Early Assessment and Prevention of Necrotizing Enterocolitis in Premature Infants

Kathryn Weber
Carroll College

Follow this and additional works at: https://scholars.carroll.edu/nursing_theses
Part of the Maternal, Child Health and Neonatal Nursing Commons, and the Pediatric Nursing Commons

Recommended Citation
https://scholars.carroll.edu/nursing_theses/62

This Thesis is brought to you for free and open access by the Nursing at Carroll Scholars. It has been accepted for inclusion in Nursing Undergraduate Theses by an authorized administrator of Carroll Scholars. For more information, please contact tkratz@carroll.edu.
Early Assessment and Prevention of Necrotizing Enterocolitis in Premature Infants

Kathryn E. Weber

Carroll College
This thesis for honors recognition has been approved for the Department of Nursing.

Director
April 10, 2008

Reader
April 10, 2008

Reader
April 10, 2008
Table of Contents

ABSTRACT ........................................................................................................................................ 5
ACKNOWLEDGMENTS .................................................................................................................... 6
DEDICATION ................................................................................................................................... 7

CHAPTER I ....................................................................................................................................... 8

OVERVIEW OF DISORDER .............................................................................................................. 8
Risk Factors ....................................................................................................................................... 9
Maternal risks ................................................................................................................................. 9
Drugs and alcohol ......................................................................................................................... 9
Gender and culture ...................................................................................................................... 9
Age and prematurity .................................................................................................................. 10
Impact of the Disease ................................................................................................................ 10
Cost ................................................................................................................................................ 10
Psychosocial impact .................................................................................................................. 10
Treatment ....................................................................................................................................... 11
Conventional treatment ............................................................................................................. 11
Alternative treatment ................................................................................................................ 12

CHAPTER II ...................................................................................................................................... 13

REVIEW OF LITERATURE ................................................................................................................ 13
Oral Probiotics ............................................................................................................................... 13
Enteral Feeding Protocols ............................................................................................................ 14
Mother-Premature Infant Dyadic Interaction .............................................................................. 15
Interaction in the Postnatal Period ............................................................................................. 17
Skin-to-Skin Contact ................................................................................................................... 19
Perspectives on Feeding .............................................................................................................. 20
H2 Blocker Therapy ..................................................................................................................... 22
Recombinant Human Erythropoietin ........................................................................................... 23
Congenital Heart Disease ............................................................................................................ 24
Massage Therapy .......................................................................................................................... 24
History ........................................................................................................................................... 25
Healing nature ............................................................................................................................. 26
Delivery .......................................................................................................................................... 27
Benefits and risks ........................................................................................................................ 27
Nursing responsibility ................................................................................................................ 28
Client teaching ............................................................................................................................. 29
Summary ......................................................................................................................................... 29
Traditional Treatment ................................................................................................................ 30
Surgery .......................................................................................................................................... 30
Human milk feeding ................................................................................................................... 30
Antibiotic administration ........................................................................................................... 30

AVAILABLE TEACHING MATERIALS .......................................................................................... 31
Websites .......................................................................................................................................... 31
Kidshealth.org ............................................................................................................................... 31
emedicine.com .............................................................................................................................. 32
Other Resources .......................................................................................................................... 32

MEDICATIONS .................................................................................................................................. 32
Clindamycin ................................................................................................................................... 33
Metronidazole ............................................................................................................................... 33
Ampicillin ....................................................................................................................................... 34
Gentamicin ...................................................................................................................................... 34
Cefazolin Sodium .......................................................................................................................... 34

TREATMENT .................................................................................................................................... 35
DIAGNOSTICS ................................................................................................................................. 35
DIET, ACTIVITY, RESTRICTIONS AND ENVIRONMENT .............................................................. 35
Abstract

Premature infants who are very low birth weight have a high mortality rate; one of the primary causes of death in infants transpires from a gastrointestinal complication, necrotizing enterocolitis (NEC). Currently there are no specialized assessment tools to determine the risk of development of NEC in neonates. The purpose of this thesis is to identify assessment protocol and prevention methods needed to increase the survival rate of babies less than 1500 grams (g). A small sample of surveys was completed by NICU nurses. The surveys were analyzed and current literature was reviewed to develop a tool by identifying risk factors strongly associated with the development of NEC. This tool needs further research, such as a pilot study and assessment of data regarding a case of NEC which could be gathered prospectively or retrospectively to determine this tool’s effectiveness.
Acknowledgments
I would like to thank Joni Walton for assisting me in writing this thesis and helping me with the idea for this topic. I would also like to thank the NICU nurses of Benefis in Great Falls for taking the time to distribute the surveys and answer all my questions about NEC. Many thanks to my readers Elizabeth Chute, Kari Cunningham, and Joan Stottlemyer.
Dedication

"'Cause there's no comfort in the waiting room, just nervous pacers waiting for bad news."

- Benjamin Gibbard

To the parents who stay up countless hours with their little ones and endure sleepless nights on a waiting room couch.
Chapter I

Overview of disorder

Necrotizing Enterocolitis (NEC) is a disorder affecting primarily premature infants weighing less than 1500 grams. Coit stated the need for the prevention of this disorder is great because it is the “most serious and frequent gastrointestinal disorder of the low-birthweight infant” (1999, p. 53). One in four infants that develop this disorder dies from it or from its complications (“Mortality Statistics,” 2004). NEC occurs in about 1 in 2,000 to 4,000 births and about 10% of babies weighing less than 1,500 grams (3 lbs., 5 oz.).

This life-threatening gastrointestinal disorder is characterized by necrosis in the intestinal tract that can lead to perforation, requiring surgery. Its etiology has been difficult to determine, but it is believed the premature infants’ mucous is immature, leaving them susceptible to necrosis (Horton, 2005). It has been hypothesized ischemia in the intestine, the presence of infection in combination with hypotension, hypoxia and anoxia may contribute to the development. Enteral feeding has been found to be a major factor in premature infants with this disorder (Horton).

Risks for failure to thrive related to infant prematurity are: weight less than 1500 g, present gastrointestinal disorder with risk for perforation, and infection. In 2004, the occurrence of NEC related deaths was 2,523 worldwide, the US being in third place among other industrialized nations, with 368 deaths in a year (“Mortality Statistics,” 2004).

The focus of this thesis is; to identify a specific assessment check list to identify the signs and symptoms of this disease quickly, to explore the research on nursing


interventions that decrease the incidence of NEC, and promote decreased failure to thrive in premature infants.

_Risk Factors_

*Maternal risks.* According to Stone, infants at risk for this disorder are “small, premature infants, infants who are fed concentrated formulas, infants in a nursery where an outbreak has occurred (suggesting an infectious cause), and infants who have received blood exchange transfusions” (2003, ¶ 22); also, the more premature the infant, the greater risk for developing this disorder (Stone).

*Drugs and alcohol.* Substance abuse contributes to the prematurity of the infant. The use of drugs such as alcohol and tobacco causes intrauterine growth restriction, which contributes to hypoxia and death of the bowel (Goldenring, 2004).

*Gender and culture.* Some studies indicate a higher frequency in African American babies than in Caucasian babies; other studies show no difference based on race (Boxwell, 2000). However, most studies indicate that male and female babies are affected equally (Boxwell). Countries and races with less access to neonatal intensive care have higher mortality rates due to the infant’s lack of care needed during the acute phase of the illness. Demographics and populations with lower incomes or socioeconomic status also have a higher rate of mortality; however, it is not certain if these demographics have a higher incidence of the disorder itself since the exact cause is not known. In relationship to multiple risk factors including race, Boxwell stated, “[i]nbfants with NEC were more likely to be black, of lower birthweight, and to have been born outside the treating hospital” (p. 343).
Age and prematurity. The primary group affected by this disease is premature infants and age contributes greatly with these babies’ prognoses. Springer suggests the, “[a]verage age at onset in premature infants seems to be related to postconceptional age, with babies born earlier developing NEC at a later chronologic age” (2006, ¶ 16). Springer also stated some studies have reported the average age of onset as 20.2 days for babies born less than 30 weeks estimated gestational age (EGA), 13.8 days for babies born at 31-33 weeks EGA, and 5.4 days for babies born after 34 weeks gestation (Springer).

Impact of the Disease

Cost. These infants need to be placed in the NICU when the condition is recognized however, “[o]ne unit that allows the medical team to stabilize a baby, then monitor and protect it costs about $40,000” and “providing this kind of equipment, round-the-clock care, ongoing training from Stanford and other vital services costs the hospital more than $3,000 per patient a day” (Fridy, 2006, ¶ 19). Boxwell examined the need for expensive procedures by stating, “[d]efinitive surgery is usually necessary within five days of diagnosis, when all monitoring parameters would have improved had conservative treatment been successful, or if perforation occurs” and “these [stomas] can be closed at a later date providing there are no strictures, but a permanent proximal stoma may be the only treatment for NEC-totalis” (2000, p. 25). Not only are these treatments and medical care measures difficult for the infant, they are also difficult for the parents and may affect their attitudes about their child’s care.

Psychosocial impact. Infants and parents exhibit different levels of stress and coping while going through the long healing process from NEC. While the infant’s
primary task is to heal, the parents must sit and wait, helplessly. According to Franck, Cox and Winter, a negative correlation was found between the amount of time the mothers spent with their infants directly after birth and the level of stress; the mothers who were able to see their infants right away reported lower stress levels than the mothers who had to wait before seeing their children (2004).

*Treatment*

*Conventional treatment.* The primary treatments for all infants with gastrointestinal diseases and disorders are to; keep the infant stable, and shorten healing time. Regarding the main treatment options for NEC, Coit suggests, “[f]luid and electrolyte management should be initiated and adjusted based on the infant’s condition” and “daily replacement of the fluids removed by decompressing the stomach is essential to prevent fluid and electrolyte imbalance” (1999, p. 59). Coit also suggests another important intervention for the premature infant is that “total parenteral nutrition should be considered to provide essential nutrition” (p. 59). Among maintaining fluid and electrolyte balance, it is critical to provide the quickest surgical care possible in order to improve their prognosis. Such surgical care involves the joining of two sections of bowel after the necrotic tissue has been removed (anastomosis). Coit explains this procedure by stating, “[p]rimary anastomosis is performed if only a short portion of the bowel is necrotic. If the necrosis is widespread, additional resections and enterostomy represent the standard approach” (p. 60). Other treatments include close monitoring, medications such as antibiotics, and total parental nutrition (Boxwell, 2000, p. 361). More seriously ill infants may require platelet transfusion, supplemental oxygen, analgesia and, in severe cases, full respiratory support, inotropes, fluid resuscitation and blood
transfusion, with operative intervention as a lifesaving measure” (p. 361). While conventional methods are important in the treatment of this disease, there are several methods that are still being researched and reviewed and are considered alternative at this time.

*Alternative treatment.* The use of alternative treatments has been researched heavily in the neonatal world. Brown, in a study on recombinant human erythropoietin (EPO) identifies that, “[a]dministration of . . . r-EPO dose, five times a week, in VLBW infants resulted in a sustained increase in erythropoietic response compared with two times a week” (1999, p. 357). In another study conducted by Burke, the author identifies another method of preventive alternative medicine by stating,

Health care professionals generally agree that providing early enteral feeding important for very low birth weight (VLBW) infants. Because development of the central nervous system is rapid during the third trimester of gestation, early nutritional support for VLBW infants is vital during this vulnerable period of adjustment to extrauterine life. The incidence of necrotizing enterocolitis (NEC) decreased significantly after implementation of standardized feeding schedules, independent of the infant’s birth weight, prenatal steroid exposure, use of breast milk, day of life at first feeding, and number of days to reach full feeding. (2006, p. 248)
Chapter II

Review of Literature

The articles used for the research of necrotizing enterocolitis (NEC) will be critiqued to discern whether or not these articles have important findings pertinent to the topic of this thesis. Analysis is important in determining if these articles can be used to support the research findings from the data collection in this thesis. The type of study, design and research question as well as the main results of these studies will be summarized in the following paragraphs.

Oral Probiotics

The incidence of NEC in very low birth weight infants (VLBW) was significantly lowered by administering the feeding supplement Infloran with breast milk. The aim of the study was to prove the hypothesis that the administration of Infloran, which contained probiotics, would reduce the incidence and severity of NEC in VLBW infants (H. Lin, et al., 2005). “Three hundred sixty-seven infants were enrolled: 180 in the study group and 187 in the control group” (H. Lin, et al., p. 1). In addition to the infants in the study group, six infants in the control group had severe cases of NEC and were in Bell Stage 3 (H. Lin, et al.). The infants in the study group were fed the Infloran with either breast milk from their mothers or the breast milk bank two times a day and the amount of feeding was administered slowly and progressed in 20 ml increments (H. Lin, et al.).

The results of the study according to H. Lin, et al. were “[t]he incidence of death or NEC was significantly lower in the [p]robiotics group when compared with the control
group (9 of 180 [5%] vs 24 of 187 [12.8%], respectively; \( P = .009 \)) and “The incidence of culture-proven sepsis was significantly lower in the study group (\( P = .03 \))” (2005, p. 2).

Possible evidenced-based nursing practices would include the addition of Infloran to each hospital’s current enteral feeding protocols in order to decrease the incidence of NEC and the deaths related.

*Enteral Feeding Protocols*

By mandating a guideline for enteral feeding in high risk infants, members of the neonatal intensive care unit team who participated in this study were able to dramatically improve the outcomes for infants with NEC. The aim of the study was to establish a routine guide for evidenced based practice to improve the consistency of care as well as outcomes (Smith, 2005). A multidisciplinary team with members from different areas of the hospital was put together to develop, implement and evaluate a research-based guideline for the feeding of very low birth weight infants (Smith).

Smith stated the “[c]ommittee members agreed that timing of the first feeding and length of time to achieve full enteral feeding varied widely” (2005, p. 10). This committee discussed protocols on the type of substrate used for feedings, timing of the first feeding, and method of feeding and rate of feeding advancement. The goals for the guidelines were laid out as follows: “[t]o enable multiple health care team members to implement a useable, research-based feeding guideline in a consistent manner while still allowing individualization for infants as necessary. To advocate that all eligible infants receive human milk. To achieve full enteral feedings no later than the third week of life for all infants. To decrease the incidence of NEC” (Smith, p. 12). In this study, the
committee researched the best evidenced-based practice and implemented those guidelines.

The evidence from this evaluation shows that greater than 50% of the infants needing enteral feedings received feedings within the newly developed guidelines (Smith, 2005). The evidence for the incidence of necrotizing enterocolitis is as follows: "[a]fter implementation of the feeding guideline in 2000, the incidence of NEC acquired by infants in the unit decreased to <0.6 percent in 2000, 2001, 2002, and 2003" (Smith, p. 15).

The evidenced-based implications from this study are an entirely new protocol for the hospital regarding the enteral feedings in VLBW infants as well evidence for other hospitals and health care facilities to adopt new protocols.

*Mother-Premature Infant Dyadic Interaction*

Through the use of kangaroo care, the stress levels of both mother and infant decrease significantly, while increasing the infant’s positive associations with its mother. The aim of the study was to look at the impact of kangaroo mother care (KMC) on the mother-infant bond developed in the first few weeks of life. The sample consisted of 40 premature infants weighing less than 1800 g and their mothers, in Italy (Tallandini & Scalembra, 2006). The study was not randomized, it was a pilot trial where mothers were asked to volunteer themselves and their and perform kangaroo care. Another group involved for control were not offered the opportunity to do kangaroo care and received traditional care. The difference between the mothers who had access and mothers who did not have access to kangaroo care was 19:21 respectively (Tallandini & Scalembra). Each mother was asked to visit her infant and hold the child unclothed on her bare chest.
for at least one hour a day, and many spent several hours giving kangaroo care (Tallandini & Scalembra). The research concepts explored in this study consisted of whether or not the procedure of kangaroo care reduced mother-infant stress and mother-infant response to feedings.

The measures used were the Parent Stress Index-Short Form (PSI-SF) and the Nursing Child Assessment Feeding Scale (NCAFS). The PSI-SF consisted of “36 items subdivided into three subscales, each of which comprises 12 items. Evaluation is made on a 5-point Likert scale” (Tallandini & Scalembra, 2006, p. 258). In order for the measure to be considered reliable Tallandini and Scalembra needed to determine the results’ validity. Tallandini & Scalembra examined the validity by saying “[t]he reliability of the three Parent Stress Index-Short Form subscales was evaluated with 800 participants over a 6-month interval with resulting values of α=.87 for Parental Distress, α=.80 for Parent Child Interaction, and α=.85 for Difficult Child” (p. 258). To further determine the validity of the measures, the Kaiser Measure of Sampling Adequacy was used and determined that it was 0.80 (Tallandini & Scalembra). Because of these scores, the authors were able to consider the results from the questionnaire reliable to the study. The other scale used was the NCAFS. This consisted of several items which were broken down into six subscales much like the previous questionnaire. Tallandini and Scalembra used the same internal consistency variables for this scale and determined that the results were,

0.60 for the Sensitivity to Cues subscale, 0.69 for the Response to Distress subscale, 0.63 for the subscale assessing Social-Emotional Growth Fostering, and 0.69 for the subscale assessing Cognitive Growth Fostering . . . 0.56 for Clarity
of Cues and 0.58 for Responsivness to Parents. The $\alpha$ value for the total score assessing infant characteristics is 0.73. (p. 258)

Through these values, the authors also considered this scale to have good concurrent validity.

The authors found that their findings supported their previous research question in that the kangaroo care had a positive influence on the mothers and infants (Tallandini & Scalembra, 2006). The authors stated:

Both mother groups presented the same level of distress at Time 1 (delivery time), but had dramatically different global and subscale scores at the second data collection (discharge time). At time 2, the target group (KMC) scored statistically significant less on general distress (total score) than did the control group (TC) and had better results on each of the three subscales. (p. 266)

Since this study determined KMC to be beneficial in the care of premature infants and their parents, evidenced-based nursing implications would be to provide the opportunity for mothers to participate in KMC in all NICUs throughout the country. Addition to current protocol should be made to ensure that the NICU nurses are encouraging mothers to participate in this type of care.

*Interaction in the Postnatal Period*

During the postnatal assessment it is imperative the mother’s self concept as well as her relationship with her mother and her partner are assessed. By doing this, assessing the interactions she will have with her child in the postnatal period will be made easier and more efficient. According to the authors, the aim of the recent study was to “explore, within a group of high-risk mothers, the association of pre/postnatal representational
change with postnatal depression and maternal interactive behavior” (Helenius, Pajulo, Piha, Savonlahti & Sourander, 2004, p. 91). The sample consisted of twelve mother-baby pairs who were asked to volunteer themselves in the study and were given questionnaires about their lifestyle background (Helenius, et al.).

The methods of measurement for the postnatal period consisted of the Parent-Child Early Ralational Assessment (P-C ERA), and the Edinburgh Postnatal Depression scale (EPDS) as well as a perceptual descriptive task in which they described the people involved in their lives relating to the birth of their infant (Helenius, et al., 2004). The P-C ERA measurement was used by videotaping the mothers with their infants and then evaluated using the six subscales of “tone of voice, parental affect, parent’s characteristic mood, parent’s expressed attitude towards the child, parental affective and behavioural involvement and parental style” (Helenius, et al., p. 93). When the researchers used the EPDS, the self-report scale showed a range of 0-15 with the ideal being 30 and 0-2 being a cause for concern (Helenius, et al.). Through the statistical analysis of using p and r values, the researchers came up with these findings:

change towards a more negative view of the child’s father in ‘personal functioning’ was associated with more problem areas in maternal interactive behavior, change towards a more negative view of their own mother in ‘sensitivity and maternal interaction’ and of the child in ‘personal functioning’ was associated with more problem areas in maternal interactive behaviour in the child, and change towards a more negative view of self-as-mother in ‘maternal role’ was associated with reporting more depressive symptom on the EPDS, as
did the change towards more negative view of the child in ‘personal functioning’ and in ‘interpersonal style’. (p. 94)

The researchers stated, “dysfunctional parenting impairs the infant’s ability to recover from the biological vulnerability of being substance-exposed” (Helenius, et al., p. 95). When the mothers did not have good interactions with their infants due to impaired interactions and beliefs of their family members and partners, they experienced difficulties bonding with their infants (Helenius, et al., p. 95). Some evidenced-based nursing implications is the assessment of the mother’s addiction, her feelings and associations of the birth of her infant, her relationships with her mother, partner, and her view of herself as a mother.

Skin-to-Skin Contact

This article demonstrated simply speaking to nurse midwives about the importance of skin-to-skin contact between mother and infant in the first few hours of life, statistically, caused the number of mothers who used skin-to-skin contact to drastically improve. According to Johnson and Price, the aim of the study was to “improve awareness of breastfeeding and the importance of skin-to-skin contact between mother and baby at birth by increasing midwives’ knowledge, improving women’s choices and facilitating the implementation of best practice” (2005, p. 154). The sample used was a purposive group of eight midwives that were interviewed, and the data collection was collected from notes of the interviews and informal discussions with the midwives (Johnson & Price). The study was done for twelve months, and each month had a different discussion topic about ways to increase the skin-to-skin contact between new babies and their mothers (Johnson & Price).
The study’s conclusions were as follows: “[e]arly figures for skin-to-skin contact showed a rise from almost nil in the first month of the project, to 36% in month ten and 52% in month eleven. Six months later, the figures rose to over 80%” (Johnson & Price, 2005, p. 158). Midwives found several methods that proving to be useful in encouraging mothers to start skin-to-skin contact right away. Interventions included a newsletter with the content discussed in the focus groups which circulated to other midwives, and a protocol was established in the hospital for patient teaching on skin-to-skin contact (Johnson & Price).

This study has the potential for evidenced based practice protocols. On Table 1 it identifies a sequence of events for newborn infants:

- Baby is quickly and gently dried, placed in skin-to-skin contact, covered with a warm blanket, comforting for baby, soothes if crying, helps mother-infant relationship, baby keeps warmer, heartbeat and breathing settles, baby looks more content and pink, protection against infections, fewer problems with breastfeeding later on and if breastfeeding, minimizes bleeding after birth. (Johnson & Price, 2005, p. 158)

The study also provided information for the implementation of posters in labor rooms providing the progress of an infant through skin-to-skin contact, as an alternate method of teaching (Johnson & Price).

Perspectives on Feeding

It was found parents with children receiving medical feedings had several fears regarding their child’s wellness and required the support of the entire healthcare team. This article examines through qualitative research incorporating phenomenology further
investigation of the experiences of parents with children that have had chronic feeding problems.

The author determined the study to be helpful in three ways:

- to clarify the nature and extent of psychosocial factors experienced by parents within the context of their family life
- to document parents' perceptions of how they coped, particularly with the protracted nature of their child's feeding difficulties
- to identify the extent that parents' perceived support networks and professional services. (Franklin & Rodger, 2003, p. 139)

The study was conducted by an occupational therapist with a strong relationship with the family. A sampling strategy was used to obtain the families involved in the study and these families had therapy involving feedings for anywhere from one to six years, lived in England, and consisted of two parent households (Franklin & Rodger). According to Franklin and Rodger, only five out of the eight families selected agreed to participate in the study and the fathers were not interviewed because of scheduling conflicts (Franklin & Rodger). Data analysis consisted of transcribing the audiotapes from the interviews and discussing the themes that were present to the parents involved in the study. Each author took notes on the interviews and then collaborated with their research partner to identify consistent themes relating to the study.

The results of this study found that there were four main themes consistent with the families involved and these included:

- fear for their child's physical survival
- the impact of stress on the parent-child relationship
- stress associated with the increased demands of parenting a child
with a complex feeding disorder and medical condition . . . factors leading to coping and adjustment. (Franklin & Rodger, 2003, p. 141)

Franklin and Rodger found that four of the five families interviewed had high levels of stress related to professionals involved in their child’s care and their failure to validate the parents’ distress about their child’s symptoms and difficulties (Franklin & Rodger). They found that “parent[s] coped better when their child was gaining weight, and they were confident that medical treatments and nutrition were being managed” (Franklin & Rodger, p. 141). Many of the mothers expressed feelings of difficulties bonding with their infant and feelings of rejection and anger when they could not manage their child’s behavior while administering feedings (Franklin & Rodger). The families described efforts that helped them cope with the daily stress of the feedings; they included “coming to terms with fears about their child’s survival and managing the additional parenting responsibilities” and “support from their partners . . . the importance of maintaining good communication, acknowledging each other’s stress and sharing parenting responsibilities” (Franklin & Rodger, p. 145). The authors identified interventions needing discussion with the families. Such interventions would be to promote positive associations between child and parent in conjunction with feedings and the access to information and resources from professionals (Franklin & Rodger).

*H₂ Blocker Therapy*

This therapy was found to be detrimental to very low birth weight (VLBW) infants, resulting in increased likelihood of developing NEC. According to studies involving VLBW infants with NEC, H-2 blocker therapy can contribute to the development of the disease (Burke, 2006). The study used case-control methodology to
determine the relationship between the therapy and the incidence of NEC and used three controls: birthweight, race and the medical center involved (Burke). Burke stated the study also found, “infants with NEC were more likely to be black, of lower birthweight, and to have been born outside the treating hospital (p. 132).

Recombinant Human Erythropoietin

According to Brown and Keith, erythropoietin therapy was found to increase VLBW infants’ hematocrit, increase red blood cell production, and decrease the development of anemia (1999). The study’s objective was to understand the response of VLBW infants to erythropoietin therapy for anemia. Eighty infants were used and selected into two age groups and were given the medication either two or five times a week for four weeks (Brown & Keith). The authors organized this trial used in infants who were “≤ 30 weeks gestation by dates or early ultrasound and confirmed by examination, ≤ 7 days of age, absence of life-threatening major congenital abnormalities, absence of significant hemolytic disease, platelet count > 75,000 and absence of significant coagulopathy, and anticipated hospital stay ≥ 4 weeks” (p. 211). The results of the study were that, the infants who received r-EPO (erythropoietin) five times a week had a higher hematocrit than the infants who received r-EPO only two times a week (Brown & Keith). Nursing implications for this therapy would be to closely monitor the infant’s hematocrit and assess the infant for anemia daily to ensure that if the infant is a candidate for the therapy, they are able to get it quickly, in order to prevent further complications.
**Congenital Heart Disease**

The risks associated for infants with NEC and congenital heart disease are substantial. This study used 21 infants with heart disease who developed NEC and 70 infants without heart disease were used as a control (McElhinney, et al., 2000). The results of the study were that infants with congenital heart disease had an increased risk for developing NEC and the other factors associated were, as McElhinney et al. described, “early gestational age and episodes of lower cardiac output . . . hypoplastic left heart syndrome, truncus arteriosis, and episodes of poor systemic perfusion or shock” (p. 1080).

**Massage Therapy**

Infant massage therapy practiced on orphans in Ecuador proved to lessen diarrheal episodes from unknown illnesses that contribute to the second leading cause of infant death in Ecuador. Infants were massaged daily, sometimes twice a day for an average of 53 days and their symptoms were recorded by the staff at the orphanage (Jump, Fargo & Ackers, 2006). The results of the study were as follows: the control group infants (those individuals that were not massaged) were 50% more likely to have diarrhea and 11% more likely to experience any other type of illness (Jump, Fargo & Ackers). This study was very detailed and gave specific evidence on how the infants were massaged, noting that each caregiver had been certified by an infant massage trainer to ensure the best quality of care.

Massage therapy, the art of touch, has been used for centuries. By using this therapy, individuals experience lower blood pressure, pain relief, and many other effects. The purpose of this section is to explain the history and technique of massage while
focusing on the aspects of massaging an infant with health conditions such as necrotizing enterocolitis. Massage therapy and its outcomes will be evaluated on whether or not it is an alternative therapy that is an appropriate evidence-based nursing intervention.

History. Scholars are not sure of the exact date the first massage took place, but they do know that it has been around since about 400 BCE, in the time of Hippocrates ("Massage Therapy," 2006). Massage was part of the Greeks’ medical practices and the word comes from the Greek root meaning “to work with the hands, as in kneading dough” ("Massage Therapy," ¶ 4). The modern massage technique grew in popularity in New York when two physicians used the techniques that Per Henrik Ling, a Swedish man, had developed ("Massage Therapy"). Massage has changed dramatically in the last century from being a popular, new treatment, to being discredited and thought to be strange and back to being a popular treatment used by Hollywood elite. Infant massage has been growing in popularity since the 1970s and has proven to be beneficial for not only baby but for the mother as well. In many countries around the world, infant massage is a regular occurrence and is believed to contribute to motor development (in India) as well as stimulate respiration, circulation, digestion, elimination, keep the infant more relaxed, relieve gas and colic, and help heal the infant during illness by easing congestion and pain (Shears, 2005). In 1973 after working in an orphanage in India and witnessing the benefits of infant massage first hand, Vimala McClure founded the International Association of Infant Massage (IAIM) in the United Kingdom (McClure, 2006). The mission of IAIM is as follows:

by fostering and encouraging Infant Massage and other cultural traditions which enhance the parent-baby bond, and by helping create more family-centered values
in our culture, we will begin to see whole generations expressing more compassion toward and responsibility for their fellow human beings. We believe in supporting parents in their love for their infants. We believe that babies are aware human beings who deserve respect, tenderness, and warmth, and above all, a listening heart. When we listen to our infants with our hearts, we discover whatever it is that we want to know. (McClure, ¶ 1)

The United States IAIM was founded in 1980 and its mission is similar to that of IAIM, UK in that the purpose of the association was “to recruit and train instructors for the public benefit of teaching parents and caregivers the theory, skills and techniques of parent-infant bonding through Infant Massage” (McClure, ¶ 2).

*Healing nature.* Massage is thought to relieve stress and reduce muscle tension. With infant massage it has been used as a treatment for colic and has been thought that by massaging the infant’s abdomen, gas is able to be moved lower in the intestine, allowing the infant to pass flatus and relieve discomfort (Lorenz, Moyse & Surguy, 2005). By rubbing into the deep tissues, massage is also thought to release endorphins, the body’s natural analgesics, thereby offering relief of any discomforts. In a study done with infants in Ecuador suffering from diarrhea, the infants that were massaged daily for 15 minutes had a reduced rate of diarrhea in comparison to the control group that did not receive massage (Lorenz, Moyse & Surguy). Jump, Fargo and Ackers concluded the results of the decreased diarrhea rate were attributed to the idea that “massage improves immune functioning, and there may have been increased immunity in the infants in the experimental group in this project. Another possibility is that massage improved infants' gastrointestinal functioning through stimulation of the vagus nerve” (2006, p. 317).
Delivery. There are more than 80 different systems of massage including Swedish and deep-tissue. Within these systems of massage, four types of motion are used: effleurage, petrissage, tapotement and friction.

Effleurage uses light and hard stroking, resulting in improved circulation to the heart and blood vessels. Petrissage includes compression of specific body parts with kneading, rubbing, and squeezing motions. Tapotement strikes a part of the body with the sides of the hands rapidly, while friction uses firm, circular movements that penetrate deep into the skin with more force. (L. Porter & O. Porter, 2004, p. 364)

In the case of infant massage, there is no definite protocol for performing massage on infants however parents are encouraged to use the four types of motion, focusing on soft touch while looking into their baby’s eyes. Parents are also encouraged to “explore” their infant using touch and speaking softly in order to promote bonding.

Benefits and risks. The primary benefit most individuals are aware of is the reduction of stress and muscle soreness resulting from any type of massage. In infants, it has been found that infants who are massaged fall asleep more quickly and are able to sleep more soundly (Lorenz, Moyse & Surguy, 2005). Dramatic weight gain and the treatment of infant colic has also been proven to be a result of infant massage (Lorenz, Moyse & Surguy). Psychologically, babies communicate through touch, so infant massage is not only a way to improve mother-infant bonding but also a way to communicate and it is thought to be helpful in cognitive preparation of the infant’s learning skills (Lorenz, Moyse & Surguy). Mothers and fathers benefit psychologically from infant massage through the ability to take more pleasure in playing with their infants.
while massaging them. It is also thought to help with post-partum depression:
“[d]epressed mothers touching their babies through massage improved their babies’
reactions towards them” (Lorenz, Moyse & Surguy). Massage between father and infant
has been shown to strengthen the bond where in many cases father-infant bonds are
lacking (Lorenz, Moyse & Surguy).

The risks associated with infant massage are few, but are something nurses and
parents they interact need to know. The use of alternative therapy in children has been a
source for debate because of the distraction it can cause upon the parents of the child,
reducing the probability that the child will receive the medical care it needs (L. Porter &
O. Porter, 2004). Educating parents on the techniques of infant massage is important in
preventing injury of the infant. Parents must be aware of how fragile the child can be and
that only light pressure and touch should be used when massaging their infant.

*Nursing responsibility.* While caring for infants with life-threatening disease
processes, the nurse must be aware of the amount of stress the infant can withstand. The
nursing staff should not perform infant massage if the infant becomes unstable when
moved. If the infant is stable, massage can be used to calm and promote weight gain in
low birth weight infants. A more important nursing role is to provide the evidence to
promote the use of this therapy in the hospital setting. This consists of gathering evidence
and demonstrating the benefits of this therapy to the unit manager in order to create a
policy regarding infant massage in the unit. In a study analyzing the effects on substance
abuse mothers (SAMs) who were trained to use the infant massage parenting
enhancement program (IMPEP), the use of infant massage for the recovery of the mother
and the infant, the author stated:
The IMPEP has the potential for raising the awareness of advanced practice nurses regarding the importance of implementing innovative interventions for SAMs that build upon natural motivating factors, such as the maternal instinct. Above all, the IMPEP promotes collaborative partnerships with the clientele and the health care system, working toward the ultimate goal of achieving healthy mothers, healthy babies, healthy families, and healthy communities. (L. Porter & O. Porter, 2004, p. 365)

It is important for nurses to be aware of new alternative therapies that may be beneficial in the treatment of their patients.

*Client teaching.* The education of parents as well as the nurses performing infant massage is crucial in preventing future problems for the infant and providing the best care possible. Parents need to be educated on the signs of rough massage such as reddened areas of the skin as well as crying while performing the therapy. The infants should coo and demonstrate that they enjoy the touch, and parents should be warned that if the infant squirms and cries during treatment, they should change the way they are massaging or seek further education.

*Summary.* Infant massage provides a multitude of benefits for both infant and parent ranging from the psychological to the physical. This alternative medicine is recent and is gaining popularity quickly with the introduction of classes specializing in infant massage as well as mother-baby yoga, and swimming, all of which promote the wellness of both parent and infant. It is important in the health care field to be up-to-date on new treatments and therapies, especially in the fields of specialization such as labor and
delivery or mother-baby care. Fathers however need not be left out as it is important to include them in the introduction of infant massage to maintain father-baby interaction.

*Traditional Treatment*

*Surgery.* Infants with severe Bell’s Stage 3 NEC are in need of surgery as soon as possible to prevent further damage to the infant’s intestine. In stage 3 NEC, surgery is needed because of the high risk of a perforation. In stage 2 NEC, surgery is usually needed within five days. Ideally, a laprotomy is performed, and the surgeons attempt to minimize the amount of intestine removed, taking only the septic areas (Allan et al., 2000). If the team cannot anastomize the intestine, a temporary or perhaps permanent stoma will be placed for elimination of wastes (Allan et al.).

*Human milk feeding.* Human milk either from the mother or from a milk bank has been found to be the best tolerated substrate for premature infants (Smith, 2005). Most hospital protocols state that if it is possible for the mother to pump her breast milk and store it for the enteral feeding of the infant that this should be done. Human milk contains many antibodies and is a source of concentrated nutrients that improve the infant’s immune system and therefore help to decrease the severity of the disease.

*Antibiotic administration.* Infants are given broad spectrum antibiotics either orally or intravenously to decrease the extent of the necrosis on the bowel. According to a study conducted with oral probiotics, the incidence of deaths from NEC in the group that was given these probiotics was significantly lower, 9 out of 180, compared to 24 out of 187, the control group being infants that were fed only breast milk (H. Lin, et al., 2005).

*Enteral feeding.* Enteral feeding in infants that are premature and have a high risk for NEC or that have developed NEC is essential to their survival. Enteral feeding
involves using either formula or human milk that is delivered directly to the stomach by way of feeding tube. By feeding these infants enterally, there is less stress on their gastrointestinal tract and can lead to promotion of healing of the intestine after part of it has necrotized (Smith, 2005). In a study done involving early enteral feedings in infants at risk for NEC, Smith found that the incidence of NEC decreased from 1.5 percent of infants developing NEC in the NICU to less than 0.6 percent in a four year period (Smith).

Available Teaching Materials

The purpose of this section is to identify and evaluate the content and quality of materials that are available to the public on the disorder necrotizing enterocolitis (NEC) and its major complications such as infection, prolonged hospital stays and surgery. Places for informational resources, magazines, support groups, and internet education will be evaluated for the accuracy and availability of information.

Websites

There are no websites specifically created for the transfer of information on NEC, however there are many different parenting and medical websites that offer much needed information about the disease in layperson’s terms that are easy for concerned parents to understand.

Kidshealth.org. This site was created by Nemours Foundation's Center for Children's Health Media and provides three separate website sections that offer health information for parents, kids, and teens. Each article on the site is reviewed by physicians and other health care professionals in order to ensure accuracy, and the website is updated often to ensure the public has access to the most recent information. The website
offers articles on a variety of topics such as: general health, infections, emotions and behavior, growth and development, nutrition and fitness, recipes, pregnancy and newborns, medical problems, question and answer, positive parenting, doctors & hospital search, recent news articles, and first aid and safety. In addition, the website provides all of this information translated into Spanish. Upon searching the website for information on NEC, the information was accurate and simplified; however it would be more helpful for parents if there were pictures and other multimedia forms for explanation of the pathophysiology of the disorder in order to allow the layperson the ability to more easily grasp the information.

emedicine.com. This website offers more information through published articles and may be daunting for many parents; however the articles on NEC offer concise but accurate information. It is easy to browse for different articles, and it is easy to browse by adult or pediatric medicine as well as adult or pediatric surgery. This site also offers information on recent medical news. Overall, the website is not as easy to navigate as others but provides much needed information for parents.

Other Resources

Parents of infants with NEC are encouraged to speak with the NICU unit coordinator, or a unit nurse to find support groups within their community. Many hospitals offer a variety of groups where people with similar conditions or people who have children with similar conditions can gather and express their feelings.

Medications

In severe cases of NEC, infants are in need of surgery for the repair of a perforated bowel. Antibiotics are an important piece of these infants’ treatment because
they not only treat the sepsis related to the bowel perforation but they are also used prophylactically to prevent other complications of this disease, and postoperative infection.

**Clindamycin**

This is a broad spectrum antibiotic in the antibacterial drug class. This medication is active against most aerobic gram-positive bacteria as well as some protazoa. Clindamycin inhibits bacterial protein synthesis by attaching to the 50S subunit of the bacterial ribosome. For neonates with abdominal infections, the dosing during week one is 5 milligrams/kilograms every 12 hours; during week 2 to 4 the dose is 5 milligrams/kilogram every 8 hours. It can be administered orally, intramuscularly, or intravenously. Possible side effects include the following: itching or hives, swelling in the face or hands, swelling or tingling in the mouth or throat, chest tightness, trouble breathing. Additional side effects are blistering, peeling, red skin rash, change in frequency of urination, dark-colored urine or pale stools, fever and sore throat, severe or bloody diarrhea, severe stomach pain, unusual bleeding or bruising or yellow skin or eyes (Micromedex, 2007).

**Metronidazole**

This is a nitroimidazole antibiotic, and it has a limited spectrum of activity that includes various protozoans and most gram-negative and gram-positive anaerobic bacteria. The neonatal loading dose is 15mg /kg and daily dose is 7.5mg/kg a day. Possible side effects include the following: Skin rash or hives, unexplained sore throat or fever, joint pain, tingling, pain, or weakness in hands or feet, mild diarrhea, nausea, vomiting, stomach pain, dizziness or lightheadedness, dry mouth, metallic taste, or when
going to the bathroom (urinating), vaginal swelling, itching, or discharge or loss of appetite (Micromedex, 2007).

*Ampicillin*

This is an antibiotic and in the penicillin drug classification. It is synthetic penicillin and acts to interrupt the offending cells in the stage of wall synthesis. Dosing via intravenous route is 50 milligrams/kilogram per day divided every 6 hours for 48 to 72 hours after the patient becomes asymptomatic or evidence of bacterial eradication is obtained. Possible side effects include the following: Rash, hives, or blistering or peeling skin, swelling of the face, throat, or lips, wheezing or trouble, breathing, severe diarrhea (watery, possibly with blood), mild diarrhea, nausea, sore mouth or tongue, vaginal itching or discharge (Micromedex, 2007).

*Gentamicin*

This drug is under the drug classification of antibacterial and aminoglycoside antibiotic. It is a bactericidal which acts by inhibiting bacterial protein synthesis through binding with the 30S ribosomal subunit. The normal dosing for neonates less than 30 weeks gestation have a loading dose of 5mg/kg and a maintenance dose of 3.5 mg/kg every 24 to 36 hours. Possible side effects are the same as Clindamycin (Micromedex, 2007).

*Cefazolin Sodium*

This medication is a 1st generation cephalosporin and in the antibiotic drug classification. Cefazolin sodium is a semi-synthetic cephalosporin that specifically targets bacterial cell wall synthesis and demonstrates bactericidal activity. Possible side effects include the following: diarrhea, nausea, vomiting, Stevens-Johnson syndrome,
pseudomembranous enterocolitis, leucopenia, thrombocytopenia, and hepatotoxicity (Micromedex, 2007).

Treatment

Infants with necrotizing enterocolitis, depending on the severity of the necrosis, are subjected to many treatments including antibiotic regimens, enteral feedings, and surgery. All of these treatments can be found under the section “Treatment” in Chapter I of this thesis.

Diagnostics

NEC is a difficult disorder to diagnosis and requires the vigilance of the entire medical team. All of the diagnostic tests and procedures associated with this disease can be found under the “Pathophysiology” portion of this thesis under “Radiology” and “Laboratory.”

Diet, Activity, Restrictions and Environment

Diet

Infants with NEC are placed on enteral feeding regimens in order to lessen the stress on the bowel and prevent further necrosis. Feeding protocols can be found in the main body of this paper under “Treatment.”

Activity and Restrictions

It is imperative for the NICU to allow the maximum amount of rest for the infants with NEC. This facilitates healing prevents further bowel necrosis. The infant is to be bothered minimally when necessary, with exception during times of alternative therapy such as kangaroo care and breast feeding if indicated.
Environment

The infant is to be kept under a radiant warmer to maintain a constant body temperature and if needed, under an oxygen hood if there are respiratory issues present. The noise level in the intensive care unit is to have a significant reduction of noise in order to facilitate adequate rest for both infant and parent.

Nursing Theory

Imogene King developed a nursing theory model using a conceptual framework to organize ideas that were needed in the field at that time. An author stated “[a]ccording to King (1992), the conceptual system served to identify essential concepts for nursing as a discipline and provided the structure to: derive and test middle-range theories, develop nursing curriculum, and implement theory-based practice” (Frey, Sieloff & Norris, 2002, p. 108). This framework consists of personal, impersonal and social systems (Frey, Sieloff & Norris).

Throughout the years King revised this framework and added new concepts. New concepts related to the personal system were perception, self, growth and development, body image, learning, time, personal space, and coping. Concepts related to interpersonal systems were interaction, communication, role, stress/stressors, and transactions. Concepts related to social systems were organization, authority, power, status, and decision making. (Frey, Sieloff & Norris, p. 108)

King also developed a methodology of goal attainment which dealt with the concepts of “perception, communication, interaction, transaction, self, role, growth and development, stressors/stress, time, and space” (Frey, Sieloff & Norris, p. 108).
This theory addresses many coping skills which are very important parts of the nursing assessment of the premature infant and parent. If a patient’s family does not have the proper coping skills, the recovery and management of the illness will be more difficult. King mentions the idea of transactions between the health care team and the patient and the patient’s family, which is an important area that may be overlooked (2002). It is important to have communication with the patient in order to help him/her maintain healthy coping skills. Several portions of King’s theory focus on the assessment of the client and the client’s interacting systems, one of the most important, being the social system. As cited by Williams, King stated,

nurse and client interactions are characterized by verbal and nonverbal communication, in which information is exchanged and interpreted; by transactions, in which values, needs, and wants of each member of the dyad are shared; by perceptions of nurse and client and the situation; by self in role of client and self in role of nurse; and by stressors influencing each person and the situation in time and space. (2001, ¶ 8)

This theory can be extended to the care of a patient with necrotizing enterocolitis by including the mothers and fathers of infants with this disorder. It can be used to determine the parents’ idea of their infant’s disease and outcome as well as help him/her maintain healthy coping strategies during stressful times. During these high stress situations, it is important for the nurse caring for the infant to assess the parents’ reaction to treatment and their beliefs and hopes for the outcome of the treatment and care. Using King’s framework, nurses are able to assess these parents adequately and more easily
adapt their education methods to these parents, promoting a sense of calm and understanding.

*Pathology of NEC*

The pathophysiology of necrotizing enterocolitis is vaguely understood in throughout the medical community. According to Neu, some findings that are consistent with this disorder are the involvement of the lower gastrointestinal tract, mucosal edema, hemorrhage of the bowel, coagulation necrosis air in the bowel, and ulcerations of the mucosa (Neu, 2005).

*Anatomy*

The immaturity of the intestine is said to be a major contributing factor to the development of NEC. Neu suggested, because of “immature physiochemical luminal environment, poor motility, aberrant microbiota, immature barrier function, and an imbalance in the inflammatory response to various inciting agents” (2005, p. 102). An infant’s intestine is also highly permeable and therefore allows more organisms to pass through. According to Neu, many studies show that “infection is necessary for the development of NEC” (p. 102). Not only does motility and permeability relate to NEC, inflammation of the bowel is seen to occur there as well. There is a correlation between the prematurity of the infants and development of this disease; the more immature the infant, the less mature the intestinal tract. Goblet cells are immature in preterm infants and, as Lin & Stoll stated, “[t]hese specialized enterocytes secrete gram quantities of mucins, forming a thick protective layer over the intestinal mucosa. This mucus layer hampers direct microbial-epithelial binding, aggregates adherent bacteria, and enhances
bacterial removal” (2006, p. 1274). When these cells are immature, they cannot work properly and lead to the development of this devastating disease.

**Inflammation**

There are endogenous inflammatory agents that are involved in the development of intestinal injury. According to Neu these include “[e]ndotoxin lipopolysaccharide (LPS), platelet-activating factor (PAF), tumor necrosis factor (TNF), and other cytokines together with prostoglandins and leukotrienes and nitric oxide” (2005, p. 103). According to Neu in 2005, these agents are thought to cause necrosis of the bowel and can be either prevented or exacerbated by other enzymes in the intestinal tract.

**Feeding**

Another widely recognized factor in the development of NEC is the rate at which the infants are fed and the type of formula is used. Postnatally, the infant’s colon that was once sterile becomes colonized and receives frequent feedings chemically similar to the amniotic fluid the infant swallowed intrauterine, if using breast milk (Neu, 2005). There is an ongoing debate regarding the use of human milk versus fortified formula in the management of this disease; however, Neu stated, “[t]he use of human milk appears to be highly advantageous to that of commercial formulas, because it appears to result in a significantly lower incidence of NEC” (p. 103).

**Hypoxia**

Hypoxia-ischemia of the intestine has also been found to contribute to the onset of NEC; however, Lin & Stoll stated “studies show a stronger association with prematurity, rapid feeding, abnormal intestinal colonization, and inflammatory mediators that with
asphyxia or ischaemia. Hypoxia-ischemia may contribute to the pathogenesis of necrotizing enterocolitis, but probably has a secondary role” (2006, p. 1273).

**Staging**

In order to further classify the disorder, a staging system was developed by M. J. Bell. Neu describes the stages as such: Stage 1 may reflect that the infant has a feeding intolerance or some kind of distress related to prematurity and this stage is primarily to alert caregivers of a possible problem (2005). Stage 2 is more severe and diagnosed by x-ray which may reveal air or bowel death in the intestine, but is most likely treated with medication and alternative therapy (Neu). Stage 3 requires surgical intervention and represents the disease with manifestations such as shock and bowel perforation (Neu).

**Radiology**

The use of left lateral decubitus series films is used to determine air trapping in the bowels. While this can be indicative of NEC, air trapping or pneumatosis is also present in a number of infant gastrointestinal problems, and therefore requires further intervention and assessment (Neu, 2005).

**Signs and Symptoms**

The signs are nonspecific however include “include diffuse distention and asymmetric bowel gas pattern” while “[d]efinite signs include pneumatosis intestinalis (intramural air) and portal venous gas” (Lin & Stoll, 2006, p. 1277).

**Laboratory**

No definite lab values correlate with NEC; however there have been common trends in these infants. Lin & Stoll describe “[s]evere or persistent thrombocytopenia, neutropenia, coagulopathy or acidosis might indicate severe disease” (2006, p. 1277).
Also, a high C-reactive protein may indicate development of the disorder (Lin & Stoll) as well as increasing granulocyte counts (Neu, 2005).

The medical community is continually providing research for of this disorder and several professionals have developed countless preventative as well as treatment oriented measures for this disease. More research is necessary to completely rid this disease from our hospitals. Neu stated “[f]uture studies designed to identify at-risk individuals and to find specific prophylactic measures should offer hope for the elimination of this devastating disease” (2005, p. 105).

Summary

There are several alternative treatments and diagnostic procedures to determine the severity of the disease. Each research study examined in chapter 2 demonstrated areas of research regarding this disorder. As a NICU nurse or a nurse involved in the care of infants, it is crucial to understand not only the pathophysiology of NEC, but to be current on the new treatments and diagnostics involved to give high-risk infants the best care possible.

With every disease and condition there are a variety of treatments available. Some of these treatments include standards in western medicine, and some are non-conventional treatments involving different areas of medicine. The purpose of this section was to analyze complementary alternative therapies as well traditional interventions for the treatment and management of NEC.
Chapter III

Methodology

The purpose of this research study was to devise a standardized model of risk assessment (Appendix B) for hospitalized infants in the NICU. The review of the current literature on NEC was utilized to identify primary risk factors for the development of NEC in infants hospitalized in a NICU. The researcher also used a descriptive survey to solicit clinical information for the development of a risk assessment tool.

Sample

The sample consisted of 12 male and female nurses, of a variety of ages working in a level III neonatal intensive care unit. Nurses were asked to volunteer to complete the survey. The required characteristics were; the nurses worked in a NICU for at least one year and had experience with NEC including early assessment and prevention. Nurses without any experience in the NICU or with NEC were excluded due to their inexperience with the disease and therefore, subsequent inability to answer the survey questions.

Survey

A survey of questions (Appendix A) related to the early assessment and prevention of this disease was distributed among the NICU nurse volunteers. The surveys were used to gain information of the opinions of the nurses on their unit's protocol on the early assessment and prevention of NEC. The nurses were asked what they believe should be changed to assure a lower rate of NEC in these premature infants. Katy Weber was the main researcher collecting the data for this study and all its components was reviewed and approved by the International Review Board of Carroll College.
Confidentiality

Confidentiality was provided and the volunteers were asked to not provide their names or any other identifiable information. The opinions gained were used strictly for this thesis and were not released to any other institutions.

Analysis

Surveys were analyzed using descriptive statistic methodology. Literature was analyzed to identify primary risk factors associated with NEC in order to develop a risk assessment tool.

Limitations

Limitations of the study consisted of a limited number of volunteers (12) who completed the survey. The survey was only distributed to one NICU in one hospital.

Another limitation was the lack of description and information provided on the survey. The questions involving assessment of the protocol for NEC were intended for the participant to write his/her opinions, therefore, lack of explanations made the survey difficult to analyze.
Chapter IV  
*Results and Discussion*

The purpose of this study was to develop a screening tool for early assessment and prevention of NEC as well as identify possible risk factors that could contribute to the development of NEC. A risk assessment tool was developed for use with the initial assessment of an infant upon admit to the NICU (see Appendix B).

Through the use of the research databases “CINAHL” and “Pub Med,” key words such as “necrotizing enterocolitis,” “premature infants,” and “pathophysiology,” were used to search for articles pertaining to evidence-based practice on the pathophysiology of the disorder. The risk assessment tool was developed through the analysis of articles found pertaining to the risk factors associated with NEC, detailing the mechanisms of NEC and the risk factors associated with the disease.

*Prematurity and Low Birth Weight*

Prematurity and low birth weight are congruent in the development of this disorder. The evaluation of research for the suspected causes for NEC showed that those factors were the main risk associations. As Neu (2005) stated in the evaluation of the possible etiology of the disorder, “[t]he exact pathophysiology of NEC remains enigmatic . . . NEC is classically described as a disorder affecting primarily premature infants” (p. 101). Also, Lin and Stoll (2006) stated, “risk is inversely related to birthweight and gestational age,” and these factors were given the highest point value on the risk assessment tool (Appendix B) (p. 1271).
Infection

Bacterial growth in the bowel remains one of the main factors in the contribution to bowel ischemia and subsequent development of NEC (Askin, Fraser & Wilson, 2005). The development of NEC and the assumption of infection as a risk factor is achieved by examining the possible causes and variables of the disease. Lin and Stoll reported, “[p]remature infants are especially susceptible to intestinal colonization by pathological bacteria because of their daily exposure to nosocomial flora and the likelihood of exposure to antibiotics on admission to NICUs” (2006, p. 1275). The bacterial colonization in neonates is likely to cause excessive inflammation, causing a disruption in homeostasis and likely bowel ischemia; and ischemia has been shown to contribute greatly to the development of this disorder (Lin & Stoll).

Aggressive Increase of Enteral Feedings

The infant intestine colonizes with bacteria within the first week of life. Prematurity contributes to the immaturity of the intestine, and with aggressive increase in enteral feedings, the intestine is exposed to higher concentrations of nutrients and is more easily stressed than the intestine of a full-term infant (Neu, 2005). In an article by Coit (1999), it was recommended that feedings be increased slowly as the infant tolerates them. Coit also discussed aggressive increases in volumes greater than “60mL/kg/day” and total volumes greater than “150mL/kg/day” were associated with an increased incidence of NEC (p. 55).

Patent Ductus Arteriosus

Kenner stated, a patent ductus arteriosis (PDA) is a “normal muscular contractile structure in the fetus connecting the left pulmonary artery and the dorsal aorta” (2004,
According to a NICU manual, infants develop decreased output due to the left to right shunting of blood, causing intestinal hypoxia and subsequent ischemia ("Intensive care," 2007). In Table 2 of Nursing Care Interventions Coit stated PDA is a contributing factor for the development of NEC (1999, p. 62).

**Maternal Risk Factors**

Another risk factor for the development of NEC is one that greatly increases the risk for intestinal hypoxia. Mothers who have underlying conditions, either chronic or acute, which cause placental insufficiency, are a factor in the development of this disorder. Springer stated, “[m]aternal risk factors that reduce fetal gut blood flow, such as placental insufficiency from acute disease (e.g. pregnancy-induced hypertension), chronic disease (e.g. diabetes), or maternal cocaine abuse, can increase the baby’s risk for developing NEC” (2004, ¶ 43).

**Enteric Hyperosmolar Fluids**

Gastric or intestinal feeding tubes deposit specialized nutrition formulas either directly into the stomach or the intestine. Parental nutrition consists of a specialized, usually high carbohydrate formula, administered via intravenous methods. Several sources explain a relationship between the hyperosmolality and development NEC. Neonates with NEC are often prescribed parental nutrition and Fraiser Askin and Wilson (2005) stated about the relationship between hyperosmolality and NEC, “[a] consistent relationship has been observed . . . It is unclear whether this connection is a result of the formula imposing stress on an ischemic bowel, serving as a substrate for bacteria or both” (p. 284). Also, Neu (2005) described that the use of human milk has a much lower incidence of NEC and the use of hyperosmolar fluids, a higher incidence.
**Polycythemia**

The NICU nurse manual at Regent’s Children’s Hospital defined polycythemia as a venous hematocrit of > 65% in infants (2007). The mechanism of action of polycythemia is, “[i]ncreased viscosity results in slowing of blood flow and sludging of red blood cells. As blood flow is further reduced, occlusion of small vessels may result in ischemia and consumption of platelets (“Intensive care,” 2007). According to Kenner (2004) polycythemia results from “fetal hypoxia and intrauterine stress that forces the body to produce more red blood cells in an attempt to provide oxygen to the developing fetus” (pp. 1141-1142). Because of bowel ischemia, polycythemia poses a great risk for the further development of the ischemia to NEC.

**UAC/UVC Placement**

There are several possible reasons for the death of the bowel tissue. The most apparent and possibly the most common reason is bowel ischemia. Umbilical arterial catheters (UAC) and umbilical venous catheters (UVC) allow for intravenous/arterial access of the neonate. Umbilical artery catheters are inserted through the umbilicus to the descending aorta, and venous catheters are inserted into the inferior vena cava (Fraiser Askin & Wilson, 2005). Fraiser Askin & Wilson described a common problem with UACs to be “vasoconstriction of peripheral vessels, which can seriously impair circulation. The response is triggered by arterial vasospasm caused by the presence of the catheter, the infusion of fluids, or injection of medication” (pp. 234-235). According to Coit, if a umbilical intravenous/arterial catheter is placed in a high position such as above the diaphragm, there is a greater chance for the mesenteric orifice to become occluded, causing a lack of blood flow to the bowel and subsequent death of tissue (1999).
Respiratory Distress Syndrome

Another cause of bowel ischemia and injury is the development of respiratory distress syndrome (RDS) in the NICU. Coit stated, not only does RDS contribute to NEC but it also “interfere[s] with intestinal blood flow and the delivery of oxygen and nutrients” (1999, p. 54). In order for the bowel to maintain proper vasculature and perfusion, the proper amount of oxygen and nutrients must be available. In the case of RDS, the infant is unable to provide adequate perfusion for the body’s systems and subsequent necrosis may occur.

Survey

One of the major pitfalls in the research of this thesis was the lack of compliance with the surveys. These surveys were distributed to a nurse manager of a Level III NICU. 25 surveys were distributed and 12 were returned complete. Most of the answers were strictly yes or no answers. In the survey, nurses were asked if a separate assessment tool would be useful. All but one of the surveys listed “no” as the answer. A “yes” came from a new graduate that had only worked in the NICU for 2 years; because she was new to the NICU she thought an assessment tool could be helpful.

Recommendations for Further Research

Necrotizing enterocolitis occurs in as many as 5% of infants admitted to the NICU every year ("Mortality Statistics," 2004). NEC can quickly lead to sepsis and in very small infants sepsis can lead to death in not days, but hours. It is recommended that further research for the evaluation of this risk assessment tool be done in order to perhaps predict NEC before it occurs. A pilot study would need to be implemented on a large sample group; According to Fain, “[p]ilot studies help to point out flaws or errors in the
construction of the instrument, selection of the sample, and data collection procedures. Pilot testing also gives insight into problems that could be encountered in editing and coding data” (2004, p. 137).

The tool is in need of psychometric evaluation for reliability and validity. The use of a tool that does not accurately predict risk factors of NEC would be worthless. Fain stated, “[i]dentifying whether an instrument used in a study has discussed issues of reliability and validity are important from a researcher’s point of view” (2004, p. 136). Fain’s recommendations for the determination of validity and reliability \( r = 0.70 \) or higher) is to “[e]xamine the similarity between subjects in an original study where the development and construction of the instrument began with those subjects in the current study” (p. 136).

Data from past or current infant hospitalizations would need to be evaluated and analyzed to assess for positive or negative correlations relating to the risk factors and the infants who developed NEC.

**Nursing Implications**

It was hypothesized that a screening tool for early identification of NEC in infants in the NICU would improve mortality, but further research is required on the effectiveness of a tool for early identification. The idea for this assessment was to have the tool become part of the standard documentation associated with NICU care, if proven through several studies to be reliable and valid in the early detection of the disorder. Once the infant was assessed with this tool, the care team would be able to more closely monitor for the development of NEC and implement the measures necessary to decrease its incidence such as switching to breast milk or providing parental nutrition.
Summary

Throughout the lifespan there are many illnesses and diseases adults and children fall prey to. NEC, a disorder affecting premature infants, can be one of the most devastating gastrointestinal disorders an infant may be forced to face in its first weeks of life. Through examination of literature and input from NICU nurses, data was gathered to develop a prototype for a risk assessment tool used for the early assessment and prevention of NEC. Further research and study is needed for the risk assessment tool to be used as a screening device. By early assessment and prevention of NEC, medical staff can more quickly recognize the disorder’s signs and symptoms, given the newly born infant a greater chance at life.
References


Intensive care nursery house staff manual (2007). *UCSF Children’s Hospital*. San Francisco, California: The Regent’s of the University of California


Appendix A

Early Assessment and Prevention of Necrotizing Enterocolitis in Premature Infants

If you have any questions please contact Katy Weber at kweber@carroll.edu or at (208) 830-6773.

Survey Questions
(answers will be kept confidential)

General:

1. How many years have you worked as a nurse? _____.

2. Are you Male ___ or Female ___?

3. How many years have you worked in an NICU? _____.

4. What was your most memorable experience with an infant with NEC? (please be as specific as time allows and use the back if necessary)

Specific to the study:

1. In your opinion, does your hospital’s current assessment allow for the prompt recognition and assessment of NEC?

2. Is there anything in this policy that you would like to change?

3. Would a separate assessment for NEC be useful to you in your clinical setting?
4. In your opinion, what is the best diagnostic tool for the early assessment of NEC?

5. In your opinion, what is the best practice for the prevention of NEC?

6. In your opinion, what is the best alternative treatment for NEC?

7. What would you recommend to increase the quality of life and survival rates of infants with NEC?
Appendix B

**NEC Risk Scale**

Instructions: Score client on each of the items. Maximum score is 14, indicating little or no risk. A score >1 indicates “at risk;” a score > 5 indicates “high risk;” and a score > 10 indicates “extreme risk”.

- <32 weeks gestation and/or <1500 g (3)
- Bacterial colonization of the bowel (1)
- Aggressive increase of enteral feedings (2)
- Patent Ductus Arteriosus (1)
- Maternal risk factors that reduce gut blood flow such as: placental insufficiency from acute disease (1), chronic disease (1) or maternal cocaine use (1). (Up to 3)
- Enteric hyperosmolar fluids (1)
- Polycytemia (1)
- UAC with tip at or above the inferior mesenteric artery or UVC with tip in portal system (1)
- Respiratory Distress Syndrome (1)

/14 Total