National Survey of Gavage Feeding Practices Used in Very Low Birth Weight Infants

DNP Final Project

Presented in Fulfillment of the Requirements for the Degree Doctor of Nursing Practice in the Graduate School of The Ohio State University

By

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2011

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Chapter One: Nature of Project

Prematurity is a significant problem in the United States. In 2008, 12.3% of all infants were born before 37 weeks gestation. Very low birth weight (VLBW) infants, those infants born at less than 1500 grams, made up 1.5% of all deliveries in 2008, a total of 63,715 infants (Centers For Disease Control And Prevention et al., 2010). Optimal nutrition is key to the survival and outcomes of these infants. VLBW infants receive gavage feedings until maturation of the suck-swallow mechanism. Gavage feeding is a complex task that is performed many times each day in the NICU, as often as every three to four hours. Across most NICUs, this is considered a basic nursing function. The need for gavage tube feedings may last weeks to months.

Providing gavage feedings to a preterm infant is a multiple step process that requires the nurse to make a series of decisions. The initial decision-making involves insertion of the gavage tube including determination of whether the tube will be inserted via the oral or nasal route, what type and size of tube to use, correct placement of the tube and accurate assessment of successful placement. Following insertion, the nurse must determine the best method (gravity or pump) for controlling the rate of feeding, proper use of the selected method, and monitoring the preterm infant for compromise and complications. The gavage feeding process continues until the preterm infant achieves full oral feeding.

Despite the fact that gavage tube feeding is one of the most common procedures performed in the NICU, very limited research has been conducted in this area and there are no nationally published standards related to gavage tube feedings. Given the growing numbers of VLBW infants surviving and requiring gavage feedings and their immature and developing physiology, it is critical that sound evidence be established to guide this procedure.

Iatrogenic complications are a serious issue in the neonatal intensive care unit (NICU) and can occur as a result of gavage feeding. Often times these complications result from a lack of sufficient evidence to guide practice (Ramachandrappa & Jain, 2008). As will be presented, evidence is lacking to guide this practice.

Purpose and Significance of the Problem to Nursing and Health Care

Nursing practice is organized around the activities of health promotion and disease prevention, which in practice dedicated to the care of VLBW infants, are activities to sustain optimal health and prevent complications. These two functions, health promotion and disease prevention, are among the priorities set forth by the National Institute for Nursing Research. Several other stakeholders have identified care of the preterm infant and prevention of morbidity as priorities. In 2003, the March of Dimes launched a campaign to prevent prematurity and the long term complications associated with prematurity. In 2006, President Bush signed into law public law 109-450 the "Prematurity Research Expansion and Education for Mothers who deliver Infants Early" Act (PREEMIE) Act. In 2006, the Institute of Medicine published a report entitled *Preterm Birth: Causes, Consequences, and Prevention*. The common theme across these stakeholders is that it is imperative that outcomes for preterm infants be improved. Ninety one percent of VLBW infants will develop growth failure by 36 weeks postmenstrual age (Fanaroff et al., 2007). Growth failure was defined as a weight less than the tenth percentile for gestational age. Adequate nutrition to support optimal growth is essential to ensuring brain growth during this period of rapid brain development. Without adequate nutrition brain growth suffers and cognitive development is at risk for compromise.

Despite the regularity with which this procedure is performed, there is a surprising lack of empirically derived evidence to guide the performance of gavage feedings in VLBW infants. This is unacceptable given the importance of gavage feedings to the survival of these vulnerable infants. The insertion and use of gavage feeding tubes poses a possible risk of injury to the preterm infant. Safety issues include misplacement of the tube into the lung or small intestine, migration of the tube outside of the stomach, perforation of the trachea, esophagus, or stomach, and aspiration of the feeding into the lungs (Ellett, 2004). Because of these potential adverse events, it is critical that NICU protocols developed for this procedure are based on the best available evidence. Safety issues surrounding the gavage feeding process ultimately impact nutritional intake and growth because feedings are stopped or withheld until resolution of the issue.

Project Objectives

The goal of this project was to provide initial data about current gavage feeding practices for VLBW infants in Level III NICUs in the United States as well as complications associated with the procedure. The results of this study will increase nursing awareness of variation in practice and the limited data available to support current practice. These data can also be used to assist in setting priorities for future research related to gavage feeding practices in the VLBW population. Ultimately, research in this area can be used to identify best practices and formulate strategies for the safe insertion and use of gavage tube feedings and to ensure that the maximal effectiveness of enteral nutrition. The specific aims of this project are to:

1. Describe current gavage feeding tube practices across Level III NICUs in the United States.
2. Report nurse observed complications associated with gavage feeding tube practices across Level III NICUs in the United States.
3. Assess nursing beliefs about the evidence base supporting current tube feeding practices and potential consequences.

Chapter Two: Review of Literature

Conceptual Framework

Inherent in the care of VLBW infants are at least three risk factors that make them uniquely susceptible to the complications of gavage feeding. These risk factors include their immature anatomy and physiology, the lack of evidence to guide care and the rapidly changing equipment and technology used in the NICU.

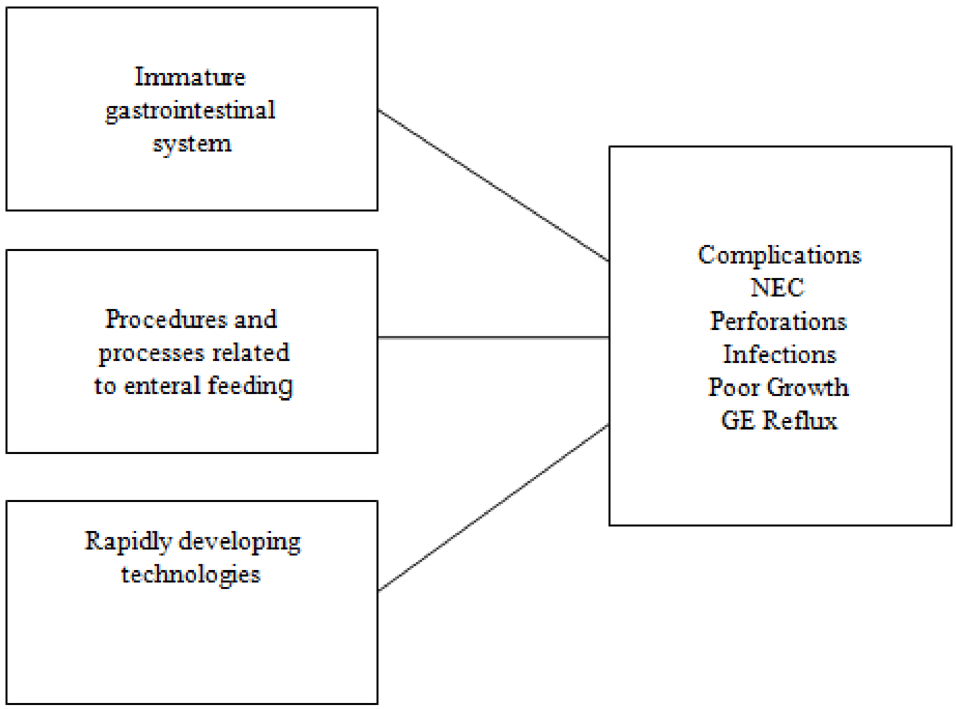

Figure 1: Conceptual framework for factors and outcomes associated with safe and effective enteral feeding in VLBW infants.

This conceptual framework outlines three major areas that put the VLBW infant at increased risk of complications. The VLBW infant has a developing anatomy and physiology. This lack of mature function puts the infant at increased risk for complications related to feeding and feeding tubes. Feeding of the VLBW infant is challenging due to immature gastrointestinal motility, digestion and absorption. Oral feeding is not possible due to an immature suck and swallow (Romero & Kleinman, 1993). The technologies and equipment used to provide enteral feeding are rapidly changing. These two risk factors are not modifiable, but the empirical studies of the practices associated with gavage feeding and the technology used to provide feedings may provide insight into the prevention of complications. In addition, examining these risk factors and how to best prevent complications may lead to safer and more developmentally supportive feeding practices.

Related Research

A thorough examination of the literature in the area of gavage feeding of the VLBW infant has demonstrated that very limited research has been done in this area and that no published evidence-based standards are available to guide nursing practice. While neonates have been included in some studies focused on tube feedings in children (Ellett & Beckstrand, 1999; Ellett, Croffie, Cohen, & Perkins, 2005; Westhus, 2004), the immature anatomy and physiology of the VLBW infant requires that gavage feeding be studied specifically in this group of infants.

Composition and Size of Feeding Tubes

There are currently no published studies identifying the advantages and disadvantages of the various materials used to manufacture different neonatal feeding tubes. However, the composition of the gavage feeding tube has the potential to predispose the preterm infant to complications. A search of products advertised as neonatal feeding tubes revealed three materials that are primarily used to make these feeding tubes, including polyvinyl chloride, polyurethane, and silicone. Filippi (2005) has suggested that the use of polyvinyl chloride tubes may predispose an infant to esophageal perforation because the chemical composition of these tubes decreases their flexibility when exposed to gastric acid. In addition, Filippi estimated that the incidence of esophageal perforation in preterm infants weighing less than 750 grams at birth to be 1 in 25 when polyvinyl chloride tubes were used. Filippi and colleagues (2005) presented several case studies of esophageal perforation in very preterm infants following the insertion of a gavage feeding tube. The common denominator among these infants was the use of a polyvinyl chloride feeding tube. There are other case reports in the literature of gastrointestinal perforation in preterm infants caused by feeding tubes (Chouteau & Green, 2003; Mattar, Al-Alfy, Dahniya, & Al-Marzouk, 1997; Sapin et al., 2000; Shah, Dunn, & Shah, 2003), however the composition of the feeding tubes was not reported.

Feeding tube composition may potentially affect ease of placement, comfort of the tube for infant and may restrict flow through the tube. Some clinicians and researchers have reported that feeding tubes made of softer materials are more likely to coil during insertion (Ellett, personal communication, July 26, 2008). While manufacturers measure the external size of the feeding tube they provide, different materials provide different internal diameters. Two tubes with the same external size, one made of silicone and one made of polyurethane, will have very different internal diameters with the polyurethane tube having a larger internal diameter (Tingey, 2000). These variations in internal diameter affect the flow rate of feedings provided by gravity. It is unknown if these variations in flow rate and length of feeding affect feeding tolerance but they do have the potential to alter nursing practice. Tubes with small internal diameters may be restrictive and lead to an increase in feeding pump usage as nurses attempt to infuse feedings through small bore feeding tubes.

Measuring for Insertion Depth

An area where there is a lack of consensus for insertion of a gavage feeding tube is determination of the distance the tube is to be inserted. Distance must be externally measured to predict the internal distance to the junction of the esophagus and stomach (Beckstrand, Ellett, & McDaniel, 2007). Given the frequency with which gavage tubes are inserted both orally and nasally in preterm infants, an important question to consider is whether the method for determining the appropriate distance to insert the tube is the same for both oral and nasal insertion. The most common measure in neonates is from the nose to ear to xiphoid process (Freer & Lyon, 2005). A variation on this method includes adding one centimeter to the measure (McGrath, 2004). Beckstrand et al. (2007) found that the nose to ear to xiphoid process often resulted in malpositioning of the feeding tube as the predicted insertion distance was frequently too short, leaving the tube tip and/or orifices in the esophagus. These researchers demonstrated that nose or mouth to ear to a midway point between the xiphoid and umbilicus was a more accurate method. Further research is needed to determine the appropriate distance.

Selection of Oral or Nasal Placement of Gastric Tubes

In addition to the issue surrounding the appropriate distance to insert a feeding tube, is the question of whether the tube should be inserted orally (OG) or nasally (NG). Currently, there is a lack of consensus on this issue. Researchers have demonstrated changes in the work of breathing and minute ventilation with nasal placement of the gavage tube in preterm infants (Greenspan, Wolfson, Holt, & Shaffer, 1990; Shiao, Youngblut, Anderson, Difiore, & Martin, 1995). Nasally placed feeding tubes have also resulted in lower oxygen saturations (Daga, Lunkad, Daga, & Ahuja, 1999). However, these changes have not always been clinically significant (Shiao, Brooker, & Difiore, 1996). In addition, Symington and colleagues (1995) and Bohnhorst, et al (2010) demonstrated that there was no difference between a nasally or orally placed tube in relation to episodes of apnea or bradycardia. In 2004, a Cochrane review was able to identify only one study regarding enteral feeding tube placement in infants and concluded that there was insufficient evidence to guide practice in this area (Hawes, McEwan, & McGuire, 2004). In a more recent survey of NICU practices in Canada, researchers reported that 75% were primarily using NG tubes (Birnbaum & Limperopoulos, 2009).

Verification of Tube Placement

An important issue with the insertion of a gavage feeding tube is determining the most accurate method for verifying the correct placement of the tube. There is much discussion in the literature related to the best practice for assuring correct placement of a feeding tube (Ellett, 2004; Huffman et al., 2004; Metheny & Titler, 2001; Sorokin & Gottlieb, 2006). Unfortunately, much of this discussion does not include the preterm infant population. Several techniques being suggested to determine correct positioning of a gavage feeding tube include checking the aspirate for pH, trypsin, pepsin, or bilirubin, assessing color of the gastric aspirate, and measurement of carbon dioxide. The measurement of trypsin, pepsin, or bilirubin in the aspirate cannot currently be done at the bedside. Thus, these specific markers are not useful in clinical practice (Westhus, 2004). Ellett (2004), in a review of how to accurately assess for correct placement, recommended pH testing of aspirates to verify correct placement in children. In the one study that examined pH testing in preterm infants, Nyqvist, Sorell and Ewald (2005) demonstrated that this method of confirming placement can be successful in a high percentage of preterm infants.

Unfortunately, the measurement of pH in feeding tube aspirates is not universally instituted in NICUs. In a survey of NICUs across the United Kingdom, only 45% of the units were using pH paper to verify placement despite a national guideline and recommendation (Freer & Lyon, 2006). Freer and Lyon (2006) also found that there was a lack of consensus among NICUs as to which pH value was indicative of accurate feeding tube placement. This variability in practice continues, in part, because agreement does not exist among neonatal nurse experts in relation to the most accurate method for verifying correct placement in preterm infants. Both the auscultation method (Kenner & Lott, 2004) and the pH method (McGrath, 2004) are proposed in nursing textbooks. While measurement of pH might hold the most promise, factors associated with physiologic immaturity of the preterm infant including delayed gastric emptying (dos Santos Mezzacappa & Collares, 2005) and immature tone of the pyloric sphincter resulting in duodenal-gastric reflux (Mihatsch et al., 2004) impact gastric pH. In addition, common therapies used with acutely ill preterm infants will alter gastric pH including the administration of supplemental oxygen (Whetstine & Hulsey, 1995) and medications that inhibit gastric acid production such has H2 blockers and proton pump inhibitors (Westhus, 2004). Currently, the procedure for inserting the feeding tube is a “blind” procedure. This blind procedure is still awaiting the development of evidence to support the optimal methods that should be used for verification at the bedside.

Continuous or Intermittent Placement of Feeding Tubes

Feeding tubes can be left in continuously or removed and then reinserted with each feed. Shiao and Difiore (1996) surveyed NICUs throughout the Midwest in terms of gavage feeding practices. Fifty percent of the NICUs reported leaving the feeding tube in place continuously, while 45% used both practices. Both ways of managing the gavage tube are not without consequences. Researchers have demonstrated that preterm infants are more likely to have episodes of gastroesophageal reflux when feeding tubes are left indwelling (Peter, Wiechers, Bohnhorst, Silny, & Poets, 2002). However, intermittent insertion of a gavage tube with each feeding increases the exposure of the infant to noxious stimulation. Sensitive tissues in the nasopharynx area are likely to be irritated with frequent insertion of a gavage tube. Each insertion of the gavage tube increases the handling of the infant and the duration of the handling by the nursing staff (Dsilna et al., 2008). Thus, the decision to insert the gavage tube with each feeding has important ramifications for preterm infants. Noxious stimuli, including pain and increased handling, present several risks to the safety of preterm infants.

Use of Pumps and Tubing

Gavage feeding tubes available for use with preterm infants range in size from 3.5 to 10 french (Fr). The use of feeding tubes with the smallest diameters has necessitated reliance on infusion pumps to provide the feedings because the small internal diameter inhibits effective gravitational flow.

Until recently there was no infusion pump available designed to provide gavage feedings to preterm infants. Many NICUs are using syringe pumps designed to infuse intravenous (IV) fluids to meet this need. Pump use has lead to unintended risks for these infants. In 2006, the Joint Commission published a sentinel event alert warning about tubing misconnections (The Joint Commission, 2006). In an effort to prevent misconnection there are many companies manufacturing safety tubing to prevent the unintended and dangerous connection of a tube feeding to an IV system. Importantly, syringe pumps were made to infuse IV fluids within pre-established pressures to prevent harm to the infant. Syringe pumps were not designed to infuse enteral fluids, whose consistency is more viscous than IV fluids. Thus higher pressures are required to infuse the enteral fluids. Whether or not there are ramifications from these higher pressures for preterm infants is unknown at this time. The single neonatal feeding pump currently available on the market is a standard syringe pump modified to only accept oral syringes. The majority of feeding pumps available require large fill volumes in order to prime the infusion tubing. For preterm infants receiving breast milk, this is an important issue since large amounts of precious breast milk is wasted.

A pilot project was undertaken to provide initial data and provide documentation of pump use. This project was a pilot survey of the use of feeding pumps in NICUs located throughout the State of Ohio. This project demonstrated that 100% of the level III NICUs in Ohio were using syringe pumps, at least intermittently, to deliver gavage feedings. No written standard of practice or evidence based guidelines have guided the use of these infusion pumps Despite widespread use, known dangers such as tubing misconnections were inconsistently addressed (Wallace & Steward, 2010) .

Known and Potential Complications of Gavage Feeding

The insertion and use of a gavage feeding tube is not without risk; one of the most important being tube mal-position. The safe provision of gavage feedings is contingent upon the accurate positioning of the feeding tube (Ellett, Maahs, & Forsee, 1998). Mal-positioning may occur both during insertion of the feeding tube, as well as afterwards with displacement of the tube. Gavage feeding tubes can be mal-positioned into the lung, the esophagus, or the intestine. Complications associated with mal-positioned tubes include pulmonary compromise, aspiration, and diarrhea (Ellett, 2004; Pillai, Vegas, & Brister, 2005). Using standard techniques (i.e., auscultation of insufflated air) for verifying feeding tube placement, results in frequent tube mal-positioning (Creel & Winkler, 2007; Ellett et al., 1998; Gallaher, Cashwell, Hall, Lowe, & Ciszek, 1993). Reported rates of mal-positioned feeding tubes vary greatly with research showing 15.5% to 43.5% of feeding tubes in children mal-positioned (Ellett et al., 1998; Ellett & Beckstrand, 1998; Ellett et al., 2005).

A study by Quandt, Schraner, Ulrich, and Arlettaz Mieth (2009) demonstrated that using the nose to earlobe to xyphoid measurement caused improper placement on x-ray 59% of the time. This study used a different set of guidelines for appropriate placement that the other studies, they considered positioning in the lower stomach with the tip bending along the greater curvature to be incorrect placement. Other studies have used placement of the tip anywhere within the gastric body to be correct positioning. This use of different criteria for appropriate placement on x-ray makes interpretation of findings more difficult and demonstrates that appropriate placement based on x-ray is not agreed upon by experts.

Interestingly, in the 1998 study by Ellett et al, abdominal distention was a significant risk factor associated with mal-positioning of the feeding tube. This is an important finding with ramifications for the preterm population for two reasons. The common use of nasal continuous positive airway pressure (CPAP) frequently results in the development of abdominal distention or “CPAP belly.” In addition, abdominal distention is also used as a sign of feeding intolerance that leads to withholding of feedings. De Boer, Smit, and Mainous (2009) were unable to demonstrate that tube position effected intragastric air, but showed an association between feeding tube size and air accumulation. The larger the gastric tube the less likely the infant was to have gastric distention with air.

Risks for Infection

The VLBW infant is at significant risk for infection due to immaturity, illness and multiple medical interventions, including the use of feeding tubes, which breech primary barriers to microbes. As stated earlier, there is no consensus as to whether a gavage feeding tube should remain continuously in place or be inserted intermittently. Given the immature immune system of preterm infants, an important question is whether an indwelling feeding tube increases the risk of infection in these infants. Indwelling feeding tubes in infants in the NICU have been shown to be a reservoir for antibiotic-resistant bacteria. Researchers cultured 125 feeding tubes from 50 preterm infants and demonstrated that only 8 of the 125 feeding tubes had cultures that were completely negative (Mehall, Kite, Gilliam, Jackson, & Smith, 2002). Thus, 94% of the feeding tubes were colonized with bacteria, 57% of them were contaminated with greater than 1000 bacterial colony forming units per tube (Mehall, Kite, Saltzman, Wallett, Jackson, & Smith, 2002). Most importantly, preterm infants who had contaminated feeding tubes were more likely to exhibit episodes of feeding intolerance and had poor weight gain. This is concerning since discharge from the NICU is contingent upon successful transition to oral feeding and demonstration of satisfactory weight gain. The length of time required for colonization to occur with an indwelling feeding tube is unknown. In a study of elderly patients, biofilm formation occurred within 24 hours in 60% of patients after insertion of a nasogastric tube (Leibovitz, Baumoehl, Steinberg, & Segal, 2005). A more recent study by Hurrell et al. (2009) and conducted on infants demonstrated that feeding tubes were frequently contaminated and that bacterial counts increased with longer dwell times. There is a lack of research focusing on the relationship between bacterial contamination and components of the gavage feeding process including frequency of tube changes, flushing of the indwelling feeding tube, and handling of the feeding tube and feeding apparatus.

Other Complications

The use of gavage tubes has the potential to contribute to the clinical morbidity associated with prematurity, specifically necrotizing enterocolitis (NEC), intraventricular hemorrhage (IVH), and gastroesophageal reflux (GER). However, because the administration of gavage feedings is such a routine procedure, it is likely that clinicians do not consider the potentially serious ramifications associated with this procedure.

One of the greatest challenges in transitioning very preterm infants from parenteral nutrition to enteral nutrition is to balance advancing enteral nutrition while avoiding the development of NEC, a devastating condition unique to preterm infants that can result in significant loss of bowel, death, or both (Newell, 2000). Decisions to advance enteral nutrition are based on determination of how well the very preterm infant is tolerating the feeding. The evidence suggests that these infants are more likely to experience feeding intolerance when compared to more mature preterm infants due to physiologic immaturity (Akintorin et al., 1997; Cobb, Carlo, & Ambalavanan, 2004). When signs of feeding intolerance are present, the clinician must always be cognizant of the possibility that feeding intolerance may be indicative of the development of NEC.

Gastric residuals are frequently used as a measure of feeding intolerance in preterm infants. Researchers report that gastric residuals are the most commonly occurring sign of feeding intolerance (Boo et al., 2000). In a retrospective study examining the relationship between gastric residuals and NEC, larger gastric residuals were associated with NEC (Cobb et al., 2004). Thus, measuring gastric residuals is not only important in terms of assessing feeding intolerance, but is also critical to early identification of NEC. Gastric residuals are measured by aspirating stomach contents through the feeding tube. Of concern is whether the small bore feeding tubes used with these infants are restrictive and prevent the accurate measurement of gastric residuals. A study of tube feeding in adults demonstrated that when adults had concurrently indwelling tubes of varying sizes, smaller residuals were obtained from smaller bore tubes and larger residuals were obtained from the larger bore tube (Metheny, Stewart, Nuetzel, Oliver, & Clouse, 2005). These findings are concerning for very preterm infants because of the reliance on measurement of gastric residuals to make clinical judgments about the development of feeding intolerance and NEC. An important question is whether or not gastric residuals from small neonatal feeding tubes are a reliable measure of feeding tolerance.

Preterm infants experience a significant number of gavage tube insertions until they transition to full oral feedings. There is evidence to suggest that the insertion of a gavage tube alters cerebral blood flow in premature infants (Baserga, Gregory, & Sola, 2003). This is significant because preterm infants less than 32 weeks gestational age are at high risk for developing intraventricular hemorrhage due to the presence of the germinal matrix, a highly vascularized cerebral structure that is unique to preterm infants that provides nutrients for rapid brain growth. Because of limited cerebrovascular autoregulation, abrupt or significant changes in blood flow to this area may result in disruption of the capillary endothelium and subsequent bleeding into the ventricles and the surrounding tissue with devastating developmental consequences (Bada, 2001). Baserga et al. (2003) demonstrated that cerebral blood flow significantly increased immediately after the insertion of a gavage tube in a group of preterm infants. In addition, researchers demonstrated that bolus feedings provided to preterm infants are associated with significant fluctuations in cerebral blood flow (Nelle, Hoecker, & Linderkamp, 1997). Potential explanations for acute fluctuations in cerebral blood flow include vagal stimulation, pain, and handling of the infant.

Insertion of a gavage tube induces a vagal response that can result in bradycardia in very preterm infants (Haxhija, Rosegger, & Prechtl, 1995). Bradycardia results in a decrease in blood pressure and the risk of decreased cerebral blood flow (Perlman, 2001). Experts in neonatal pain recognize that gavage tube insertion is a painful procedure (Anand, 2001) and that painful experiences should be minimized in order to prevent IVH (Carteaux et al., 2003). When asked to rate the severity of pain associated with various interventions carried out in the NICU, clinicians rated the insertion of a gavage tube as moderately painful (Simons et al., 2003). McCullough and colleagues (2007) demonstrated that the pain response to gavage tube insertion in preterm infants was comparable to the pain response accompanying a heelstick. In addition, insertion of a gavage tube requires handling of the infant with some manipulation of the head and neck which may also induce pressure changes.

GER appears to be a common problem in very preterm infants but the true incidence of this disorder is unknown (Jadcherla & Rudolph, 2005). It can be associated with feeding problems, inadequate weight gain, and esophagitis (Slocum, Hibbs, Martin, & Orenstein, 2007; van Wijk et al., 2007). Transient or inappropriate relaxation of the lower esophageal sphincter appears to play an important role in the development of GER in very preterm infants (Jadcherla & Rudolph, 2005). As stated above, researchers have demonstrated that the number of episodes of GER is increased when feeding tubes remain in place. GER may lead to aspiration of feeding into the lungs as well as poor weight gain associated with loss of feeding volume.

Summary

Clearly research in the area of gavage feeding in very preterm infants is lacking. While much work has been done with adults (by Metheny) and older children (by Ellett), this work needs to be replicated in very preterm infants. The immature anatomy and physiology of preterm infants renders the application of findings from adults and children to this population inappropriate. In no other group, is gavage tube feeding more important to their survival than in very low birth weight infants. Therefore, it is of critical importance that clinicians provide gavage feedings based on protocols that are evidence based. The proposed study will provide a foundation for describing the standard of care that exists across Level III NICUs in the United States.

Chapter Three: Methods

Research Design

A descriptive research design using an internet survey was used to address the proposed specific aims:

1. Describe current gavage feeding tube practices across Level III NICUs in the United States.
2. Report nurse observed complications associated with gavage feeding tube practices across Level III NICUs in the United States.
3. Assess nursing beliefs about the evidence base supporting current tube feeding practices and potential consequences.

Sample

The target sample was the 808 Level III NICUs in the United States listed by the American Academy of Pediatrics, Perinatal Section (American Academy of Pediatrics, 2009). This directory lists all of the NICUs located in the United States and the level of care they provide. The list was narrowed to those NICUs that provide Level III care, since those are the NICUs most likely to care for VLBW infants (American Academy of Pediatrics Committee on the Fetus and Newborn, 2004). A total of 808 Level III NICUs were identified from this list. The final sample of responding nurseries was 59, for a response rate of 7.4%.

Sample recruitment

A letter was sent to all Level III NICUs in the United States. This letter was addressed to the Nurse Manager and invited this individual or a designee, on behalf of the NICU, to participate in the study. The Nurse Manager was asked to participate in a web-based survey that included a series of questions in relation to the policies and procedures for gavage feeding practices. In an attempt to improve response rate, all communications were brief, personalized and designed to interest the participant and impress the importance of their participation. The following plan was followed: 1) A pre-notice email was sent to a list serve for Nurse Managers (msignet is a list serve for managers, maintained by the National Association of Neonatal Nurses) a few days prior to implementation of the survey informing Nurse Managers of the upcoming internet survey and its significance; 2) A detailed letter explaining the online survey and how to participate was sent to the Nurse Manager; 3) A thank you message was presented at the end of each completed survey; 4) A follow-up postcard was sent to non-responders four weeks after the detailed letter was mailed if the survey had not been completed by an NICU staff member (Dillman, 2007).

Instrument/Survey

A web-based survey was developed for this study based on clinical observations and a review of the literature. Content validity of the survey was established by two methods. The survey questions were compared to the available literature for congruence and relevance. In addition, the survey and the specific aims of the project were given to a multidisciplinary panel of experts in the area of neonatal nutrition. This group consisted of a neonatal nutritionist, a doctorally prepared nurse involved in feeding tube research, and two nurses that routinely participate in gavage feeding VLBW infants. These experts were asked to evaluate the survey in relation to the specific aims as well as survey clarity, completeness, and content validity (Nieswiadomy, 2008). This panel provided input into amending the final survey.

The survey methodology and its implementation were developed using the Total Design Method suggested by Dillman (2007). The Total Design Method is a survey research methodology that is designed to improve response rates. It includes such features as prenotice, invitations by first class mail and gives suggestions for language that encourages participation. The software Checkbox© was used to implement the web-based survey. Checkbox supports data export to SPSS©.

Web-based surveys have several important advantages including; 1) they are relatively inexpensive to administer, 2) display of response data is almost immediate, 3) data can be easily imported into data bases, and 4) it is easy to compare early responders to late responders (Dillman, 2007). This functionality was ideal for a potentially large sample. A written document was made available for those who preferred this format. The complete survey tool is attached as Appendix A.

Human Subjects

This study was determined by the IRB to be exempt from review. Consent was inferred by completion of the survey. Confidentiality was maintained by the assignment of a site number for each unit involved. The unit of analysis for this study is the NICU. Each NICU was given a subject number to assure that an individual NICU was only entered once into the database and to track response rates. Assignment of a number also ensured the confidentiality of the responses.

Data Analysis

Data were analyzed using descriptive statistics on both Checkbox© and confirmed by duplication in SPSS©. Data reported includes response rates for individual questions, frequencies and percentages. Open ended questions were examined for common themes and frequency tables created when possible.

Chapter Four: Findings

Results

The goals of this survey were to describe current nursing practice around gavage feeding VLBW infants, to report nurse observed complications associated with gavage feeding and to assess nursing beliefs about the evidence base supporting current practice. A complete tabulation of all responses can be found in Appendix B, attached to this document.

Responding Nurseries

Of the 808 Level III NICUs identified in the United States, eight invitations were returned as undeliverable, leaving 800 potential respondents. Fifty-nine units responded to the survey for a response rate of 7.4%. These responses represent neonatal units in 31 states. The majority of these units (82.8%) were Level IIIB units according to American Academy of Pediatrics Guidelines (AAP, 2004). To be considered a Level IIIB unit, a unit has to have capabilities to care for infants <1000 grams, <28 weeks gestation, those requiring advanced respiratory support and they must have the availability of subspecialty consults (AAP, 2004). These 59 units cared for a total of 4,295 VLBW infants in 2009; this is a mean of 72.8 VLBW infants per unit (range 12-222 infants). The majority of these units participated in at least one neonatal multicenter database or quality organization, with 54 of the units (96.43%) participating in the Vermont Oxford Database.

Composition and Sizes of Feeding Tubes

The majority of units reported using tubes made of polyurethane (59%), but 3.7% continue to use tubes made of polyvinyl chloride (PVC) at least a portion of the time. Thirty five % of the responding units used feeding tubes made from silicone. Figure 2.

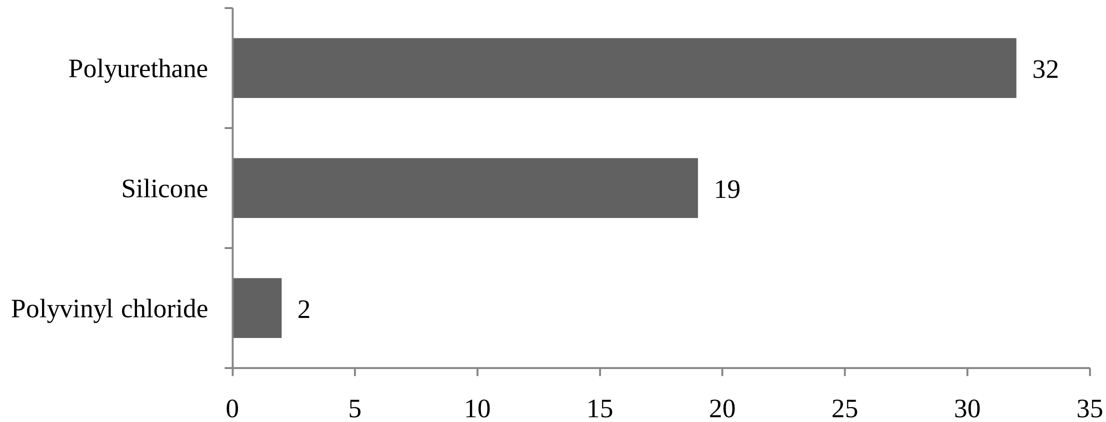

Figure 2: Composition of feeding tubes. N=54.

The most frequently used size for feeding VLBW infants was a 5Fr feeding tube (69.5%), but the majority of units reported having multiple sizes available to them and 36.5% of these units reported having no specific policy to guide decisions regarding feeding tube size. Policies and practices surrounding the sizes of feeding tubes used varied widely. These policies ranged from one unit that used a 3.5Fr feeding tube for any infant less than 2500 grams to a unit that used an 8Fr feeding tube in infants less than 1500 grams. Four units reported using bigger feeding tubes when venting the stomach to prevent distention for the infant on continuous positive airway pressure (CPAP) or high flow nasal cannula. See Figure 3.

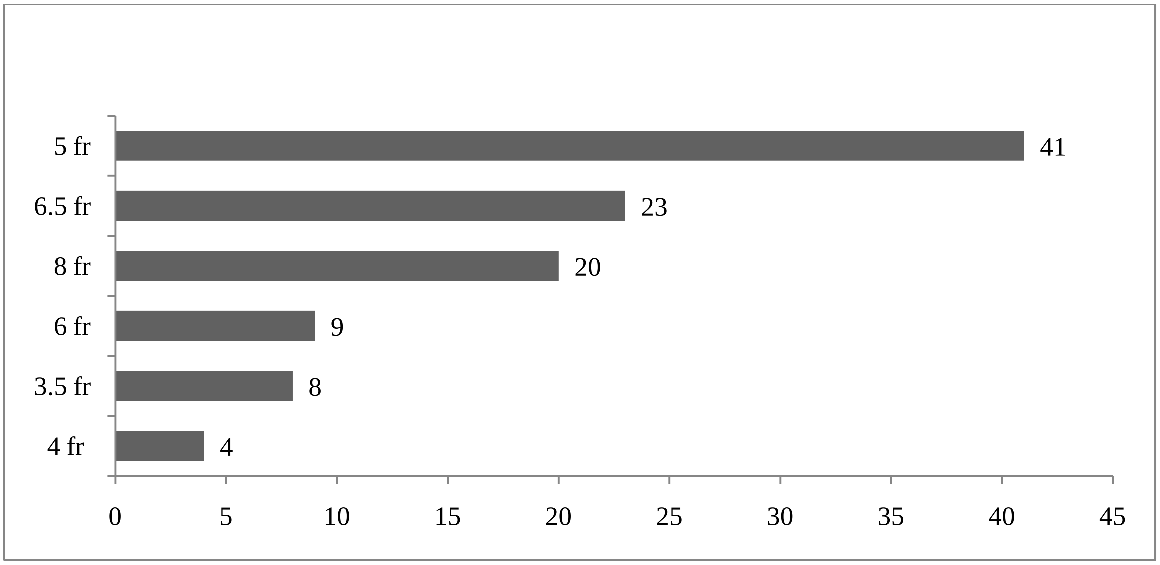

Figure 3: Sizes of feeding tubes reported units reported they were using. N=59 (allowed more than one response).

Measuring for Insertion Depth

There was great variation in the method used to measure for placement of a feeding tube, as shown in Figure 4. Tip of the nose to the earlobe to the xiphoid (NEX) and nose to earlobe to half way between the xiphoid and the umbilicus were the two most frequently used measures, but no one measure was used by more than one third of the respondents.

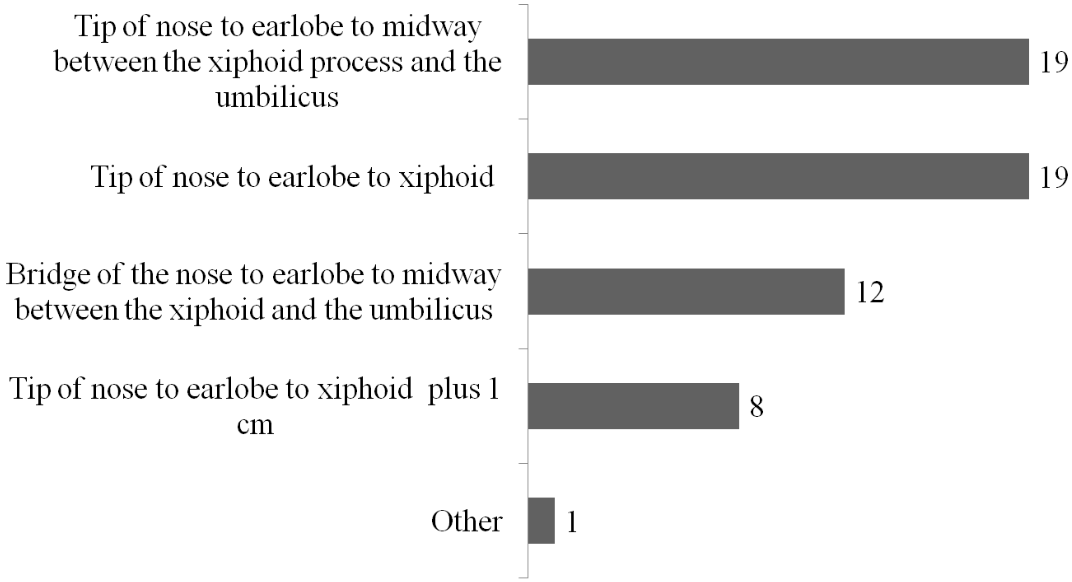

Figure 4: Method used to determine depth of feeding tube insertion. N=59.

Selection of Oral or Nasal Placement of Gastric Tubes

There was great variation in the use of oral and nasal tubes (Figure 5). Forty-four percent of units used NG tubes as infant began to attempt oral feedings.

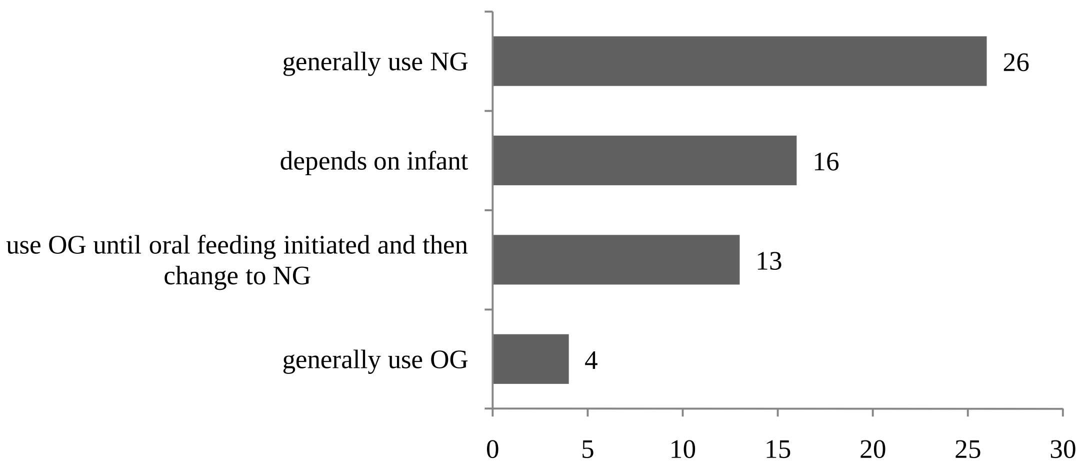

Figure 5: Frequency of NG versus OG use. N=59.

Units reported using multiple criteria to determine if an NG or OG was to be placed, including the size or weight of the infant (55.1%), the presence of respiratory support (95.9%), or if the infant was orally feeding (65.3%). Only 6 units (12.2%) report using the presence of lung disease to determine what type of tube to place.

Verification of Tube Placement

After a new tube was placed, position was assessed most frequently with auscultation of air and examination of any aspirated gastric contents (Figure 6). This was also the most frequent way that policies suggested the nurse check placement prior to each feeding. The units answering this survey seldom used x-ray for primary confirmation of placement. Testing any aspirate for pH was mandatory in only 3.5% of nurseries. While x-ray was not routinely used for confirmation of feeding tube placement, in 46.1% of units, the nurse as able to request an x-ray confirmation of placement.

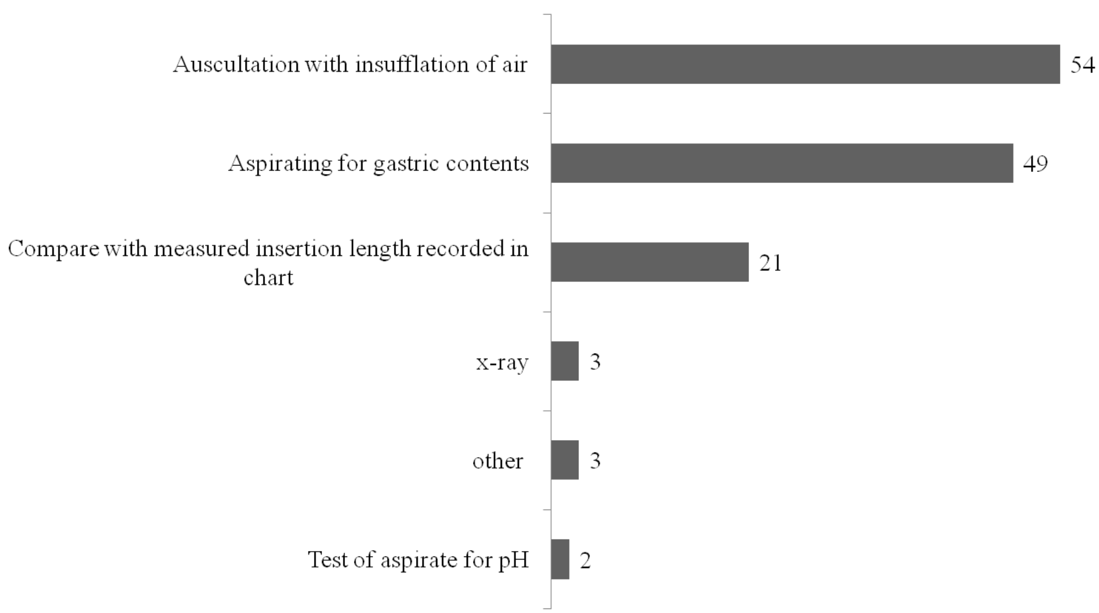

Figure 6: Number of units using each method for assessment of feeding tube placement. N=58 (more than one answer was allowed).

Continuous or Intermittent Placement of Feeding Tubes

Fully 93.2% of all units left feeding tubes indwelling the majority of the time, with only one unit removing tubes after each feeding (Figure 7).

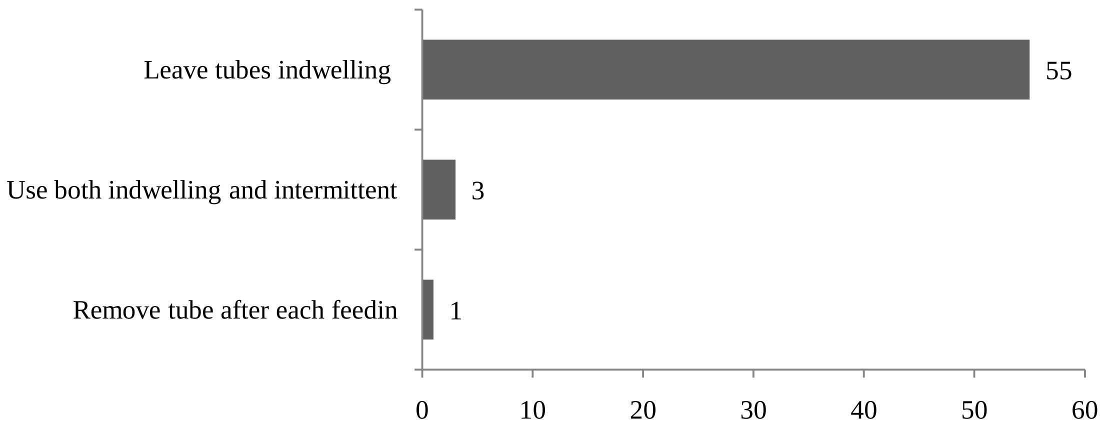

Figure 7: Use of Indwelling or intermittent feeding tubes. N=59.

The frequency of changing tubes ranged from every 3 days to once a month (Figure 8). The nurses' comments in this section about the frequency of changing tubes included multiple notations that tubes seldom stay in as long as allowed due to infants pulling them out. When tubes were displaced, 58.6% of units required that a new tube be placed, but 41.4% allowed the same displaced tube to be replaced. One unit provided a protocol for cleaning the tube prior to replacing it (Figure 9).

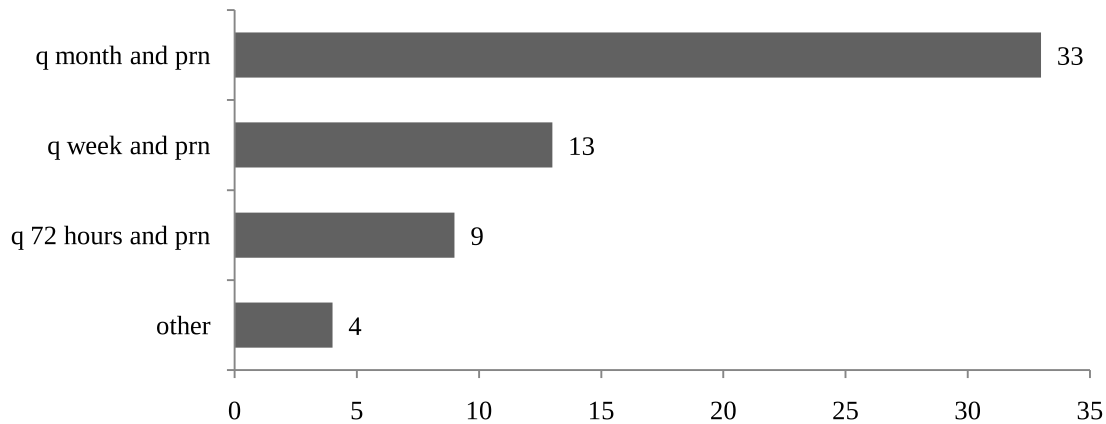

Figure 8: Frequency of routine feeding tube changes. N=59.

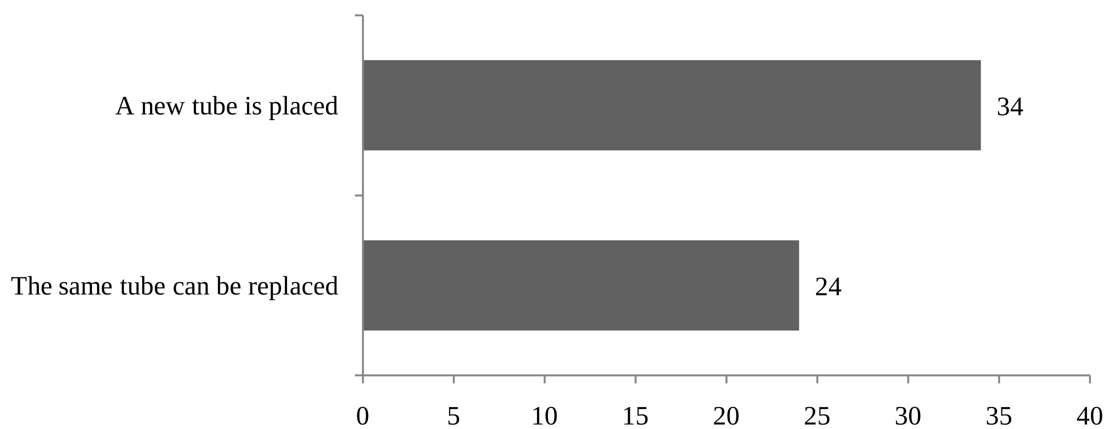

Figure 9: Handling of tube if tube is accidentally displaced. N=58.

Use of Pumps and Tubing

This survey identified large variations in how units provided gavage feedings. When the feedings were complete, 65.5% of units reported flushing the feeding tube with air, while 13.8% flushed it with sterile water (Figure 10). The several of the units that flushed feeding tubes with water did not report counting this volume in intake and output. After the tube was flushed, 49% of units report that the tube may or may not be capped depending on the specific infant and the infant's other medical therapies. Five units (8.5%) reported that tubes were left vented if the infant was on high flow nasal cannula and an additional four units reported clamping the tube for a period of time and then venting it to air if the infant was on respiratory support.

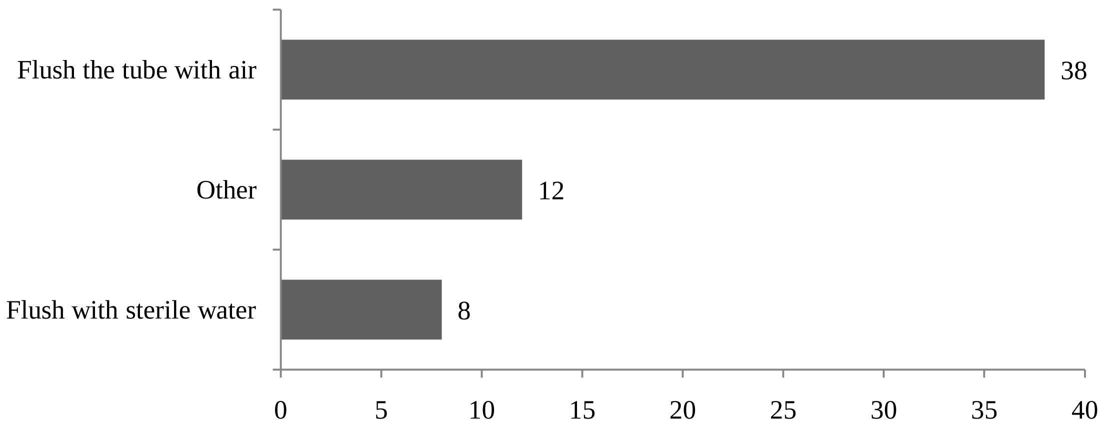

Figure 10: Flushing tubes after feeding. N=58.

In this survey, just over one third of the units (35.6%) reported always using a pump to infuse feedings for VLBW infants, another 40.7% of units report using them frequently. The majority of these units (91.4%) are using safety, enteral-only tubing to prevent tubing misconnections and 15.3% of units were using enteral-only pumps.

The frequency with which the tubing used for these pumps was changed varied from with each feeding to twenty four hours (Figure 11).

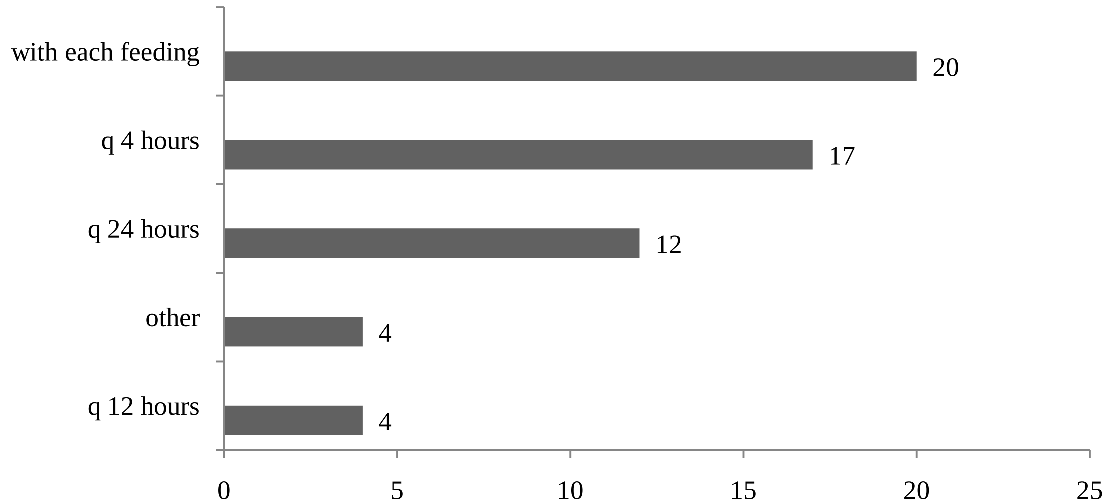

Figure 11: Frequency of tubing changes for feeding containing human breast milk. N=57.

When questioned about different types of feeding, i.e. breast milk versus formula, the times for tubing changes changed slightly, but the large range of times remained.

Nurse Observed Complications

Forty-three units (43) were willing to provide some information about their rate of necrotizing enterocolitis in VLBW infants. However, only one unit reported a rate >10%, while 62.8% of units reported a rate <5%, and 16.2% of the units reported no NEC for 2009. Much of these data were reported as nursing impressions, for example "I don't remember an NEC in the last year" or the rate was reported at "3-5%".

When asked about complications observed related to tube feeding, nurses most frequently reported reflux (68.7%). The survey also provided a section to discuss complications of feeding tubes. Four of twenty-two respondents discussed the frustrations associated with diagnosing and treating reflux in this population of infants. No information was gathered about whether this was clinically suspected or confirmed gastroesophageal reflux. When asked about other clinical practices that may have had consequences for gavage feeding, 6 units reported the frequent use of prokinetic medications and 6 reported use of post gastric feeding (duodenal or jejunal feeding).

The second most frequent nurse reported complication was tube malpositioning, reported by 43.8% of units. Nurses also reported esophageal or gastric perforations and aspiration as complications they had seen in their unit.

Nursing Beliefs about Their Use of Evidence Based Practice

An overwhelming percentage of nurses were confident that their current practice was evidence-based. When asked if they believed that their unit's current practices for handling gavage feeding (frequency of tube changes, types of tubes, procedures for checking placement, etc) reflected current evidence-based practice, 86% answered yes (Figure 12).

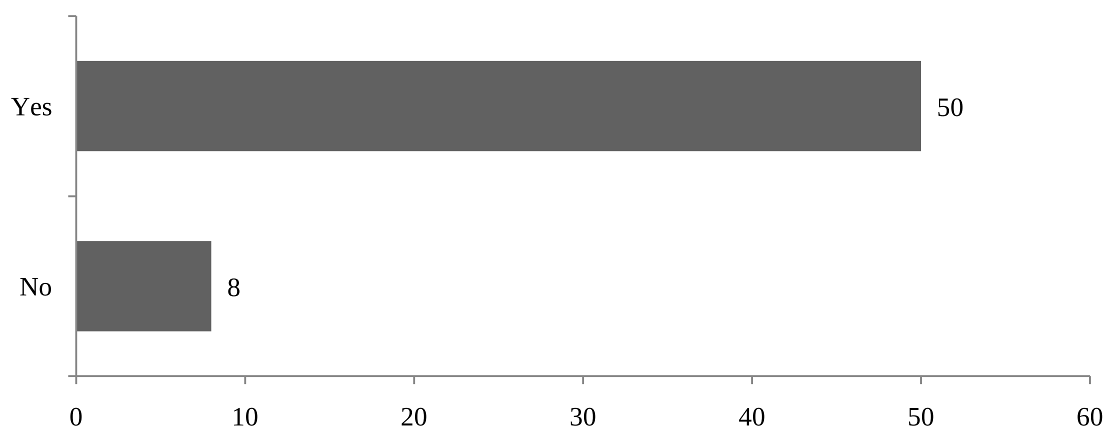

Figure 12: Nurses answer when asked if they felt their units current practices were evidence based. N=58.

Discussion and Conclusions

The majority of gavage feeding practices were found to be highly variable among units. The practices that demonstrated the greatest variability among units included those focused on care and confirmation of feeding tube placement. For example: four different ways to measure for feeding tube placement were discussed and none of them were used by more than one-third of the respondents. The practices that demonstrated the least variability were those that had the potential to cause discomfort to the infant as evidenced by the fact that 93% of units routinely leave feeding tubes indwelling and did not remove them between feedings. Findings from the current study were consistent with those of Birnbaum and Limperopoulos (2009) and Shiao and DiFiore (1996) who demonstrated significant variability in feeding practices among NICUs.

Composition and Sizes of Feeding Tubes

In 1996, Shiao and Difioro reported that units were using mainly tubes that were manufactured from polyvinyl chloride (PVC). In 2002, the Food and Drug Administration published a public health notification about the plasticizers in PVC (FDA, 2002). The current study demonstrated continued use of PVC products by 3.7% of units. The continued use of these products was unexpected given the known toxicities to the reproductive systems of male infants (Takatori et al., 2008).

A silicone tube was being used by 35.2% of the units and polyurethane was being used by 59.3% of the units. These two materials have very different properties and, therefore, different advantages, disadvantages and potential rates of complications. Silicone is a very soft and flexible material. This soft material may mean the catheter causes less trauma. However, the soft nature of this material requires that the wall of the catheter needs to be thick enough to maintain strength (Di Giacomo, 2009;Mayer & Wong, 2002)). These thick walls decrease internal diameter and limit flow rates through small bore silicone tubes and increase the need for feeding pumps. Polyurethane is a stiffer material and allows for an increased internal diameter and therefore increased flow through small bore tubes. Small internal diameters that restrict flow, may also potentially affect the nurse's ability to accurately assess gastric residuals.

Filippi, Pezzati, & Poggi (2005) documented increased esophageal perforations with polyvinyl chloride tubes, another stiff material. While esophageal and gastric perforations from feeding tubes are a well documented complication (Chouteau & Green, 2003; Mattar, Al-Alfy, Dahniya, & Al-Marzouk, 1997; Sapin et al., 2000; Shah, Dunn, & Shah, 2003), a review of the literature could not find a comparison of rates based on feeding tube materials.

The material used to manufacture feeding tubes may affect the performance of these tubes and the potential complications associated with their use. In order to provide optimal patient care and monitor patient safety it is important that the nurse understand the materials used and their relative advantages and disadvantages.

In 1996, Shiao and Difiore reported that units were using feeding tubes ranging from a 5 Fr to a 10 Fr, with 94% using sizes 5, 6.5 and 8. The current study found much smaller tubes to be available and in clinical use. At least 19% of units had a tube smaller than 5 Fr in use. The authors postulate that this move toward smaller tubes is associated with the availability of new materials to make this possible and with clinicians' desires to minimize respiratory compromise and maximize patient comfort. While there are no studies examining the use of these small tubes, they have the potential to significantly alter practice. These small tubes may increase the need to use feeding pumps and decrease nursing's ability to monitor gastric residuals.

Frequent feeding pump usage was demonstrated in this study. Traditionally pumps have been used to slow feedings, but small restrictive tubes may mean pumps are being used to force feedings through the tube. One ramification of the increased use of feeding pumps and their tubing has been the need for safety tubing to prevent misconnections. There may be other ramifications of these small tubes that have not yet been realized.

The pressure required to move fluids through a tube and the velocity of that movement depends on the viscosity of the fluid, the length of the tube and the radius of the tube. Poiseuille's equation, a law of physics, states that of these variables, the radius of the tube has the greatest impact (Farlex, 2007). In 1984, Hearne, Besser, Groshen and Daly demonstrated these relationships when studying the flow rates of enteral solutions through nasoenteric tubes in adults. They demonstrated that for the most part flow rates were proportional to the internal diameters and lengths of the tubes. They also examined how caloric density, viscosity, osmolality and amount of protein affected flow rates and found that these factors alone could not predict flow rates (Hearne, Besser, Groshen, & Daly, 1984). These are all variables that are modified when infant feedings are supplemented, concentrated and otherwise modified to optimize nutritional intake. Infant feedings may be quite viscous, so using smaller tubes may require the use of a feeding pump to infuse the feeding. Eisenberg, Metheny, and McSweeney (1989) demonstrated that smaller feeding tubes and the material they were made from affected their ability to withdraw a known volume of fluid from a reservoir. This suggests that these very small, soft feeding tubes may prevent an accurate of assessment of gastric residuals. This is an important clinical concern given the frequent use of residuals as a measure of feeding tolerance and a symptom of necrotizing enterocolitis. In the current survey, nurses reported placing larger tubes when gastric decompression was required. This need for a larger tube to assist with gastric decompression was consistent with the limited available literature. De Boer, Smit, and Mainous, (2009) noted that improper positioning of the tube did not increase the amount of gastric distention, but the size of the gastric tube used did. The bigger the gastric tube, the less gastric air the infant had. It is interesting that nurses observed the need for a larger tube to relieve gastric distention, but had not recognized potential problems with flow or the ability to accurately check residuals through small bore feeding tubes.

Measuring for Insertion Depth

The current survey demonstrated wide variation in the measurement used to determine the insertion depth for a feeding tube. These findings are much different than those of Shiao and Difiore (1996), who noted that 98% of units were measuring nose to ear to xyphoid process (NEX), while only 32% of the sample in this survey was using this method. As early as 1987, Weibley, et al., demonstrated that in a population of preterm infants using the NEX method, tubes were found to be misplaced 55.6% of the time. These tubes were universally not deep enough with many positioned in the lower esophagus. When tubes were placed after measuring from nose to ear to midway between xyphoid and umbilicus, a slightly longer distance, the rate of misplaced tubes decreased to 39.3%. In 1993, Gallaher, et al., again looked at feeding tubes in NICU infants. They found that using the NEX method resulted in feeding tube were malposition 33.3% of the time. They developed a set of minimum insertion depths determined by infant weight. Using this tool they were able to improve accuracy of gastric placement to 24% of the time. Perhaps the decreasing frequency in the use of this measure represents nursing awareness of research by some authors showing that this measurement frequently leads to feeding tubes that are placed too high (Beckstrand, Ellett & McDaniel, 2007; Gallaher, Cashwell, Hall, Lowe, & Ciszek, 1993; Weibley, Adamson, Clinkscales, Curran & Bramson, 1987). Feeding tubes positioned in the distal esophagus have the potential to increase reflux and the risk of aspiration (Gallaher, Cashwell, Hall, Lowe, & Ciszek, 1993).

Selection of Oral or Nasal Placement of Gastric Tubes

NG tubes were placed routinely by 44% of the units and this increased to 66% by the time the infant reached the stage of oral feeding. This is fairly consistent with the findings of a Canadian survey which revealed that 75% of nurseries used NG tubes the majority of the time (Birnbaum & Limperopoulos, 2009). When compared to the survey by Shiao and DiFoire (1996) it appears that the use of NG tubes may be increasing over time. They reported that only 14% of units used exclusively NGs, 66% of units used both NGs and OGs, and 22% of units used only OG tubes. This increase in NG use is interesting given the lack of conclusive research in the literature. Placing a nasal feeding tube may increase the work of breathing (Greenspan, Wolfson, Holt & Shaffer, 1990). This change in work of breathing is not always clinically evident (Shiao, Youngblut, Anderson, Difiore, & Martin, 1995). Oral feeding tubes may be more frequently displaced and be more mobile than nasal tubes (Hawes, McEwan, & McGuire, 2004). In a Canadian study, some units felt that NG tubes elicited less gagging from babies (Birnbaum & Limperopoulos, 2009). The placement of both types of tubes has the potential to cause pain for the VLBW infant. A Cochrane Review was only able to locate one small clinical trial that met their criteria for inclusion in the review. This trial examined the incidence of apnea and bradycardia in infants with nasal versus oral tubes, it did not examine other outcomes such as growth and development.

This Cochrane Review determined that there was too little evidence to make recommendations about tube placement (Hawes, McEwan, & McGuire, 2004).

Verification of Tube Placement

Both this survey and the previous one done by Shiao and DiFoire (1996) suggest that nurses are still verifying placement with procedures known to be unreliable. In this study, 93.1% of units were still using insufflation with air and auscultation as a method of assessing tube placement. The accuracy of this method has been demonstrated to be only 34% in an adult population (Metheny, McSweeney, Wehrle, & Wiersema, 1990).

The majority of units also used examination of aspirated fluids, but the lists of acceptable colors and characteristics of fluids were inconsistent. A study by Gordon, Watson, Roy and Edi-Osagie (2009) demonstrated that health care providers did not always agree about whether a residual was bile stained. This makes using examination of aspirated fluids an inconsistent method of assessing placement.

X-ray is the gold standard for establishing feeding tube placement and the method most frequently used in adults to verify placement, but it is seldom used in the neonate. The cumulative radiation risk from multiple x-rays and the cost make x-rays a poor choice for routine use (Ellett, 2004).

Testing of gastric aspirate for pH has been successful in adults and children; it also has the advantage of being an inexpensive bedside test (Ellett, 2004). pH testing has been demonstrated to be a potentially viable option for infants (Nyqvist, Sorell, & Ewald, 2003). This method of verifying placement is not without its challenges. It may be impossible to obtain an aspirate if the tube is malpositioned or the tip is not in a pool of fluid. Nyqvist, Sorrell & Ewald (2003) were able to obtain an aspirate only 62% of the time. There is no consensus on what pH represents gastric placement (Freer & Lyon, 2006) and pH values may overlap (Ellett, 2004). The pH of gastric secretions may also be affected by medications that affect the gastric pH and continuous feedings. The testing of pH has potential to assist the nurse in verifying placement, but best practice may be a combination of available methods.

Continuous or Intermittent Placement of Feeding Tubes

In 1996, Shiao and Difiore reported only 50% of the Midwestern NICUs they surveyed were leaving tubes in continuously. Birnbaum and Limperopoulos (2009) in their survey of feeding tube practices in Canada, reported that of the units that used primarily OG tubes, 3 of the 5 centers were using them intermittently. At least one study looked at the practice of removing feeding tubes with each feeding. Symington, Ballantyne, Pinelli and Stevens (1995) were unable to demonstrate any difference in weight gain, apnea or bradycardia between infants with indwelling or intermittent feeding tubes. Whether indwelling versus continuous tubes affect oral feeding progression is not documented in the literature. In the current survey, the majority of units were leaving tubes indwelling (93.2%); comments suggest that this was to limit the number of uncomfortable tube placements.

Use of Pumps and Tubings

Feeding pumps are being used frequently or always in 76% of nurseries in this survey. Nurses were aware of the dangers associated with tubing misconnections (JCAHO, 2006) as demonstrated by the fact that 15.3% of units were using specially designed feeding pumps and 91.4% were using safety tubing to prevent misconnections. These findings demonstrated an increased use of recommended safety measures from those found by Wallace & Steward (2010) just one year prior.

When a feeding was complete the majority of units cleared the feeding tube with air, but 14% of units report flushing with sterile water. The most frequent volume was 0.5 to 1ml and most units did not report that this was included in the infant's intake and output. This is an interesting finding given that in a very small infant, this may represent a significant amount of fluid. Twenty one percent of units reported "other" for flushing; the comments section for this question did not provide a clear answer as to what these other options might be. This large number of units answering "other" may represent a poorly designed survey question with incomplete options or widely varying processes in the units. There was no consensus about capping feeding tubes after the feeding was complete, with 49.1% of units reporting that it depended on the infant and the comments described a wide variety of situations where tubes were left vented for variable amounts of time.

Comparison with the results of the survey done by Shiao and Difiore (1996) suggest that feeding tubes are staying in place for much longer periods of time. The authors of the current survey speculate that this is related to new materials available for feeding tube composition as the increasing dwell times mirror manufacturer recommendations for newer materials. No studies looking at infectious risks or complications over this longer period of time could be located.

No other survey could be located that has examined the frequency of tubing changes associated with pump feedings. In this survey, the majority of units changed tubings with every feeding or q 4 hours (64.9% for breast milk feedings, 54.4% for sterile formula, and 56.2% for feedings with supplements). This interval is consistent with the recommendations of the American Dietetic Association (ADA, 2011). It is interesting that a significant percentage of units reported changing tubings once a day and 7-12% report “other” as their interval. These tubings have the potential to change the nutrient content of milk since fat adheres to tubing surfaces and to act as reservoirs for bacterial growth.

The wide range in times is concerning given what is known about bacterial growth in formula and breast milk. An association between feeding intolerance and contamination of feeding tubes was documented by Mehall, et al (2002). These tubings deliver the feeding solution to the feeding tube and, therefore, represent a potential reservoir for bacterial growth and feeding tube contamination. Hurrell, et al., (2009) cultured feeding tubes that had been in place from six hours to greater than forty-eight hours. The longer the tube had been in place, the greater the bacteria count. The authors of the study suggested that these organisms can then enter the stomach as a bolus with each feeding. Nursing care of the feeding tube and infusion tubings should be explored as an area of nursing care that might affect feeding tolerance and the development of NEC.

The fat content of human milk (Greer, McCormick, and Loker, 1983) and the concentration of fat soluble vitamins are affected by flow through feeding tubes (Tacken, Vogelsang, van Lingen, Slootstra, Dikkeschei, van Zoeren-Grobben, 2010). In the study by Greer, Mccormick and Loker (1983) the fat content of feedings provided by intermittent bolus and by infusion pump were compared. They found that the fat content of human milk was lower in feedings provided by syringe pump. Positioning of the syringe tip (horizontal or vertical) did not significantly affect fat content when milk was infused at slow rates. Taken, et al., (2010) also demonstrated significant fat loss despite positioning of the tubing system; they also demonstrated loss of carotenoids in human milk. These carotenoids may play a role in antioxidant protection in VLBW infants. Medium chain triglycerides oils (MCT oil) have been used by some NICUs for supplemental fat and calories in VLBW infants. Multiple studies have documented that this MCT oil adheres to feeding tubes and other tubings (Mehta, Hamosh, Bitman & Wood, 1989; Mehta, Hamosh, Bitman & Wood, 1991). This adherence limits delivery of these needed supplemental calories. The use of tubings to provide feedings by pump may limit the delivery of fat and fat soluble vitamins to infants at risk for growth failure.

Nurse Reported Complications

Nurses were aware of and reported a wide range of consequences and complications of gavage feeding VLBW infants. Shiao and DiFiore (1996) reported that nurses had difficulty answering questions about average length of stay and mortality. Those questions were not asked in this survey, but nurses again had difficulty answering questions about outcomes. Nurses’ answers to questions about their unit’s NEC rate were very nonspecific. Many rates were reported as nursing impressions, for example “I don’t remember an NEC in the last year” or the rate was reported at “3-5%”. Questions about outcomes in both studies suggest that there are patient outcomes that nurses were either unaware of, do not have access to, or were uncomfortable reporting. The lack of data that could be categorized, made correlation of nursing practices with outcomes impossible.

When asked about complications observed related to tube feeding, nurses most frequently reported reflux (68.7%). As noted earlier, reflux is a known and common complication of prematurity and feeding tubes. Reflux is difficult to measure and while testing is available, it is generally diagnosed based on clinical suspicion. Four of twenty-two respondents discussed the frustrations associated with diagnosing and treating reflux in this population of infants. When asked about other clinical practices that may have had consequences for gavage feeding, 6 units reported the frequent use of prokinetic medications and 6 reported use of post gastric feeding (duodenal or jejunal feeding) for the treatment of reflux.

The second most frequent nurse-reported complication was tube malpositioning. It should be noted that while nurses were aware of frequent malpositioning, this had not translated into nursing research about the issue. There is still a paucity of studies examining measuring insertion depth and verifying placement of infant feeding tubes. Nurses were aware of aspiration as a complication associated with feeding tube use. Nurses also reported esophageal or gastric perforations as complications they had seen in their unit; no national data are available about the incidence of these complications. The occurrence of perforations in VLBW infants have been documented in multiple case reports (Chouteau & Green, 2003; Filippi, Pezzati, & Poggi, 2005; Mattar, Al-Alfy, Dahniya, & Al-Marzouk, 1997; Sapin et al., 2000; Shah, Dunn, & Shah, 2003). These perforations have significant consequences for infants resulting in feedings withheld, infections, possible surgeries and potential long term complications.

Nursing Beliefs about the Use of Evidence Based Practice

The survey revealed that the majority of nurses chosen by their unit to complete the survey believed that their practices were consistent with current evidence. This is an interesting finding considering the lack of empiric evidence to provide guidance in performing this procedure as well as the variability in current practices. There has been much research about nurses' attitudes toward evidence-based practice (EBP), but few have examined beliefs about how much of their nursing care is based on empiric evidence. In one such study, Melnyk et al. (2004) surveyed nurses attending an evidence-based conference. These nurses believed that 46% of their care was evidence based, however their knowledge of EBP was much lower than their beliefs. Thiel and Ghosh (2008) examined nursing readiness for EBP.

In their survey, 72.5% of respondents admitted that when they needed information they consulted colleagues rather than journals.

Freer and Lyon (2006) examined the adoption of a policy change on health care workers use of pH paper to check gastric pH. They noted that 55% of units were using the traditional practice and other supplemental methods of checking placement that were no longer recommended. These authors speculate that there is resistance to change when there is not a perceived need for change and when evidence is lacking (Freer& Lyon, 2006).

Previous surveys of feeding tube practices have suggested that much of the care is guided by tradition and caregiver preference (Birnbaum & Limperopoulos, 2009; Shiao & Difoire, 1996). The results of the current survey suggest that nurses are unaware of how much tradition guides practice and how much of their practice is truly evidence-based.

Chapter 5: Summary

Summary

Nurses completing this survey believed that their tube feeding practices were evidence-based. They held this belief despite that fact that research about feeding tubes and gavage feeding is extremely limited for the VLBW infant. This survey also demonstrated that clinical practices vary widely among units. Variation in practice is likely to continue without evidence to guide nursing procedures. Some authors have postulated that medical illness and medical treatment may contribute to the postnatal growth failure seen in VLBW infants (Loui et al., 2008). Perhaps nursing practices and nursing care also contribute to postnatal growth failure.

Nurses were aware of and concerned about complications related to gavage tube placement and feeding. Nursing research specific to this unique group of patients is needed to determine the best methods for providing gavage feedings that are safe and developmentally appropriate as well as prevent complications.

Limitations

The utility of this survey is limited by its low response rate. It has been well-documented that email surveys sent to health care professionals have a low response rate (McMahon et al., 2003). Concerns also include threats to external validity, such as the ability to obtain a representative sample and an adequate response rate (Braithwaite, Emery, De Lusignan, & Sutton, 2003). Comparing the response rates of this survey to others is difficult because of the use of multiple forms of communication media. No name, address or email list of managers could be located and lists of NICUs in the United States are kept by only two sources. Without a list of emails, invitations had to be sent by traditional mail without a specific addressee. An attempt to improve awareness of the survey and the response rate was made by using multiple forms of communication. A prenotice email was sent to a list serve designated for NICU nurse managers operated by one of two national organizations for neonatal nurses. Each unit manager was also sent an invitation by first class mail. This invitation was addressed simply to the Nurse Manager of the NICU and asked them to participate in an online survey. Postcard reminders were also sent by first class mail. Multiple emails and phone calls to the author asking for information and links to the survey suggest that many managers did not receive all of the communications. A search of the healthcare literature failed to reveal any other study attempting to use a mix of communication methods in order to reach participants.

For those who did receive their invitations, but chose not to answer, there are other limitations to consider. Because nurse managers received a letter of invitation asking them to go to a website, it is possible that some nurse managers failed to respond due to discomfort with the on-line format and lack of familiarity with the investigators. Another limitation may have been that the nurse manager felt that clarifications of items on the survey was not possible (Waltz, Strickland, & Lenz, 2005). However, the Nurse Managers were provided an email address in the letter of invitation to use in requesting clarification of questions. Several emails were received and all questions were answered by the research team. Another potential limitation was that nurse managers might not have been comfortable sharing information about their unit policies or complication rates and, thus, were willing to share only some elements of the information requested.

The use of multiple communication strategies and an internet-based survey were not successful in achieving a sufficient response rate to assure generalizability of the results. Emails and phone calls to the researchers suggested that mail addressed to Nurse Manager Newborn Intensive Care Unit is not an effective method for reaching these managers and that many did not receive their invitations. Braithwaite, et al (2003) suggested that controlled access to a national list of email addresses might provide a mechanism to improve participation in future studies and the generalizability of results.

Implications for the Doctor of Nursing Practice (DNP), for Clinical Nursing Practice and Future Research

This study has significant implications for the nurse with a Doctor of Nursing Practice (DNP) degree and other nursing leaders in neonatal care. The review of the literature and the findings of this study are an example of the continued reliance on tradition to guide important aspects of nursing practice and the limits of evidenced based practice in a developing specialty. It also suggests that the nurse at the bedside may not be aware that her actions are not evidence based. This has wide implications for DNP-prepared nurses as they plan education, quality initiatives and translational research studies.

On the macrosystem level, this study and others point out weaknesses in the systems used to measure and assure high quality care for the most fragile of neonates. There is no organizational leader shaping the agenda for neonatal nursing research priorities much less facilitating multi-site collaborative efforts among nurse researchers. Practical resources to support researchers' efforts such as a list of NICU nursing contacts to use when planning nursing research or a database of nursing quality indicators are lacking.

The response rate for this survey project was limited significantly by the lack of direct contact information for nurse managers. As suggested by Braithwaite, et al (2003) a limited access national list of contacts might improve participation in projects; this could be created, maintained and protected by one of the national organizations for neonatal nursing.

Neonatal nursing research is further hampered by the lack of benchmarks and standardized quality measures. A national database of benchmarks for quality neonatal nursing outcomes would assist researchers in standardizing measurements and definitions. These could be used in creating research projects that can be compared and contrasted and provide direction for logical progression in establishing evidence-based data to guide neonatal nursing care. This database could be initiated by one of the neonatal nursing professional organizations or created through a partnership with one of the neonatal outcome or quality organizations already working with neonatal data.

DNP-prepared nurses are clinical experts with a focused educational background in quality initiatives and leadership. They provide a pool of well educated nursing professionals ready to serve as key players in creating the mechanisms to support ongoing, coordinated research in neonatal nursing.

Clinical nursing care has significant consequences for this population of infants. Nursing care providers need improved education and awareness about the lack of evidence to support current practices surrounding gavage feeding the VLBW infant. Nurses should initiate and participate in data collection regarding infant feeding outcomes and complications to provide information to guide practice. Improved nursing knowledge may improve vigilance for and safety of the infant, creating an interest in nursing research participation and findings.

Safe, effective, evidence based nursing procedures are needed to promote optimum developmental and growth outcomes for these infants. The identification of appropriate measurement, placement and placement verification strategies should be the priority for future nursing research as these practices have demonstrated the greatest amount of variability and have the greatest potential to harm infants.

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Appendices

Appendix A: Survey Tool

Language: English

Enter site number provided in letter.

Unit Demographics

Does your unit currently participate in a multicenter database?
Check all that apply.

☐ Vermont Oxford

☐ NICHD

☐ Other

☐

Level of Care Provided by your Unit (AAP, 2004).
Pick the option that best describes the populations your unit routinely cares for and is licensed to care for.

○ Level 1 (basic newborn care)

○ Level 2 A (>32 wks, >1500 gms)

○ Level 2 B (2A + short term ventilation)

○ Level 3A (>28wks, >1000gms, minor surgical procedures)

○ Level 3 B (<1000gms, <28 wks, advanced resp support, subspecialty consult availability)

○ Level 3 C (Three B + ECMO, surgical repairs that require Cardiopulmonary bypass)

Number of Very Low Birth Weight Infants (< 1500 gms) cared for in your unit in 2009.
The last full year that admission data is available for.

○ less than or equal to 25

- 26 to 50
- 51-100
- >100

The number of VLBW infants cared for in your unit in 2009?
Actual number cared for.

Do you believe that your unit's practices for handling gavage feeding (frequency of tube changes, types of tubes, procedures for checking placement, etc) reflect current evidence-based practice?

- yes
- no

Types and sizes of tubes used
What material is your current feeding tube made of?
This should be the tube you routinely use for VLBW infants. If you do not know, enter the brand and product name below.

- Polyvinyl chloride (PVC)
- Polyurethane
- Silicone/silastic
- other

Manufacturer and name of feeding tube you use.

Current Sizes of feeding tubes used in VLBW infants:
Check all that apply.

- 3.5 fr
- 4 fr
- 5fr
- 6 fr
- 6.5fr
- 8 fr

Do you have a policy for what size feeding tube to use?
Summarize below or please feel free to forward policy/procedure to Wallace.55@osu.edu.

Use and handling of feeding tubes
Do you: Answer the option that best describes routine practice in your unit.

- Leave feeding tubes indwelling between feedings
- remove feeding tube after each feeding
- both, depends on infant

If you answered both above. Please estimate the percentage of time you use indwelling tubes.

- 25%
- 50%
- 75%

Criteria or policy used to make decision for indwelling or intermittent feeding tube use.
Please summarize or send policy/procedure to wallace.55@osu.edu

How frequently do you replace the feeding tube?
Discard the tube and use a new feeding tube.

- q 24 hours and prn
- q 72 hours and prn
- q week and prn
- q month and prn
- other

Comments about frequency of feeding tube changes:

If a feeding tube is accidently displaced is it?

- replaced with a new tube
- the same tube can be replaced

Comments about tubes that are accidently displaced:

When a feeding is complete:

- flush the tube with air
- flush the tube with sterile water
- other

Specifics of flushing tubes after feeding:
What is the volume of flush? Is it counted in I&O?

After a feeding is complete.

- Tube is left open, vented to air
- Tube is immediately clamped
- Vented if on cpap
- depends on infant
- other

Comments about leaving tubes open or clamping them.

Specifics of tube placement.
What method do you use to measure for depth of feeding tube insertion?

- Tip of nose, to earlobe, to xyphoid process
- Tip of nose, to earlobe to xyphoid process+1 cm
- Tip of nose to earlobe to midpoint between xyphoid and umbilicus
- bridge of nose, to ear lobe, to mid point between xyphoid and umbilicus(NRP)
- nomogram
- other

Do you measure differently for an NG vs an OG?

- yes
- no

Comments: measuring for an NG vs an OG?

What methods are mandatory to use to assess placement of feeding tubes?
Methods you must use prior to using the tube for the first time

- ☐ Auscultation with insufflation of air
- ☐ Aspirating tube for gastric contents
- ☐ Xray
- ☐ Testing of aspirated liquid (ex: pH)
- ☐ Compare measured insertion length with that in medical record
- ☐ other
- ☐

What methods are routinely available to the nurse placing a tube, but not mandatory to use to assess placement of feeding tubes?

- ☐ Auscultation with insufflation of air
- ☐ Assessing the color and consistency of the tube aspirate
- ☐ Xray
- ☐ Testing of aspirated liquid (ex: pH)
- ☐ other

What methods are used to monitor tube placement routinely between insertions?
Prior to each feeding if tube left indwelling

- ☐ Auscultation with insufflation of air
- ☐ Assess the color and consistency of tube aspirate
- ☐ Testing of aspirated liquid
- ☐ other

Comments about assessing tube placement:
What colors of fluid appropriate? If testing aspirate, what pH is acceptable?

Do you routinely use NGs or OGs?For the feeding of VLBW infants.

- generally use OG
- generally use NG
- Use OG until oral feeding initiated and then change to NG
- depends on infant

Criteria used to determine if infant gets an NG or OG:
Check all that apply:

- size/weight of infant
- presence of resp support (cpap or vent)
- Presence of lung disease
- use of nasal cannula oxygen
- is infant orally feeding

Comments and criteria used to determine if infant gets an OG or NG:

Tube use while transitioning to oral feeds.
Is the feeding tube routinely removed for oral feeding attempts?

- yes
- No

Comments: removing feeding tubes for oral feeding attempts.

Use and handling of feeding pumps and tubing
Does your unit use a pump to deliver bolus feeding to VLBW infants?
This is for the infusion of bolus feedings, not continuous feedings.

- No, never
- occasionally
- frequently
- always

What type of pump is used to infuse enteral feedings to VLBW infants?
any type of feeding on pump

- standard syringe pump
- IV pump
- kangaroo (feeding pump)
- syringe pump designed for use for enteral feeds (orange color)
- not applicable

Does your unit use safety tubing?
Answer yes if you use tubing that is different from IV tubing (orange in color, only fits oral syringes or feeding tubes)

- yes
- no

How frequently is tubing changed for enteral feeding changed if feeding contains breastmilk?

- with each feeding
- q 4 hours
- q 12 hours
- q 24 hours
- other

How frequently is tubing for enteral feeding changed if feeding contains sterile, premixed formula?

- with each feeding
- q 4 hours
- q 12 hours
- q 24 hours
- other

How frequently is tubing for enteral feeding changed if feeding contains supplements or specially mixed formulas?

- with each feeding
- q 4 hours
- q 12 hours
- q 24 hours

○ other

Your unit's incidence of Necrotizing Enterocolitis in infants born <1500gms for 2009.
Bells stage II or higher. Express as a % of infants <1500 grams

Are there any specific tube related problems that have occurred in you unit?

- ☐ Gastroesophageal reflux
- ☐ eosphageal or gastic perforations
- ☐ malpositioned tubes
- ☐ Aspiration
- ☐ others

Comments about complications?

Are there any other clinical practices in your unit that may have consequences for gavage feeding?

- ☐ Frequent use of prokinetics (metaclopromide or erythromycin)
- ☐ routine use of post gastric feeding (duodenal or jejunal feedings)
- ☐ other

Any specific tube related practices or problems you are willing to share?

Do you have other data you are willing to share?
Average gestational age at which oral feedings are initiated? Breast/bottle
Average gestational age at which full oral feeding achieved?
Other helpful data?

Thank you for taking the survey.

Appendix B: Survey Results

Question	Responses
Does your unit currently participate in a multicenter database? (more than one answer allowed)	58 responses 55 (96.43%) participated in Vermont Oxford 16 (28.57%) participate in other data bases 4 (8.93%) participate in NICHD
Level of care provided by your Unit (AAP, 2004 guidelines)	All were level III units (58 responses) 2 level 3A 48 (82.76%) were level 3 B 8 (13.79%) were level 3C centers.
The number of VLBW infant (>1500 grams) cared for in your unit in 2009	57 responses 25 (43.86%) cared for >100 17 (29.82%) cared for 51-100 9 (15.79%) cared for 26-50 6 (10.53%) cared for less than or equal to 25
Actual number of VLBW infant cared for in your unit in 2009	50 responses Range 12-222 Mean 85.9
Do you believe that your unit's practices for handling gavage feeding (frequency of tube changes, types of tubes, procedures for checking placement, etc) reflect current evidence-based practice?	58 responses 50 (86.21%) responded yes
What material is your current feeding tube made of?	54 responses 32 (59.26%) responded polyurethane 19 (35.19%) responded silicone 2 (3.7%) responded polyvinyl chloride (PVC) 1 (1.85%) responded other
Manufacturer and name of feeding tube you use	13 different manufacturers identified No patterns in use identified

Question	Responses
Current sizes of feeding tubes used in VLBW infants	59 responses (were allowed more than one answer) 41 (69.49%) are using 5 fr tubes 23 (38.98%) are using 6.5 fr tubes 20 (33.90%) were using 8 fr tubes 9 (15.25%) are using 6 fr tubes 8 (13.56%) are using 3.5 fr tubes 4 (6.78%) are using 4 fr tubes
Do you have a policy for what size feeding tube to use?	52 responses 19 (36.53%) have no specific policy. Remainder have a policy or unit routine These policies/practices range from a 3.5 fr for any infant <2500 grams to an 8 fr for any infant <1500 grams. Several units mentioned that bigger tubes were used when venting to prevent distention (cpap).
Do you: leave tubes indwelling, remove tube after each feeding or both depending on the infant?	59 responses 55 (93.22%) leave feeding tubes indwelling 3 (5.08%) do both, depends on the infant 1 (1.69%) remove feeding tube after each feeding
If you answered both above. Please estimate the percentage of time you use indwelling tubes.	10 responses 7 (70%) responded that they use indwelling at least 75% of the time
Criteria or policy used to make decision for indwelling or intermittent feeding tube use.	35 responses Most responded that tubes left indwelling, but occasional removed to evaluate oral feeding skills
How frequently do you replace the feeding tube?	59 responses 33(55.93%) q month and prn 13 (22.03%) q week and prn 9 (15.25%) q 72 hours and prn 4 (6.78%) other internals
Comments about frequency of feeding tube changes	18 responses Commonly identified themes: Seldom actually stay in the length of time prescribed Rotation of nares for nasally placed tubes Depends on which type of tube placed

Question	Responses
If a feeding tube is accidentally displaced is it replaced with a new tube or the same tube can be replaced?	58 responses 34(58.62%) replace with a new tube 24 (41.38%) may replace the same tube
Comments about tubes that are accidentally displaced	13 responses Common themes: Depends on date it was due to be changed RN discretion One unit provided policy for cleaning tube prior to replacement
When a feeding is complete is the tube flushed with air, sterile water, or handled in some other manner?	58 responses 38 (65.52%) flush the tube with air 12 (20.69%) other 8 (13.79%) flush with sterile water
Comments about flushing tubes after feeding	27 responses Common themes: Only flushed if did not go down with gravity Most did not count flush in I&O
Capping tube after a feed	59 responses 29 (49.15%) depends on infant 11 (18.64%) tube is immediately capped/clamped 10 (16.95%) tube vented if on cpap 6 (10.17%) tube is left open, vented to air 3 (5.08%) other
Comments about leaving tubes open on clamping them	33 responses Common themes 5 units mentioned venting for infant on high flow nasal cannula (HFNC) 4 units discussed clamping for a period of 30min to 1 hour and then venting to air.
What method do you use to measure for depth of feeding tube insertion?	59 responses 19 (32.20%) tip of nose, to earlobe, to xyphoid process 19 (32.20%) tip of nose to earlobe to midpoint between xyphoid and umbilicus 12 (20.34%) bridge of nose, to ear lobe to midpoint between xyphoid and umbilicus 8 (13.56%) tip of nose to earlobe to xyphoid process +1cm 1 (1.69%) other

Question	Responses
Do you measure differently for an NG vs an OG?	59 responses 39 (66.10%) no 20 (33.90%) yes
Comments about measuring for gastric tubes	21 responses 15 (71.42%) measure from mouth or nose depending on which is site of placement.
What methods are mandatory to use to assess placement of feeding tubes?	58 responses (more than one answer allowed) 54 (93.10%) auscultation with insufflation of air 49 (84.48%) aspirating tube for gastric contents 21 (36.21%) compare measured insertion length with that in medical record 3 (5.17%) xray 3 (5.17%) other 2 (3.45%) testing of aspirated liquid (ex. pH)
What methods are routinely available to the nurse placing a tube, but not mandatory to use to assess placement of feeding tubes?	52 responses 36 (69.23%) auscultation with insufflation of air 34 (65.38%) assessing the color and consistency of the tube aspirate 24 (46.15%) xray 5 (9.62%) testing of aspirated liquid (ex. pH) 4 (7.69%) other
What methods are used to monitor tube placement routinely between insertions?	59 responses 53 (89.83%) auscultation with insufflation of air 45 (76.27%) assess the color and consistency of tube aspirate 4 (6.78%) other 2 (3.39%) testing of aspirated liquid
Comments about assessing tube placement	28 responses Common themes Acceptable aspirates: clear, white, tan Unacceptable aspirates: bloody, green One unit who tested aspirates noted pH should be <6
Do you routinely use NGs or OGs?	59 responses 26 (44.07%) generally use NG 16 (27.12%) depends on infant 13 (22.03%) use OB until oral feeding initiated and then change to NG 4 (6.78%) generally use OG

Question	Responses
Criteria used to determine if infant gets an NG or OG	49 responses 47 (95.27%) presence of resp support (cpap or vent) 32 (65.31%) use of nasal cannula oxygen 32 (65.31%) is infant orally feeding 27 (55.10%) size or weight of infant 6 (12.24%) presence of lung disease
Comments and criteria used to determine if infant gets an OG or NG	15 responses 5 units required OGs if infant on cpap or had a high flow nasal cannula
Is the feeding tube routinely removed for oral feeding attempts?	59 responses 56 (94.92%) no 3 (5.08%) yes
Comments about removing tubes for feeding	22 responses Common themes NGs generally left in place 4 units reported oral feeding goals that must be reached to remove feeding tube
Does your unit use a pump to delivery bolus feedings to VLBW infants?	59 responses 24 (40.68%) frequently 21 (35.59%) always 9 (15.25%) occasionally 5 (8.47%) never
What type of pump is used to infuse enteral feedings to VLBW infants?	59 responses 46 (77.97%) standard syringe pump 9 (15.25%) are using syringe pump designed for use with enteral feeds (orange) 2 (3.39%) IV pump 1 (1.69%) kangaroo (feeding pump) 1 (1.69%) not applicable
Does your unit use safety tubing?	58 responses 53 (91.38%) yes 5 (8.62%) no

Question	Responses
How frequently is tubing changed for enteral feeding that contains breast milk?	57 responses 20 (35.09%) with each feeding 17 (29.82%) q 4 hours 12 (21.05%) q 24 hours 4 (7.02%) q 12 hours 4 (7.02%) other
How frequently is tubing for enteral feeding changed if the feeding contains sterile, premixed formula?	57 responses 17 (29.82%) with each feeding 16 (28.07%) q 24 hours 14 (24.56%) q 4 hours 7 (12.28%) other 3 (5.26%) q 12 hours
How frequently is tubing for enteral feeding changed if feeding contains supplements or specially mixed formulas?	57 responses 18 (31.58%) with each feeding 14 (24.56%) q 4 hours 14 (24.56%) q 24 hours 7 (12.28%) other 4 (7.02%) q 12 hours
Your units incidence of Necrotizing Enterocolitis in infants born <1500 grams for 2009	48 responses 5 units did not report Of the 43 units that reported rates: 27 (62.79%) reported rates of <5% 7 (16.27%) reported no NEC in 2009 Only one unit reported a rate >10%
Are there any specific tube related problems that have occurred in your unit?	32 responses (nurse perception of problems) 22 (68.75%) reflux 14 (43.75%) reported malpositioned tubes 9 (28.13%) reported esophageal or gastric perforations 7 (21.88%) reported aspiration 1 (3.13%) others
Comments about complications	22 responses 4 respondents discussed a perforation 4 respondents discussed problems with diagnosing reflux and causes

Question	Responses
Are there any other clinical practices in your unit that may have consequences for gavage feeding?	10 responses 6 reported frequent use of prokinetics (metaclopromide and erythromycin 6 reported routine use of post gastric feeding (duodenal or jejuna feeds) 1 reported other
Do you have other data that you are willing to share? (examples: when do you start oral feedings, at what estimated gestational age does that average VLBW infant achieve full oral feedings, etc))	36 responses Common themes: All reported using some form of cue based feedings 13 (36.11%) reported starting oral feeds at 32-22 weeks, the remainder started at 34 weeks. Estimated average age that infant obtained full oral feedings: ranged from 35-38 weeks

Appendix C: Curriculum Vitae

Curriculum Vitae

Tamara Jane Wallace
Neonatal Nurse Practitioner
8134 Kaitlin Lane
Ooltewah, Tennessee 37363
twallace269@gmail.com

EDUCATION

Degree/ Certificate	Institution	Field(s) of Study	Dates Conferred
DNP.	The Ohio State University College of Nursing Columbus, Ohio	Nursing	enrolled
M.S.	The State University of New York College of Nursing Long Island, New York	Nursing	2001
	The Ohio State University College of Nursing Columbus, Ohio	Nursing	
B.S.N.	The Ohio State University College of Nursing Columbus, Ohio	Nursing	1992
Cert	Children’s Hospital NNP Program Columbus, Ohio	NNP	1992
A.D.	Lima Technical College Lima, Ohio	Nursing	1982

CERTIFICATIONS

Cert.	Cert. No.	Description	Cert. Agency
RN	RN-182807	Licensure	Ohio Board of Nursing
	RN00001795		Tennessee Board of Nursing
APN	NP-01255	Certified Nurse Practitioner	Ohio Board of Nursing Certificate of Authority
	APN0000015454	Advanced Practice Nurse	Tennessee Board of Nursing

CTP	01255-RX	Certificate to Prescribe	Ohio Board of Nursing
DEA	MW1368047	DEA Identification	US Drug Enforcement

PROFESSIONAL EXPERIENCE

Regional Neonatal Intensive Care Unit, Children's Hospital
700 Children's Drive
Columbus, Ohio 43205

Neonatal Nurse Practitioner	1991 – present
Currently rotating hospitals	
Clinical Educator	
Children's Neonatal Services	2001- 2006
Transport Team	1999- 2001
Project Coordinator, Survanta Study	1994-1996
Staff Nurse (on call) PICU	1989-1995
ECMO Specialist	1989-1991
Preceptor	1988-1991
Staff Nurse NICU	1986-1991

From 1999 to 2001 Employment was found in several local NICUs during graduate education.

Grant Medical Center (Ohio Health) 2000-2001
111 S. Grant Ave.
Columbus, Ohio 43215-1898

Neonatal Nurse Practitioner

Marion General Hospital 1999-2001
McKinley Park Drive
Marion, Ohio 43302

Neonatal Nurse Practitioner

St. Ann's Hospital (Mount Carmel Health) 1999-2007
500 South Cleveland Ave.
Westerville, Ohio 43081

Neonatal Nurse Practitioner

Grady Memorial Hospital
561 West Central Avenue
Delaware, Ohio 43015

Nurse Manager, Grady Family Birthplace 1998-1999

Mount Carmel Medical Center 1997- 1998
793 West State Street
Columbus, Ohio 43222

Neonatal Nurse Practitioner

First Choice Home Health and Personal Services, Inc.
9 Buttles Avenue
Columbus, Ohio 43215
(614) 229-2588

Private duty and supplemental hospital staff 1989-1990

Regional Neonatal Intensive Care Unit, Children's Medical Center
One Children's Plaza
Dayton, Ohio 45404

Transport Nurse	1984-1986
Preceptor	1984-1986
Staff Nurse	1983-1986

RESEARCH AND GRANT ACTIVITIES

2011 Wallace, T.; Podium presentation: A national survey of feeding tube practices in VLBW infants. The National Association of Neonatal Nurses Research Summit.

2010 Wallace, T.; Steward, D. Poster Presentation MNRS: Use of Pumps for Providing Enteral Feedings to Very Low Birth Weight Infants

2008 Chosen to participate in The Ohio State University's T32, Road map training Program in Clinical Research (A National Institute of Health Grant) for a project entitled: Infusion Pressures Associated with Enteral Feedings in Very Premature Infants.

2005-2008 Multicenter trial: HELP (Heat loss Prevention Trial) Vermont Oxford Network. Co-Investigator for The Children's NICU at Riverside.

2001 Wallace, T: Graduate Project: Completeness of Neonatal Discharge Summaries. State University of New York at Stony Brook.

1998 Wallace, T: Abstract: Comparison of Care by Surgical House Staff vs. Neonatal Nurse Practitioners for Surgical Neonates With Gastroschisis: Quality of Care and Cost Indicators. Presented in poster format at Ross Lab's Advanced Practice Conference, Washington DC, May 1998 and the Yearly Conference for the National Association of Neonatal Nurses, Cincinnati, Ohio, September 1998.

1994-1996 Project Coordinator, Survanta Study, Columbus Children's Hospital

PRESENTATIONS

Wallace, T. (February 9, 2011). Cognitive Errors: How our brains sometimes lead us astray. Nationwide Children's Hospital Neonatal Quality Retreat, Columbus, Ohio.

Wallace, T (November 4, 2010). Jeopardy: Infection Prevention in Neonates. (Podium) Riverside Methodist Hospital Yearly Perinatal Conference, Columbus, Ohio.

Wallace, T. (September 20, 2010). Cognitive Errors in Diagnostic Reasoning and the Neonatal Nurse Practitioner. (Podium). Yearly Conference for the National Association of Neonatal Nurses, Las Vegas, Nevada.

Wallace T., Keels, E., Kaminski, M. (March 19, 2010) A Program for Documenting ongoing Competency in Neonatal Nurse Practitioners (podium and poster). American Academy of Neonatal Nurses, Advanced Practice Conference, San Francisco, California.

Wallace T. (Sept 26, 2007) Do We Know How to Safely Gavage Feed Very Low Birthweight Infants? Yearly Conference for the National Association of Neonatal Nurses, San Diego, California.

Wallace T, Newhouse L, Tipple J (Oct 29, 2005) Poster: We're Delivering, Who is Attending? The Art and Science of Perinatal Care, Chicago, IL.

Wallace T and Gest A: (Oct 3, 2003) Towards Improving Outcomes. Infants at Risk, Children's Hospital, Columbus, Ohio.

Wallace T: (Oct 2, 2003) Comparison of Care by Surgical House Staff vs. Neonatal Nurse Practitioners for Surgical Neonates With Gastroschisis: Quality of Care and Cost Indicators. Academy of Pediatrics, Surgical Section, New Orleans, Louisiana.

Wallace T: (presented bi-annually 2001 to present) Metabolic and Endocrine Problems in the Neonate, Care of the Sick Newborn, Columbus, Ohio.

Wallace T: (1998) Birth Trauma. Yearly Conference for the National Association of Neonatal Nurses, Cincinnati, Ohio.

Wallace T: (presented bi-annually 1993-1998, annually 2003-present) Immune Function in the Neonate, Neonatal Nurse Practitioner Program, Columbus, Ohio. Currently a part of the physiology section, Neonatal Nurse Practitioner Program the Ohio State University.

Wallace T: (presented biannually 1994-1998, annually 2003-present) Evaluating lnborn Errors of Metabolism. Neonatal Nurse Practitioner Program, Columbus, Ohio. Currently a part of the physiology section, Neonatal Nurse Practitioner Program the Ohio State University.

Wallace T: (presented biannually since 1993) Fluid and Glucose Homeostasis, Care of the Sick Newborn, Columbus, Ohio.

Wallace T: (presented biannually since 1994) Genetics for the Bedside Nurse, Care of the Sick Newborn, Columbus, Ohio.

Wallace T: (winter 1994) What's New in Neonatal Nursing, American Health Care Institute, Long Island, New York.

Wallace T: (presented biannually 1992-1994) The Physiology of Lactation, Neonatal Nurse Practitioner Program, Columbus, Ohio.

Wallace T: (1993) Immunology, Children's Hospital, Columbus, Ohio.

Wallace T: (1993) Problems of Prematurity. Children's Hospital, Columbus, Ohio.

Wallace T: (1992) Control of Bleeding on ECMO, ECMO Training Program, Columbus, Ohio.

Wallace T: (1991) ECMO Update, Nursing Grand Rounds, Children's Hospital, Columbus, Ohio.

Wallace T: (1990) ECMO, NAACOG, Cambridge, Ohio.

AWARDS AND HONORS

2011	Nominated for a Cameo of Caring
2009	Nominated with Dublin NSCU Team for a Prism Award for Excellence, Ohio Health
2009	Nominated with Riverside Methodist Hospital/Nationwide Children's Hospital Delivery Team for a Prism Award for Excellence, Ohio Health.
2007	Edith Crowley Blessing Scholarship
2006	Nominated for a Cameo of Caring
2004	Nominated for March of Dimes, 2004 Health Leadership
2002	Nominated for The Prism Award for Excellence, Riverside Methodist Hospital.
1996	Neonatal Nurse Practitioners named Surgical Nurses of the Year
1994	Nominated for Children's Hospital Nursing Award for: Commitment to Patient/Family Advocacy
1994	Nominated for Children's Hospital Nursing Award: Mary Lou Herron Award for Excellence in Nursing Leadership
1993	Inducted into Sigma Theta Tau, Epsilon Chapter
1981-1982	Emily Patterson Memorial Scholarship, awarded by Mary Rutan Hospital, Bellefontaine, Ohio

PROFESSIONAL ORGANIZATIONS

2010-present	Council of International Neonatal Nurses (COINN)

2007-present	Midwest Nursing Research Society
2001-present	Academy of Neonatal Nurses
1991-present	National Association of Neonatal Nurses
1991-2002	Central Ohio Association of Neonatal Nurses President of COANN 1999 Became Central Ohio Association of Neonatal Professionals 2001
1993-1995 2007-present	Sigma Theta Tau, Honorary Nursing Society
1992-1993	AWHONN (Formerly NAACOG)

PUBLICATIONS

Wallace, T. (2010). The Things I Know. *Neonatal Network*, Vol 29 (5), p 337.

OTHER PROFESSIONAL ACTIVITIES

Educational Provider Committee for the National Association of Neonatal Nurses (2011).

Planning Committee, NANNP: (2009-2010) Competency guidelines for Neonatal Nurse Practitioners.

Planning Committee Member: (2007) A Passion for Excellence. Creating Brighter Tomorrows for Babies, the 23rd Annual Educational Conference for the National Association of Neonatal Nurses.

Item writer for National Certification Corporation, Neonatal Nurse Practitioner exam, Jan 2007

Manuscript review for Advances in Neonatal Care, 2006-present