Neonatal Nurses’ Knowledge and Assessment of Necrotizing Enterocolitis (NEC) in the Premature Infant

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Neonatal Nurses' Knowledge and Assessment of Necrotizing Enterocolitis (NEC) in the Premature Infant

Kathryn Taylor Van Hoose

Paper submitted in partial fulfillment of the requirements for the degree of

Doctor of Nursing Practice

University of Louisville
School of Nursing

Date Finalized

Signature DNP Project Chair

Signature DNP Project Committee Member

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Date

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Acknowledgments

I would like to first acknowledge and thank my four classmates; Amy, Blair, Liz, and Brittany. I would have never made it to the end of this program without them. I would like to extend special recognition to all the members of my committee for countless hours of advice, insight, and dedication, which ultimately led me to the completion of this program. Thank you, Dr. Sharon Barton, Dr. Vicki Hines-Martin, Dr. Leann Brewer, and Kim Knott, for your guidance and attributions to this project and my evolvement and growth in the clinical setting. Finally, I would like to extend my appreciation for Dr. Sandra Smith as she assisted me from the beginning of my project and has been an influential contributor to my experience in this program.
Dedication

I would like to dedicate this project to all the NICU patients that I have cared for in the past, specifically the one patient I cared for that succumbed to this disease process, as this patient served as my motivation and ambition to strive for improvement of the care of infants diagnosed with NEC. I would also like to dedicate this project to my husband, father, and all of my extended family members and friends. I could not have completed this program without their continued love and support.
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Abstract

Necrotizing Enterocolitis (NEC) is the most common gastrointestinal emergency seen in the Neonatal Intensive Care Unit (NICU) (Cleveland Clinic, 2015). NEC occurs most frequently in premature infants, accounting for approximately 60 to 80 percent of all cases (Singh et al., 2008). Mortality rates associated with NEC are estimated to be between 20 and 30 percent reaching upwards of 50 percent for patients requiring surgical intervention (Cleveland Clinic, 2015).

There is an abundance of research surrounding the pathophysiology, potential causes, and protective factors related to NEC in the premature infant. Comparisons of various interventions such as: feeding practices and protocols, administration of packed red blood cells (PRBC) transfusions, temporal clustering of disease, and medication interactions have been thoroughly studied, however further research and evaluation is warranted in order to drive practice change.

Infants who survive NEC often times have secondary issues that pose lifelong challenges, which require collaboration among multiple disciplines throughout the child’s lifetime. The initial signs and symptoms of NEC are most commonly observed and noted by the bedside nursing staff. Early identification of the signs and symptoms associated with the onset of NEC could potentially save an infant’s life from this devastating disease. It is the aim of this project to assess the NICU nurses’ knowledge level related to NEC, implement an educational experience to enhance the baseline knowledge level, with reassessment to evaluate if there was an increase in the knowledge level.

Key words: Necrotizing enterocolitis; NEC; premature infant; blood transfusions; premature gut; risk factors
Neonatal Nurses’ Knowledge and Assessment of NEC in the Premature Infant

Premature infants are susceptible to a variety of illnesses and medical conditions that are unique to this patient population. Premature infants have not yet had time for their organs and bodies to properly develop and mature, which makes them susceptible to adverse disease processes not observed in term infants. One of the most devastating illnesses seen in the preterm infant is NEC. NEC is the most common gastrointestinal emergency in the neonatal intensive care unit (NICU). The disease process begins with inflammation of the intestines and becomes life threatening if not identified and treated promptly (Cleveland Clinic, 2015). NEC occurs most frequently in premature infants, accounting for 60 to 80 percent of all cases (Cleveland Clinic, 2015). Mortality rates of NEC are estimated to be between 20 and 30% reaching upwards of 50% for infants requiring surgical intervention (Cleveland Clinic, 2015). Despite the fact that infants survive this disease, the long-term consequences of NEC are not benign. In a comparison to infants not diagnosed with NEC, infants who survive NEC are often faced with additional lifelong complications including; intestinal strictures, short gut syndrome, and worsening neurodevelopmental outcomes (Doty et al., 2016). The exact cause of NEC is unclear, however there are numerous hypotheses and associations related to NEC.

A literature review on NEC was conducted, utilizing the databases CINAHL, PubMed, and Cochrane Review to identify the most common associations with NEC. The literature search generated fifteen quantitative articles for evaluation and critical appraisal. There were six articles reviewed that highlighted the association between packed red blood cell (PRBC) transfusions and NEC, seven articles that focused on enteral feeding methods, and three articles that focused on common medications utilized in the neonatal population and their potential risk and association with the onset of NEC.
Marin et al., (2014) conducted an observational study that was designed to evaluate the mesenteric tissue oxygenation response in preterm infants fed and not fed during PRBC transfusions. The mesenteric regional oxygen saturation values were measured using a Food and Drug Administration approved near infrared spectroscopy (NIRS) somatic oximeters. The study was conducted at Emory University at a level III NICU from November, 2010 through December, 2011. All premature infants born less than 33 weeks’ gestation who were fed and not fed during PRBC transfusions were included in the study and separated by feeding status during transfusion. Tissue oxygenation means were examined up to 48 hours after each transfusion event. The results show that mesenteric tissue oxygenation during PRBC transfusions was not influenced by feeding status. However, infants fed during PRBC transfusions had, for the next 15 hours, decreasing postprandial mesenteric tissue oxygenation patterns compared with infants not fed during PRBC transfusions, which could potentially be a contributor to the onset of NEC.

Feeding during PRBC transfusions may in fact increase the risk for mesenteric ischemia and the development of transfusion associated necrotizing enterocolitis (TRANEC). There were no statistical differences in gestational age in infants fed versus not fed during transfusions, yet infants fed during transfusions had a trend toward being slightly older and received greater volumes of feedings. Larger studies are needed to further evaluate the findings from this study. The study had Institutional review board (IRB) approval and the researchers included all statistical analysis and measures that were utilized. The weakness of the study that was listed by the authors is that all patients involved were from the same NICU, thus exposed to the same protocols and standards of care, which may have had influence outcomes.

The literature review yielded numerous results regarding the associations and contributing factors to NEC in the premature infant. However, the only definite causative factor
predisposing an infant to NEC is prematurity (Cleveland Clinic, 2015). Gibbins et al., (2008), Grephart et al., (2012), Mally et al., (2006), Singh et al., (2011), Gephart et al., (2014), Whyte & Jefferie (2014), and Wan-Huen et al., (2013) all provided significant research findings regarding a combination of the signs, symptoms, and associations of NEC in the premature infant. The combination of the literature review and clinical experience caring for infants’ diagnosed with NEC, were the driving forces for the educational intervention at the nursing level.

Therefore, using extant literature, it was the aim of this project to assess the current knowledge level of the nursing staff in a level IV NICU, related to the associations as well as signs and symptoms of NEC, educate the staff about this topic, and then evaluate the nursing staffs’ knowledge post educational intervention. The project was designed to improve the knowledge and ultimately the practice of the bedside nursing staff regarding the incidence, contributing variables, and best evidence-based practices about NEC in the premature infant. The onset of NEC can have a fatal effect on a premature infant in less than eight hours, thus prompt identification by the bedside nursing staff and providers of the signs and symptoms of NEC is vital (Cleveland Clinic, 2015).

The rationale for selecting this topic in this patient population is directly related to a clinical experience with an infant who was diagnosed and succumbed to the disease within a ten-hour period. I have taken care of numerous patients diagnosed with this disease process, however the patient that sparked my desire to study this topic further is one that I will always remember and continue to advocate for throughout my career.

**Theoretical Framework**

The conceptual framework that was applied to this project is Kent’s Web of Causation (Kelly, Kelly, & Russo, 2014). This theoretical framework is most well known for its
application to the science of epidemiology, however the application of this theory to the incidence and prevalence of NEC in the preterm infant is merited. Epidemiological research that utilizes Kent’s theory often studies the distribution of disease within and across populations and looks for the causes of such distributions (Kelly, Kelly, & Russo, 2014). Kent’s theory applies to this project because the theory itself is multifactorial and emphasizes the fact that some disease processes are not the result of a single causative factor, but rather multiple influences (Kelly, Kelly, & Russo, 2014). Except for prematurity, there is no direct cause of NEC, the disease process involves numerous contributing factors and associations. Causes of NEC often occur sporadically as isolated cases and have been theorized to occur in outbreaks, most likely related to bacterial invasion (Doty et al., 2016). These outbreaks of NEC suggest need for an epidemiological approach.

The project design involved an educational intervention for the bedside nursing staff, which was composed of information related to the most common associations that have been identified as associations with NEC, as well as the most common signs and symptoms displayed by infants with the disease. Similar to epidemiological research that utilizes Kent’s theory (Kelly, Kelly, & Russo, 2014), this project was designed to address the numerous contributing risk factors and associations related to the onset of NEC. A figure provided illustrates how there can be multiple causes for something and inversely those things can cause something else. Example E can cause D, while D can also cause E, and C can cause D and E (Appendix A).

Setting and Organizational Assessment

Setting

The setting for this project is a 70 bed, level IV, urban NICU in the state of Kentucky. Level IV NICU care designates the institution as having additional capabilities and considerable
experience in the care of the most complex and critically ill newborn infants. Inclusion for level IV designation involves: pediatric surgical specialty with providers 24 hours a day, care for congenital cardiac malformations, as well as other complex neonatal diagnoses requiring extracorporeal membrane oxygenation (ECMO).

**Purpose**

NEC continues to be a significant cause of mortality and morbidity in the premature infant. Mortality rates of NEC are estimated to be between 20% and 30% reaching upwards of 50% for infants requiring surgical intervention (Cleveland Clinic, 2015). There is an estimated additional annual cost of $500,000 per patient diagnosed with NEC in North America, averaging between 1-3 per 1000 births (Nino, Sodhi, & Hackam, 2016). Although NEC has a low volume, it is high risk, with a significant risk of mortality and morbidity (Cleveland Clinic, 2015). The rate of NEC in this institution in 2018 was six patients, 3.7%. When compared to the national average of 7 patients and 4.5%, this value is not significantly lower. It would be the ultimate goal of this project being one that improves education practices and provides evidence-based knowledge to support practice changes resulting in earlier recognition of NEC. This practice can assist with the decline of rate of NEC in the unit in the future and earlier intervention to decrease the severity of NEC outcomes.

The purpose of this project is to assess the bedside nursing staffs’ level of knowledge and awareness of the signs and symptoms of NEC in the premature infant. Following the assessment, an educational program was delivered to the bedside nursing staff to address knowledge gaps and current evidence-based practice and to assess premature infants at risk for developing NEC. The incidence of NEC in the unit where this intervention occurred is relatively
low already, however the disease process has such devastating effects, there is always need for further education aimed at reducing the incidence of NEC.

**Intervention**

The study design included a pretest and posttest (Appendix B) with an educational experience (Appendix D) between the two measures. Questions on the pretest and posttest were the same and included associated risk factors for NEC development such as: gestational age, birth weight, oxygen requirement, PRBC transfusion history, feeding method at time of diagnosis, antibiotic use, probiotic use, and increase in abdominal circumference. Questions on signs and symptoms included those frequently associated with the onset of NEC such as; lethargy, increased oxygen requirements, increased abdominal circumference, emesis, hypotension, temperature instability, increased apnea and bradycardia, and irritability (Gregory et al., 2013). The educational intervention included current evidence-based practices for nursing assessment related to sings/symptoms of NEC as well as the most common associations with NEC. The educational intervention itself was a PowerPoint presentation that was distributed to the nursing staff via e-mail. Permission for this project was granted by the University of Kentucky Nursing Research Council. The University of Louisville Institutional Review Board approved the study.

**Participants/Consent**

Participation was entirely voluntary. An e-mail with information regarding the project was distributed to the entire NICU nursing staff at Kentucky Children’s Hospital. The opportunity to participate was extended to all NICU staff including part-time and on-call employees, regardless of their level of experience or training in the unit. Consent from
participants was assumed upon completion of the pretest. A statement explaining this assumed consent was noted on the pretest, as well as the posttest. Confidentiality and anonymity were maintained. No protected health information was collected for this project.

Data Collection

The data collection was conducted by the DNP student via e-mail and Survey Monkey™. Participants who completed the survey did so electronically. There was a two-week time period between each component; the pretest, educational intervention, and posttest. A unit based visual stimulus (Appendix C) (magnet for patient white boards) served as a reminder of the educational presentation and the importance of bedside nurses’ early recognition and awareness of signs and symptoms of NEC.

Measurement and Data Analysis

Data were maintained on an encrypted, password-protected personal laptop. There was also the implementation of a visual stimulus (magnet) posted on a white board, which served as a reminder of the educational experience and the importance of bedside nursing staff being aware of the risk factors and signs/symptoms of NEC. The pre/post tests were composed of ten questions, with one demographic question which assessed the years of experience as a NICU nurse, and the remaining nine questions pertaining to NEC. Seven NEC questions were multiple choice, one was fill in the blank, where the participants were asked to list three risk factors for NEC, and one question was a yes/no option. The questions on the pre/posttests were derived from a summary of the literature review with application to most commonly assessed measures of the bedside nursing staff related to the care of premature infants. The data were measured and summarized with percentages, displaying the difference in response between pretest and posttest.

Results
The opportunity to participate was extended to the full bedside nursing staff, consisting of 197 nurses. The pretest yielded 70 responses (36% of the staff), with the posttest having 44 responses (22% of the staff) and a 63% retention rate between pretest and posttest. The pretest revealed 30% of respondents had been NICU nurses between (0-3 years), 30% between 4-6 years, 17% between (7-10 years), and 14% greater than 10 years. The posttest was similar but varied slightly, due to participant attrition. There were 49% between (0-3 years), 23% between (4-6 years), 12% between (7-10 years), and 16% greater than 10 years. This totaled an average of 38% (0-3 years), 29% (4-6 years), 18% (7-10 years), and 15% greater than 10 years (Figure 1).

The second and fifth questions focused on the best enteral feeding options for premature infants, with the questions assessing the optimal time to initiate enteral feeds and the second inquiring which type of enteral feeding reduces the risk of NEC. The eighth question inquired about bedside nursing practice related to assessing for gastric residuals, which is contraindicated in neonatal care (Doty et al., 2012). The question addressing the optimal time to initiate enteral feeds after birth showed a slight increase in knowledge. There were three options for which the pretest revealed 19% of participants believed that initiating enteral feeds on day of life (DOL) 1 was best. This number declined to 12% on the posttest. The correct response, that enteral feeds should begin on DOL 2-3, was recorded by 60% of participants on the pretest and increased to 81% of participants on the posttest. The incorrect option to initiate enteral feeds after DOL 3 was recorded as 21% on the pretest and only 7% on the posttest (Figure 3). The options for the enteral feeding associated with a reduced risk for NEC were breast milk, fortified breast milk, or formula. The pretest had 2.9% of participants choosing an incorrect answer, fortified breast milk, and 0% selected this incorrect answer on the posttest. The pretest showed 94% of respondents on the selected the correct answer of breast milk, with a minimal increase to 95% on
the posttest. There were two individuals (3%) that selected the incorrect answer, formula, on the pretest and two (4%) selected formula on the posttest (Figure 4).

The fourth question related to various medication options and their association with increasing the risk of NEC. There were eight medication options with two of the eight being medications (Zantac and Indomethacin) that are associated with increasing the risk of NEC in the premature infant. The two correct answers increased from 21% (Zantac) and 93% (Indomethacin) on the pretest to 83% (Zantac) and 95% (Indomethacin) on the posttest (Figure 5). There was one question regarding knowledge of the risk associated with continuing feeds while an infant is receiving a PRBC transfusion. Seventy percent of participants replied yes on the pretest, this value increased to 90% on the posttest (Figure 6).

The third question asked the respondents to list three risk factors for NEC. The pretest had 69 individuals respond (99%). 1.4% of these respondents did not correctly identify any risk factors, 7.2% correctly identified one risk factor, 44.9% correctly identified two risk factors, and 46.4% correctly identified three risk factors. The posttest had 42 respondents (98%) for this question with 2.4% of respondents not correctly identifying any risk factors, 4.8% correctly identifying one risk factor, 28.5% correctly identifying two risk factors, and 64.3% correctly identifying three risk factors (Figure 7). The ninth question was related to the common signs/symptoms of NEC, with twelve options listed: increased FiO2 requirements, bilious emesis, hypotension, temperature instability, increased apnea/desaturation events, increased urine output, irritability, distended abdomen/increased abdominal circumference, discoloration of abdomen, decreased urine output, hypertension, and lethargy. All symptoms, excluding increased urine output and hypertension, were correct responses and directly related to the premature infants’ signs/symptoms of NEC. Pretest revealed 1.43% and posttest revealed 1.77%
of respondents selected increased urine output. Pretest revealed 12.86% and posttest revealed 6.98% of respondents selected hypertension. Correct responses on the pretest ranged from 70% - 98.6% and posttest percentages ranged from 84%-100% (Figure 8). The tenth question assessed the knowledge of which patient group is at the highest risk for NEC according to corrected gestational age (CGA). The correct response of 32-35 weeks CGA was 14.3% on the pretest with an increase to 67% on the posttest. The incorrect response of 25-28 weeks CGA was 37.1% on the pretest and decreased to 12% on the posttest. The incorrect response of 28-32 weeks CGA was 48.6% on the pretest and 21% on the posttest. There was one possible answer of greater than 35 weeks CGA that was not selected on either pretest or posttest (Figure 9). The seventh question was related to when the nurse would contact a provider regarding increased abdominal circumference. The incorrect option of 1-2 cm was 22.8% on the pretest and 6.9% on the posttest. The correct option of 3-5 cm was 77% on the pretest and 91% on the posttest. The incorrect option of >6 cm was 0% on the pretest and 2% on the posttest (Figure 10).

Discussion

Interpretation

Interpretation of project results is limited due to participant attrition from pretest to posttest. The response rate of this project was 36% from the total number of nurses notified of the project. The attrition rate was 63%, which affects the robustness of the findings because the findings could be due to chance alone, rather than a real change. However, according to Amico (2009), between 30-40% attrition is acceptable. The results of this project illustrate that there was an increase in the level of knowledge from pretest to posttest. The ultimate goal of increasing the NICU nurse’ knowledge of the risk factors and associations related to NEC was enhanced. As evidenced by the figures, which show an increase in the number of correct responses and a
decrease in the number of incorrect responses, there is an increase in the NICU nurses’ level of knowledge of the signs, symptoms, and associations of NEC. There were two questions that showed the largest increase in the number of correct responses, one being the question related to medications that increase the risk of NEC. This question had a 52% increase in one of the correct responses. The question related to the respondent’s ability to correctly identify three risk factors associated with NEC increased from 46.4% to 64.3% between the pretest and posttest.

Despite the fact that infants survive this disease, the long-term consequences of NEC are not benign. In a comparison to infants not diagnosed with NEC, infants who survive NEC are often faced with additional lifelong complications including; intestinal strictures, short gut syndrome, and worsening neurodevelopmental outcomes (Doty et al., 2016). The exact cause of NEC is unclear; however there are numerous hypotheses and associations related to NEC. Cases of NEC can appear sporadically as isolated cases and have also been theorized to occur in outbreaks, most likely related to bacterial invasion (Doty et al., 2016).

The initial signs and symptoms of NEC are most commonly observed and noted by bedside nursing staff. Nurses play a crucial role throughout every stage in the process of prevention and early recognition of NEC (Doty et al., 2016). Early identification of the signs and symptoms associated with the onset of NEC could potentially save an infant’s life from this devastating disease. NEC research is still a very active area of neonatal research; thus, it is often challenging for health care providers to stay up to date on the latest research and update practice accordingly.

**Limitations**

There were limitations to this project, specifically with application to the intervention design. The pretest/posttest design is dependent upon the participants completing both the
pretest and posttest. The pretest had 70 participants while the posttest only had 44 participants, yielding approximately a 63% retention rate, which is an issue of participant attrition. However, there is no way to verify that the same individuals completed the pretest as well as the posttest. There is also no specific means to validate that the 44 participants of the posttest were all participants on the pretest. This poses a reliability and validity issue. There were also respondents who skipped questions, which also negatively contributes to the validity of the project. There were three respondents who only provided two risk factors for question three, where they were asked to list three risk factors associated with NEC. There were also two respondents who skipped question eight, which assessed if the nurse checked gastric residuals.

There is opportunity for improvement of the questionnaire. The study also has a limitation related to data analysis. Additional analysis would be helpful in determining the statistical significance of the educational intervention with further analysis of the pre/posttest data.

**Conclusion**

It is evident that between the pretest and posttest for this project there was an increase in the number of correct answers and a decrease in the number of incorrect answers in all 8 of the applicable questions. The findings were disseminated to the staff and healthcare team via e-mail at the completion of the project. The direct goal of this project was to assess the NICU nurses’ knowledge of the associations and assessment of an infant with NEC, implement an educational experience, and subsequently reassess the level of knowledge with the aim to improve this knowledge.

Future implications will potentially provide valuable information for a potential quality improvement project related to NEC or to implement further teaching/training regarding NEC.
into the nursing orientation process. The ultimate goal was to increase the bedside nurses’ knowledge level of the risk factors and associations related to NEC, which was achieved.

It was the aim of this project to assess the baseline knowledge level of the nursing staff, regarding the associations as well as signs and symptoms of NEC. Following the initial assessment there was an educational opportunity implemented to the staff, and then a re-assessment of the nursing staffs’ knowledge. The project was designed to improve knowledge of the bedside nursing staff regarding the incidence, contributing variables, and evidence-based practice regarding NEC in the premature infant.

The outcome of this project establishes that there is a need for further education of the bedside nursing staff regarding the associations as well as the signs and symptoms of NEC. The ultimate goal of this project is to demonstrate the need for continued education of the bedside nursing staff in hopes to improve early diagnosis of NEC as well as decrease the incidence of morbidity and mortality secondary to NEC.
References


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Appendix A

Kent’s Web of Causation

Appendix A: Kent’s Web of Causation (I, II, III, IV represent each scenario demonstrating a different cause)
Figure 1. Demographic question related to years of experience as a NICU RN
Figure 2. Assessment of the amount of NICU RNs that assess for gastric residual

(Contraindicated in neonatal care, correct answer is No)
**Figure 3.** Knowledge of the ideal timeframe to initiate enteral feeds in a premature infant

(Correct answer is DOL 2-3)

**Figure 4.** Knowledge of the best enteral feeding type in order to reduce the risk of NEC (Correct answer is breast milk)
Figure 5. Ability of the NICU RN to correctly identify risk factors associated with NEC

Figure 6. Knowledge of continuing enteral feedings during PRBC transfusions and the association with NEC (Correct answer is yes)
Figure 7. Knowledge of medications associated with an increased risk of NEC (Correct answers are Zantac and Indomethacin)
Figure 8. Knowledge of signs/symptoms associated with the onset of NEC (All answers are correct except increased urine output and hypertension)

![Graph showing CGA and association with time of onset]

Figure 9. Knowledge of most frequent CGA associated with onset of NEC (Correct answer is 32-35 weeks)

![Graph showing increased in AC and notification of provider]

Figure 10. Knowledge of appropriate time to notify provider regarding increased AC (Correct answer is 3-5 cm)
Appendix B

Pre/Posttest

1. How long have you been a nurse in the NICU?
   a. 0-3 years
   b. 4-6 years
   c. 7-10 years
   d. > 10 years

2. Which type of feeding decreases the risk of NEC?
   a. Fortified breast milk
   b. Breast milk
   c. Formula

3. Please list three risk factors associated with NEC. *(Fill in the blank)*

4. Which medications are associated with an increased risk of NEC? *(Select all that apply)*

5. When is the best time to initiate enteral feeds for premature infants < 36 weeks’ gestation? *(excluding infants with a known gastrointestinal anomaly)*

6. Is there an increased risk of NEC associated with continuing enteral feeds while an infant is receiving a PRBC transfusion?

7. Which value range, referring to an increase in abdominal circumference (AC), would alert you as the bedside nurse to notify the provider?

8. Do you check for gastric residuals during your shift?

9. Please select the signs/symptoms that are associated with the onset of NEC? *(Select all that apply)*

10. At what corrected gestational age (CGA) is a patient at the highest risk for developing NEC?

*(Appendix B: Pre/Posttest)*
Appendix C

Visual Reminder

(Appendix C: Visual stimulus implemented as a magnet to be utilized on patient white boards)
Appendix D

PowerPoint (Educational Intervention)

DNP Project:
Neonatal Nurses' Knowledge and Assessment of Necrotizing Enterocolitis (NEC) in the Premature Infant

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Problem Statement

• NEC is the most common gastrointestinal emergency seen in the neonatal intensive care unit (NICU).
• The initial signs and symptoms of NEC are most commonly observed and noted by the bedside nursing staff.
• These symptoms can vary in degree and include:
  • Lethargy, increased oxygen requirements, increased abdominal circumference, discoloration of abdomen, bilious emesis, hypotension, frank blood in stool, temperature instability, increased apnea and bradycardia, decreased urine output, and irritability.

Incidence/Significance

• NEC begins with inflammation of the intestines and becomes life threatening as it progresses to bowel necrosis if not identified and treated promptly.
• Mortality rates associated with NEC are estimated to be between 20% and 30% reaching upwards of 50% for infants requiring surgical intervention.
• Infants most at risk for developing NEC are typically premature infants born less than 27 weeks gestation who are at a corrected gestational age between 32-35 weeks.
Associations

- The only definitive risk factor for NEC is prematurity.
- There are a number of risk factors that range from prenatal, intrapartum, and postnatal risk factors.
- Some of the associations and contributing risk factors related to NEC include: cyanotic congenital heart disease, polycythemia, IUGR, formula feeding, umbilical catheters, perinatal asphyxia, mechanical ventilation, RDS, lack of feeding protocols, advancing feeds too quickly, intolerance of fortified breast milk, indomethacin treatment for PDA closure, NPO status, hemodynamic instability requiring vasopressor therapy, and sepsis.
- The literature supports the increased evidence that there is a strong correlation between NEC and PRBC transfusions as well as correlating feeding practices.
- Premature infants with lower hematocrit levels are at a higher risk for developing NEC, however there is evidence suggestive of a protective effect of holding feedings before and during transfusions, specifically related to transfusion associated NEC. However, there is also evidence that there is more damage caused by NPO status in the premature gut, thus trophic feedings would be indicated.

*This particular area of NEC research warrants further study prior to implementing a change in practice.*
**Medications**

- There are numerous medications associated with an increased risk of NEC in the premature infant. A few of these medications are: Zantac and Indomethacin.

- H2 Blockers such as ranitidine (Zantac) has a known increased association of NEC in the premature infant. The use of H2 blockers prophylactically is ill-advised in this patient population.

- It is well known in neonatal research that NSAIDS should be used for the closure of PDA in the premature infant rather than indomethacin. Despite this evidence, indomethacin is still routinely used in practice.

- It is around the 34th week of gestation that migrating motor complexes appear, which facilitate normal motility through the gut. Normal motility is critical for digestion and absorption. This normal motility is a critical aspect of preventing stasis and subsequent disease in the premature GI system.

- It is important that trophic feedings be implemented early on in a premature infant if the infant is hemodynamically stable, typically day 2-3 of life.

- The implementation of a feeding protocol in the NICU is a risk reduction strategy for NEC. These protocols allow the infants gut to be primed and feeds to be initiated early and advanced slowly, thus protecting the immature gut form injury.

- Premature infants fed formula have an increased risk for developing NEC. Fortified feedings are not a direct risk factor, however it is important to monitor feeding tolerance in these infants.
• NEC is associated with high morbidity and mortality and treatment options are often unsuccessful and there is little improvement of outcomes even after early diagnosis.

• NEC survivors often suffer from short and long-term co-morbidities. Prophylactic measures to reduce the incidence of NEC are key to improvement.

• It is the bedside nurses responsibility to be aware of the risk factors as well as the signs and symptoms of disease in the premature infant, in order to intervene as quickly as possible.

• I sincerely thank you all for your time and participation in my project and I hope that there was at least one take away that will assist you in your future practice and care of the most premature infants. -Taylor

(Appendix D: PowerPoint-Educational Intervention)