or OG tubes placed during the 4-month time period. Chart audits of each event evaluated the first and last 48 h of feeding tube placement. Variables assessed were selected to determine the use of pH measurement at appropriate intervals and documentation of tube depth with each feeding. Specific variables included documentation of x-ray, whether or not pH was checked on insertion, pH value recorded, length of tube documented, and pH checked every 8 h.

Data analysis

Pre and post- implementation survey data were entered into an Excel spreadsheet and checked for accuracy. Chart audit data were retrieved directly into an Excel spreadsheet for analysis. Data analyses for this project were completed using SPSS Statistics software, Version 24.0 (SPSS, Inc., Chicago, IL). Summary statistics were calculated in order to describe nurse survey participants, key variables, and to test for relevant assumptions. Chi-square analyses were used to compare selected indicators pre- and post-implementation.

Results

Staff knowledge and practice pre-implementation

The pre-implementation performance assessment was completed by 71 nurses with a mean years of experience of 19.6 years (S.D. 11.5, minimum – 1 year, maximum – 42 years). Prior to education and practice change, auscultation was the most likely (n = 62, 88%) to be used strategy for assessing tube placement across all units. Assessing pH was the least likely (n = 8, 11.3%) strategy to be used. Seventy-four percent (n = 52) of respondents accurately indicated the primary problem

associated with auscultation is transmission of sounds to the epigastrium regardless of tube location. In assessment of implications of level of pH in relation to gastric placement, <10% of respondents accurately indicated the pH of stomach aspirate (pH = 1.0–5.0). Respondents were not able to identify all symptoms of improper tube placement.

Staff knowledge and practice post-implementation

The post-implementation knowledge and practice survey was completed by 64 nurses. The percentage of respondents who correctly indicated the primary problem with aspiration increased from 74% to 94% ($\chi^2 = 14.9$, df = 1, $p < 0.0001$). Aspiration and checking pH were the most frequently endorsed assessment method (n = 59, 92.2%) and auscultation was the least endorsed method (n = 20, 31%). Seventy-three percent (n = 47) of respondents indicated they could routinely find pH paper; 70% (n = 45) of the nurses indicated their practice had changed since the implementation of the algorithm.

Adherence to protocol

To evaluate a sustained change in practice, 231 events of nasal or oral enteral tube placement over 4 months in infants and children were audited for compliance with the evidence-based algorithm a year following the practice change. Twenty-three percent of NG/OG tubes were checked for placement on insertion with radiograph following implementation of the algorithm. Of those events without x-ray verification, 65% had pH level documented at appropriate intervals per protocol. Ninety-one percent of the tube placement events had documentation of tube length. Of those events without documentation of x-ray or pH measurement, 15% had evidence of visual inspection of aspirate. No evidence from the chart audit indicated use of auscultation.

Discussion

We were successful in developing and rolling out an Evidence-based Algorithm for Management of Naso/Orogastric Tubes in Infants and Children by providing extensive staff training, engagement of unit champions, modifying documentation cues and options in the electronic medical record, and consequently implementing a practice change. Notably, nurses reported a substantially decreased use of auscultation as a strategy for tube placement assessment in a self-report practice audit immediately following implementation. The use of pH for assessing appropriate tube placement substantially increased. In addition, nurses consistently documented tube length upon insertion.

We also experienced challenges consistent with those reported by other nurse researchers in implementing evidence-based practice in the clinical setting (Melynk, Fineout-Overhold, Gallagher-Ford, & Kaplan, 2012, Smith-Strom, Oterhals, Rustad, & Larsen, 2012, Melynk, Fineout-Overhold, Long, & Gallagher-Ford, 2014; Melnyk et al., 2017, Wallis, 2012). Examples in the literature of other tube placement verification practice change efforts are limited. As recently as 2017, however, Northington, Lyman, Guenter, Irving, and Duesing (2017) found 44% of feeding tube placement verification was by auscultation in parents and homecare providers of pediatric patients. Similarly, Lyman et al. (2016) found wide variation in tube placement assessment and verification strategies in multiple pediatric and neonatal units. Likewise, Bourgault et al. (2014) reported incomplete adoption of evidence-based tube verification strategies in the adult critical care setting despite being aware of an associated practice alert. Use of outdated methods and practice, even in the homecare setting and critical care setting, despite safety alerts and warning highlights the challenge of implementation and practice change. In evaluating a hard-wired practice change, indicators of adherence to protocol, as evidenced by chart review, suggest continued areas for improvement. For example, documentation of checking pH and documentation of the specific pH value were less consistent across the units.

Several steps are planned to address these opportunities for improvement and to further support the sustained uptake of the tube placement algorithm. For example, chart audit data will be shared with bedside caregivers, unit educators, and department managers. The EBP team is also checking in with the unit NG champions and unit educators to assure that the training modules are included with orientation to each unit and with annual competency fairs.

Despite challenges and lessons learned, this project had notable strengths. This project occurred within a formal evidence-based practice fellowship framework, demonstrating an overall supportive environment for development and evaluation of evidence-based practice changes. This EBP infrastructure provided for the collaboration between bedside expert clinicians, a clinical nurse specialist, and a nurse researcher——a collaboration that was critical to the synthesis of evidence, development of the algorithm, the credibility of the staff education efforts, and the design of a comprehensive evaluation plan. The development of consistent, evidence-based guidelines for practice in the acute care pediatric setting also serves as a model for teaching families discharged with a child or infant with a feeding tube. The development of an education plan for children and infants being sent home with feeding tubes has been developed for families and incorporated into the electronic medical record for consistent, comprehensive discharge teaching. In conjunction with this project, the Pediatric Subspecialty clinic is forming a multidisciplinary team to assist parents in meeting the needs of their children at home using a coordinated, collaborative approach.

Conclusion

Evidence-based insertion and verification of NG/OG tubes in pediatric patients is life-saving and essential to safe, quality care. Nurses in the acute care settings place most of these tubes. Further research is needed to verify effectiveness of protocols and establish consensus on approaches for specific populations. The greatest challenge continues to be the dissemination of evidence-based protocols and sustained implementation into current practice. The implications of the protocol spread beyond acute pediatric care to outpatient settings, and any area providing family teaching on NG/OG placement.

Additionally, families managing NG/OG tubes for children at home need evidence-based, consistent resources and support. Access to resources for cases where replacement or trouble-shooting is challenging is critical. Feeding clinics that address not only the issues of oral feeding and formula recommendations, but also the ongoing management of NG tube can provide the needed expertise and reinforcement for a vulnerable population.

CRediT authorship contribution statement

Mary A. Kisting: Conceptualization, Investigation, Writing - original draft, Writing - review & editing, Supervision. **Layna Korcal:** Conceptualization, Investigation, Writing - review & editing. **Debra L. Schutte:** Conceptualization, Methodology, Formal analysis, Writing - review & editing, Supervision.

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