Evaluation of a Program Aimed at Improving Feeding Outcomes for Infants Receiving Noninvasive Nasal Ventilation

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Table of Contents

Abstract

Introduction: Infants in the neonatal intensive care unit (NICU) often require respiratory support. Nasal ventilation (NV) is preferred over endotracheal ventilation due to fewer adverse effects. Nasal ventilation inadvertently forces air into the stomach, which can precipitate abdominal distention and feeding intolerance. Due to a perceived increase in instances of abdominal distention associated with the use of NV, the Mercy Hospital NICU implemented a policy change on January 3, 2022. The goal of the policy change was to expedite achievement of full enteral nutrition. The benefits of full enteral nutrition include fewer adverse effects related to intravenous (IV) use, improved growth and development, and decreased length of stay. Policy changes included: change in feeding tube product (different length and diameter), delivery of feedings over a shorter duration of time, and intentional evacuation of air from the stomach between feedings. *Methods:* 250 participants were included in this retrospective chart review. The review spanned from six months prior to the policy change date until six months after the policy change date. *Discussion:* Results demonstrate a statistically significant improvement in the number of days of life from first feed to full feed (p=.0026). There was a decrease in the number of times feedings were held, as well as a shorter length of stay in the post policy change group. Overall, infants receiving NV in the Mercy NICU achieved full enteral feedings faster and experienced less exposure to IV nutrition.

Program Evaluation of Enteral Feeding Policy for NICU Patients Receiving Nasal Ventilation

Respiratory distress is a prevalent problem for infants in the Neonatal Intensive Care Unit (NICU), especially those born prematurely. Utilizing nasal ventilation (NV) options to treat respiratory distress is becoming the gold standard for patients in the NICU as it reduces the need for intubation and the risk of lung injury. Evacuating swallowed air caused by NV is vital for improving feeding tolerance and reducing pressure on the diaphragm from gastric distention. This program evaluation assessed the effectiveness of an enteral feeding policy change implemented in the Mercy NICU in 2022.

Background

Infants born prematurely require meticulous care and present unique challenges to neonatal providers. An estimated 15 million infants are born prematurely every year (World Health Organization, 2018). Each year, the leading cause of infant death in the United States is premature birth, defined as birth before 37 weeks of pregnancy (March of Dimes, 2019). The rate of infants born before 37 weeks is increasing, and the United States' preterm birth rate is among the highest of developed countries (March of Dimes, 2019). Approximately one million children die annually due to complications of prematurity, making it the leading cause of death in children under the age of five years (World Health Organization, 2018). Surviving premature infants face lifelong health problems such as chronic lung disease, intellectual disability, cerebral palsy, visual impairment, and hearing loss (American Academy of Pediatrics, 2019). Caring for this fragile population is complicated and requires multi-organ support. Two integral aspects of caring for preterm infants include providing effective respiratory support and delivering optimal nutrition, both of which significantly affect overall development and long-term outcomes. Historically, mechanical ventilation via endotracheal intubation has been the primary method for

providing respiratory support to premature infants with respiratory distress. While capable of providing effective ventilation, this method can lead to upper airway injury, bronchopulmonary dysplasia (BPD), and sepsis (Lemyre et al., 2017). Minimizing these complications has been a goal of NICU providers since the 1980s, and NV was widely employed to do this, especially after a sentinel article published in 1987. Avery et al. showed significantly lower chronic lung disease rates in patients who received NV at Colombia Presbyterian Medical Center, even in extremely low birth weight (ELBW) infants, as compared to eight similar U.S. NICUs that still employed invasive ventilation via endotracheal tubes (1987). Extensive evidence demonstrates a direct correlation between lower BPD rates and decreased endotracheal intubation and mechanical ventilation in NICU patients. Multiple NV modalities have become widely accepted (Permall et al., 2019). These include high-flow nasal cannula (HFNC), nasal continuous positive airway pressure (NCPAP), bubble nasal continuous positive airway pressure (bCPAP), and nasal intermittent mechanical ventilation (NIMV).

In addition to optimizing respiratory support in this population, improving outcomes involves early optimization of nutrition. A frequent roadblock to achieving optimal nutrition is abdominal distention, as evidenced by visible bowel loops upon physical examination. Abdominal distention is a non-specific finding in the preterm population that can indicate an array of problems, from general feeding intolerance or constipation to ileus or necrotizing enterocolitis (NEC). Necrotizing enterocolitis is a serious condition that inflames the intestinal tissue and can lead to perforation and/or bowel ischemia (AlMatary et al., 2021). Diagnosing NEC and other serious intraabdominal processes requires radiographic imaging (x-ray), which exposes the infant to radiation.

Abdominal distention is commonly associated with use of NV which increases the amount of air forced into the stomach, which can cause gaseous distention (Tyagi et al., 2014). Premature and sick infants often have gastrointestinal (GI) dysmotility, which can then slow down the passage of air through the GI tract, increasing the likelihood of distention (Guay et al., 2018). Because clinical investigation of abdominal distention often warrants withholding of feedings, infants suffering from distention may experience delayed achievement of full feedings, exposure to intravenous nutrition, repeated exposure to radiographic imaging, and prolonged requirement of central venous catheters.

Problem Statement

Infants in the Mercy Hospital NICU have experienced high rates of abdominal distention in recent years. There are two plausible explanations for this finding. First, during this period, NV usage has dramatically increased, particularly with bCPAP use among premature infants born prior to 32 weeks gestation. Second, management of gastric distention by the Mercy NICU has been sub-optimal due to the gastric tube utilized. The ability to effectively evacuate air from an infant's stomach is dependent on optimization of the size (internal diameter), length, and composition of the gastric tube being used.

Organizational "Gap" Analysis of Project Site

The standard of care in the Mercy NICU prior to January 3, 2022, did not include venting, or passive evacuation of air from the stomach, with gastric tubes for infants receiving NV. Feeding practices included administering gavage feedings via 5 Fr. gastric tubes with infusion duration ranging from 60 to 120 minutes. Venting was not performed due to the relatively small diameter of the gastric tube which does not allow for passive evacuation of air. Also, with feedings being administered every three to four hours per schedule, the prolonged

duration of feedings meant that there was insufficient time for venting with a gastric tube prior to the subsequent feeding. Nursing staff, physicians, and nurse practitioners observed increased abdominal distention over time after an expanded use of NV.

At this institution, the increased prevalence of abdominal distention led to an increase in cessation or withholding of enteral feedings, more frequent abdominal radiographs, more frequent investigations for sepsis that required IV antibiotics, an increased length of time on IV fluids, an increased the time required to achieve full volume feedings, and ultimately, an overall increased length of hospital stay. Using the Agency for Healthcare Research and Quality (AHRQ) gap analysis toolkit, Mercy NICU stakeholders first observed that as NV increased in the unit, the incidence of abdominal distention and subsequent perception of possible feeding intolerance also increased; this was identified as the clinical problem (AHRQ, 2017). A review of the literature and assessment of the enteral feeding policy by the stakeholders led the quest for a change in practice and equipment.

Upon further review of the evidence, providers and nursing staff identified both a knowledge and equipment gap between the increase in abdominal distention and the ineffective use of gastric tubes as a tool for gastric decompression. There is a significant relationship between tube size and capacity for gastric air evacuation (de Boer et al., 2009). Any patient in the NICU receiving NV would now also receive a gastric tube to decompress the stomach while simultaneously providing safe enteral nutrition. Gastric tubes are crucial to a critically ill infants' overall health and are a valuable, multi-functional tool used to aid in growth (Wallace & Steward, 2014). In order to facilitate effective gastric decompression between feedings and relieve the associated aerophagia, the need for gastric tubes with a shorter length and a larger diameter was identified. Stakeholder focus groups met and recognized that a change in the brand

of gastric tube product was necessary. They also identified the need to modify the route of tube placement between orogastric and nasogastric based on the chosen NV modality and size of the infant. Thus, the enteral feeding policy was amended effective January 3, 2022, with the following changes:

- All infants receiving nasal ventilation by HFNC ≥ 2 liters per minute (LPM), NCPAP, bCPAP, or NIMV, regardless of weight or gestational age, shall undergo gastric decompression between scheduled gavage feedings every three to four hours.
- 6.5 or 8 French (Fr) feeding tubes shall be utilized (in place of the previously utilized 5 Fr tubes); size selection shall be determined by the infant's weight. The larger bore will improve evacuation of air.
- 16-inch-long feeding tubes shall be utilized (in place of previously utilized 36-inch-long tubes) to provides a shorter length of tubing for air evacuation to occur.
- Duration of enteral feeding administration shall decrease from 90 minutes to 30 minutes. A shorter feeding duration allows adequate time for venting the feeding tube for gastric decompression prior to the subsequent feeding. The longer the feeding duration, the shorter the amount of time for passive gastric decompression.
- To optimize comfort and ventilation via nasal passages the preferred route for feeding tube placement shall be orogastric versus nasogastric.

Review of the Literature

A systematic review was conducted and reported following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Figure 1). Published data regarding feeding intolerance in preterm infants during nasal ventilation was searched using three online databases up to June 18, 2022.

Databases were searched using the following terms: (premature infant OR preterm infant; OR premature baby OR preterm baby) AND (continuous positive airway pressure OR non-invasive ventilation) AND (feeding tolerance OR abdominal distention OR abdominal distension). The MeSH terms used were infant, preterm; continuous positive airway pressure; nutrition; and intensive care unit. The searched databases were PubMed, EBSCO Host, including all databases, and OVID. Included articles described randomized controlled trials (RCTs), observational studies, case reports, or one RCT follow-up study. Studies that did not include patients in the neonatal intensive care units were excluded. The articles were initially filtered by date to include only the last five years (2018-2022), but the date filter was removed due to a lack of articles related to the topic. Articles without access to the full text were excluded. Three of the articles located by this search were analyzed in detail for this review.

The process of identifying these three articles started with 117 articles from EBSCO Host, 23 from OVID Medline, and 37 from PubMed. After excluding duplicates within each database and refining the search to articles only available in English, the number of articles from EBSCO Host decreased to 46 and PubMed to 30. Next, evaluating for duplicates between the databases reduced the number of articles to 22 only found in EBSCO Host, three were only found in OVID Medline, and four were only found in PubMed. The remaining 70 articles were found in at least two databases, and 18 were in all three. Next, the articles were evaluated for relevance to the topic. Fourteen articles evaluated were excluded due to only focusing on respiratory interventions. Five articles were excluded due to only evaluating feeding protocols, most of which pertained to oral feedings. Fourteen articles were excluded due to lack of relevance to the topic. The articles specific to enteral feedings and nasal ventilation yielded three articles, one of which is the sentinel article on this topic from 1992 (see Figure 1).

Results

Reviewing the literature regarding feeding protocols for infants on NV revealed no procedural consensus regarding how feedings should be administered. The amount of literature in support of NV for infants requiring respiratory support is ample, but specific recommendations regarding how to feed this population are limited. A sentinel study by Jaile et al. was the first of its kind to address abdominal distention among infants receiving NCPAP (1992). The term "CPAP belly syndrome" originated from this research. A prospective study, Jaile et al. examined a nonrandomized group of 54 preterm infants weighing less than 2000 grams at birth, of which 25 received NCPAP and 29 did not. The authors did not describe the type of support, if any, that the latter group received. Babies classified as ELBW with a weight of < 1,000 grams were of specific interest in the results. Fifty percent of the infants in the NCPAP group developed gaseous bowel distention; 91% of those weighing < 1000 grams developed abdominal distention. Comparatively, only 10% of the infants who did not receive NCPAP developed distention, all of which were < 1000 grams. Due to the increased risk of distention among infants weighing < 1000 grams, Jaile et al. postulated a correlation between functional immaturity of bowel motility, the severity of aerophagia from NCPAP, and the condition of being ELBW (1992). Notably, a correlation between "CPAP belly syndrome," or abdominal distention, and true feeding intolerance was not demonstrated. This finding was important because abdominal distention from CPAP could be classified as a benign condition and not a contraindication to feeding or the use of NCPAP.

A randomized clinical trial by Gonzalez et al. (2020) compared two techniques used to manage abdominal distention, "cenit" versus "2 x 1". The cenit technique involves using an orogastric tube (OGT) for venting, which remains permanently open and elevated above the

infant. The 2 x 1 technique differs in that the OGT remains closed for two hours after a feeding and is then opened for an additional one hour prior to the next feeding. Ninety-seven patients were included and randomized, 46 in the cenit group and 51 in the 2 x 1 group. Their primary outcome was abdominal distention greater than two centimeters above baseline, and there was no difference found between the two groups. There was no significant difference among the groups in terms of time required to reach full enteral feedings (defined as 150 mL/kg/day), with the average being 17.5 days for the cenit group and 13.5 days for the 2 x 1 group. Oxygen saturations during the feedings were statistically significant and higher in the cenit group when feeds reached 150 mL/kg/day. Gonzalez et al. did not mention the number of infants whose feedings were withheld, who required abdominal radiographs, or who experienced difficulty with feeding advancement. It is important to note that both groups experienced OGT venting for at least 60 minutes between feedings.

Priyadarshi et al. (2020) described a case of severe abdominal distention that led to restriction of the diaphragm, decreased chest expansion, and, ultimately, respiratory decompensation. The infant, born at 27 weeks gestation weighing 850 grams, initially required a brief period of endotracheal ventilation but was extubated to NCPAP at 12 hours of age and remained stable while enteral feedings via OGT were advanced to full volume on day of life 14. The patient was transitioned to bCPAP at age 3 weeks and soon developed gaseous abdominal distention with visible loops of bowel on examination. However, radiographs were reassuring, and his enteral feeds were continued. On day of life 37, his exam became notable for a firm, grossly distended abdomen. He developed respiratory distress, requiring endotracheal intubation. A radiograph demonstrated a massively dilated bowel pattern without evidence of NEC. As with most “NEC scares” in the NICU, a sepsis work-up was performed, and the infant received IV

antibiotic therapy as a precaution. Following intubation, withholding of enteral feedings, and continuous venting of the OGT, his abdominal girth returned to baseline within 36 hours. The infant required no further respiratory support by age 15 weeks and was discharged home one week later. The infant's sudden clinical deterioration was determined to be caused by a severe case of CPAP belly syndrome. It is hypothesized that a contributing factor for CPAP belly syndrome is delayed gastric emptying time due to pressure of the diaphragm on the stomach (Priyadarshi et al., 2020). This case demonstrates the need to consistently perform maneuvers to evacuate gastric air for infants receiving NV.

When evaluating abdominal distention, a persistent challenge for NICU providers is distinguishing non-life-threatening complications like CPAP belly syndrome from other serious conditions like NEC. Necrotizing enterocolitis remains one of the most common causes of morbidity and mortality for premature infants in the NICU (Reid & Thompson-Branch, 2016). Due to the serious nature and sudden onset of NEC, providers often overtreat and over-investigate abdominal distention. The literature, though limited, is clear that utilizing venting through an OGT while a baby is receiving NV is a practical method of alleviating abdominal distention.

Evidence-based Practice: Verification of Chosen Option

There are accepted standards of care and research surrounding the details of when to initiate feedings and how quickly to advance them, but there is not a consensus on how to administer enteral feedings to preterm infants receiving nasal ventilation. There are no published recommendations regarding providing enteral feedings to preterm infants receiving nasal ventilation. This program evaluation compares outcomes, including severity of abdominal

distention and the time required to achieve full feeding status, among infants receiving nasal ventilation before and after implementing a policy change.

Theoretical Framework or Evidence-based Practice Model

Mefford's Theory of Health Promotion for Preterm Infants Based on Levine's Conservation Model of Nursing offers a relevant theoretical framework for this project. This theory proposes that both the premature infant and the family require rapid and ongoing engagement with the process of adaptive change (Mefford, 2004). The theoretical concepts (latent variables) are physiologic immaturity, structural immaturity, neurologic immaturity, and family system characteristics (Mefford, 2004). Premature infants constitute a vulnerable patient population. In utero, a developing fetus has a consistent regulation of temperature, noise, light, nutrition, and oxygenation. Unless a pregnancy experiences complications, the fetus exists in an ideal environment for development and growth in a sequential manner that is neurologically and developmentally supportive. When a baby is born prematurely, this maturation process is disrupted. The latent variables addressed in the Theory of Health Promotion for Preterm Infants describe this unnatural environment in which a preterm baby must continue to develop after premature birth (Mefford, 2004). See Appendix A for the theoretical concept map.

Physiologic immaturity in a premature infant involves many challenges. The primary challenge is establishing adequate ventilation, oxygenation, and circulation. Mefford's theory links Levine's conceptual model of energy balance regarding physiologic immaturity. This concept focuses on the infant's ability to independently perform physiologic processes necessary for survival in the extrauterine environment (Mefford, 2004). An essential part of the physiologic maturation of a preterm infant is the ability to eventually breathe independently without the aid of supplemental oxygen and mechanical ventilation. Nutrition is an important factor in the

setting of physiologic immaturity; optimal nutritional status has been shown to decrease the rate of chronic lung disease (Hair et al., 2016).

A preterm infant's structural maturity level is suitable for intrauterine life, not extrauterine existence. Nutrition and growth are the primary ways to improve the structural maturity of the preterm infant. Growth parameters, including weight, length, and fronto-occipital circumference (FOC), are followed closely. Improving feeding tolerance for adequate nutrition is essential in facilitating a preterm infant's growth.

Nutrition plays an essential role in all infants' neurological development and maturation, especially neonates born prematurely. Neurologic immaturity directly impacts the long-term outcomes of a premature infant. It has become increasingly more common for premature infants to be resuscitated as early as 22 weeks gestational age. The goal of providers caring for preterm infants is not just for the infants to survive but also to thrive.

Family system characteristics are essential in a preterm infant's NICU course and long-term outcomes. The range of a family's understanding and involvement varies widely. Regarding feeding tolerance, a parent's familiarity with the infant's baseline abdominal exam helps them appreciate changes and signs of intolerance.

The corresponding measurement variables are the intensity of nursing care and the consistency of nursing caregivers leading to the health status at discharge. Consistency of nursing caregivers directly affects patient care and is crucial, especially for patients with long-term hospital stays of up to several months. A nurse's familiarity and knowledge of a preterm infant's "baseline" abdominal exam is imperative to then appreciate changes in the exam and other signs of feeding intolerance (frequency and volume of emesis, stool characteristics, and gastric residuals). The current goal for a premature infant is that the baby and the family are

ready for discharge around the baby's original due date. The transition from nursing staff being the primary caregiver to the parents accepting that role should be a focus throughout the NICU stay.

Goals, Objectives, and Expected Outcomes

The goals and objectives of this project were to evaluate the incidence and severity of abdominal distention among infants receiving NV who were being fed in accordance with an updated enteral feeding policy. Expected outcomes included lower rates of abdominal distention and earlier achievement of full enteral feeding status.

Methods

The aim of this scholarly project was to evaluate the impacts of a NICU feeding policy change that occurred on January 3, 2022. A retrospective chart review was performed, and data was collected six months before the policy change was implemented (July 1, 2021 – January 2, 2022) and six months after the change (January 3, 2022 – June 30, 2022). The primary outcome was the number of days to reach full feedings. The ability to reach full feedings in a shorter amount of time would be a positive indicator that abdominal distention was reduced. Secondary data included the average weight gained per day during the NICU stay, duration of length of stay, number of times feedings were stopped (NPO, or nothing by mouth), number of total days spent NPO, gestational age, and weight at the time of NICU discharge.

Project Design

The enteral feeding policy change included the utilization of an alternative enteral feeding tube system. The chosen feeding system was the Medela® polyurethane enteral feeding system®. The previous brand, being longer and having a smaller diameter, was ineffective at evacuating air. The Medela® tube has an open-end hole with multiple side holes, decreasing the

risk of occlusion or air entrapment. This tube also offers the largest available interior diameter with the smallest exterior diameter. Medela Gravi-Feed® lids are specific caps placed on the end of the syringe during either gravity feeding or venting. These lids ensure maximum ventilation without the need for absorptive materials, such as gauze or cotton balls, which can inadvertently cause occlusion. The hydrophobic filter in the lid allows air to escape while securely containing fluid.

The policy change also included utilizing the feeding tube product with the shortest available length. A decreased length yields a lower overall surface area, resulting in improved venting. The tube's optional extension set can be connected during the feeding to facilitate access to the mechanical feeding pump. It can then be removed after the feeding is completed to allow venting. The feeding policy specifies the appropriate size and length of the tube based on the infant's weight. If a baby weighs less than 1000 grams, a 6.5 Fr, 16-inch OGT is used. If an infant weighs greater than 1000 grams, an 8 Fr, 16-inch OGT is used. All feedings are infused via a feeding pump for 30 minutes compared to 60 to 120 minutes before the practice change. After the feeding has completed, the nurse waits 30 minutes and then applies the Medela Gravi-Feed® lid. The OGT is elevated above the baby to allow for the passive evacuation of air but not liquids. The venting period occurs for approximately 90 minutes after each feeding. Feedings are administered every three to four hours on a consistent schedule, per provider's discretion.

Data collection included the following:

- Gestational age (weeks)
- Birthweight (grams)
- Number of days required to reach full feeding status, from initiation of trophic feedings to a volume of at least 140 mL/kg/day

- Average weight gain per day from birth to discharge
- Number of times placed NPO during feeding advancement, and the total number of days the infant was NPO
- Number of days on nasal ventilation
- Length of stay
- Weight and gestational age at the time of hospital discharge

Project Site and Population

This program evaluation occurred in a 42-bed level III Neonatal Intensive Care Unit at Mercy Hospital in Oklahoma City. The Mercy NICU cares for preterm and term infants requiring specialized care after birth. Infants are either born at Mercy Hospital or transported in from surrounding hospitals. Births at this facility average 4,000 per year. The average daily census of the NICU is 28 infants, of which approximately 40% require NV. Included participants were infants who required NV greater than or equal to 24 hours and were born in the facility. Exclusion criteria were presence of chromosomal abnormalities, gastrointestinal abnormalities, infants requiring patent ductus arteriosus (PDA) treatment, NEC diagnosis, and infants who were transferred between the Mercy NICU and another facility.

The Mercy NICU employs 85 registered nurses, 12 respiratory therapists, 10 neonatal nurse practitioners, and four physicians. Around-the-clock care is provided. Ancillary staff include occupational, speech, and physical therapists; lactation nurses; chaplains; and social workers. Stakeholders for this population are patients, parents and family members, nursing and respiratory staff, ancillary staff, and providers (physicians and nurse practitioners).

Measurement Instruments

Data for this project was collected from electronic medical records (EMR), including Epic® (hospital data) and BabySteps® (provider data). A search was performed in BabySteps® to identify all infants born between July 1, 2021, and June 30, 2022, who required admission to the Mercy Hospital NICU, and who received NV for 24 or more hours. Infants were divided into two groups: pre-intervention and post-intervention, with January 3, 2022, marking the dividing point.

Data Collection Procedures

The practice medical director provided a letter of support for this program evaluation project (see Appendix B). Prior to data collection, approval was obtained from the Mercy Hospital and the University of Alabama Institutional Review Boards (IRB) (see Appendixes C and D). All data was stored and secured electronically in the University of Alabama UA Box system, accessible only by the student principal investigator, clinical advisor, faculty advisor, and UA statistician.

Data Analysis

The retrospective chart review included 250 participants. All collected data were reported as numerical values and entered into an Excel spreadsheet. Dr. Christina Ezemanaka, biostatistician at the Capstone College of Nursing, performed the statistical analysis. Independent t-test, Wilcoxon test, and Chi-square tests were performed to analyze and compare days to full feeds, length of stay, discharge weight, and the number of times infants were placed on NPO status.

Cost-Benefit Analysis/Budget

No expenses were incurred for this project. The student principal investigator submitted the Mercy Hospital and UA IRB requests and performed data collection for this project. Statistical analysis was provided as part of the student's academic support at no additional cost.

Timeline

In July 2022, Dr. Staci Simmons, faculty advisor, approved the initial project proposal. The Mercy Hospital IRB application was approved on August 8, 2022, and UA IRB approval was obtained on September 23, 2022. Data collection began on September 25, 2022 and was completed on January 3, 2023. Data analysis and interpretation of outcomes occurred in January of 2023. Dissemination of findings to the stakeholders occurred in March of 2023. Presentation of findings at The Capstone College of Nursing Doctor of Nursing Practice (DNP) Intensive occurred in March of 2023. See Appendix E.

Ethical Considerations/Protection of Human Subjects

Patient data obtained from the EMR was protected by the Health Insurance Portability and Accountability Act of 1996 (HIPAA) which protects the privacy of patient's health information (*Summary of the HIPAA Privacy Rule*, 2013). Mercy Hospital and its affiliated EMR systems adhere to all HIPPA guidelines. The information collected during this program evaluation did not include patient identifiers. The collected data were aggregated. Patient confidentiality was assured by assigning each patient a unique identification number. The care received by the patients in this evaluation was congruent with the standard of care adopted by the Mercy NICU and since this is a retrospective program evaluation, there were no risks to the participants.

Results

Demographic Summary

Infants born between July 1, 2021, and June 30, 2022, who required NV in the Mercy Oklahoma City NICU totaled 303 infants. Fifty-three infants were excluded per exclusion criteria, leaving 250 participants. Pre-protocol infants totaled 130, and post-protocol infants

totaled 120. On average, participants (N = 250) were 34.0 weeks and weighed 2,299 grams at birth. The average discharge weight of all participants was 2,686.3 grams. All patients achieved full feeding status. Characteristics were similar across protocol conditions, with the exception of gestational age, days of life to achieve full feeding status, days of life from first feeding to full feeding status, and days on nasal ventilation. The mean gestational age for the pre-protocol group was 33.5 weeks, and birthweight was 2,194.6 grams, while the gestational age and weight were higher post-protocol at 34.5 weeks and 2,412 grams, respectively. See Table 1.

Days to Full Feeds Comparison

Data were collected according to the project design, with the main comparison value being the number of days from initiation of enteral feeding to full feedings (140 mL/kg/day). The median days of life for the first feed for both groups was day of life 1.0. Results from a Wilcoxon Rank Sum Test suggest that the number of days of life from first feed to full feeding differ significantly based on protocol conditions ($p = 0.0026$). Participants had fewer median days of life to full feed status post-protocol (Median = 3.0) in comparison to pre-protocol (Median = 4.0). The median interquartile range proved to be a better center estimator due to excluding outliers. The main goal of the policy change was achieved by decreasing the amount of time it takes to achieve full feeds, thus decreasing the number of days on IV nutrition. See Figure 2.

Number of Times Placed NPO Comparison

The number of times that feedings were held (NPO), as defined by greater than two withheld feedings in 24 hours, was decreased in the post-intervention group though not at a statistically significant level (total 14 pre-intervention versus 11 post-intervention). The total

number of days the infants spent NPO due to feeding intolerance also decreased (18 days pre-intervention versus 11 days post-intervention).

Hospital Length of Stay Comparison

The hospital length of stay between the pre- and post-intervention groups was decreased (16.5 days pre-intervention versus 13 days post-intervention) which correlates to the quicker advancement to full enteral feedings in the post intervention group. Infants in both groups shared a median of initiation of feedings on day of life 1, so there was not a significant difference as it relates to length of stay. While these findings were not statistically significant, they were clinically significant in that those infants who were weaned off IV fluids more quickly and received enteral feeds sooner were able to discharge home earlier.

Gestational Age and Birthweight Comparison

A Wilcoxon Rank Sum Test showed the gestational age mean results from the pre-intervention group to be 33.5 weeks versus the post-intervention gestational age of 34.5 weeks which was statistically significant ($p = 0.031$). The birthweights also differed with the mean pre-intervention at 2,194.6 grams versus 2,412 grams post-intervention, though these were not statistically significant ($p = 0.62$). The number of days on nasal ventilation was statistically significant between groups ($p = 0.0043$). The median for the pre-protocol group was 5.0 days versus 3.5 days post-protocol. These findings are consistent with the older gestational age infants also having higher birthweights in the post-protocol group. The amount of respiratory support required often correlates proportionally to the severity of prematurity.

Discussion and Study Limitations

When comparing the two groups, this program evaluation found a statistically significant improvement ($p = 0.0026$) in the number of days from the first feeding to full enteral feedings.

The ability to improve the feeding tolerance of infants that are receiving nasal ventilation was the main goal of the policy change. By decreasing the aerophagia between feedings, enteral nutrition was provided more efficiently. Care was improved post-policy change as evidenced by the reduced number of days to achieve full enteral feeds by decreasing the number of times the infants were placed NPO, reducing the number of days spent on IV nutrition, and ultimately decreasing the length of stay.

A limitation of this study was that there was also a statistically significant difference in the gestational age between the two groups, with the post-protocol group being one week more mature (33.5 weeks versus 34.5 weeks gestation). Higher gestational-age infants may experience less feeding intolerance and abdominal distention as compared to lower gestational-age infants. However, the difference in birthweights between groups was not statistically significant, indicating that the two groups were comparable despite differences in gestational age. Originally, a secondary outcome measure was the frequency of abdominal imaging (radiographs). This information may help to quantify the occurrence of abdominal distention. However, abdominal radiographs may be obtained for purposes not related to feeding tolerance, such as central line placement. Providers did not consistently indicate the specific rationale for ordering abdominal radiographs. Therefore, the number of radiographic studies performed was not collected.

Of the 303 infants that met the inclusion criteria initially, 53 were excluded. Infants admitted to the NICU prior to the policy change who remained after implementation were excluded from participation. Infants were also excluded if they were transferred from Mercy NICU to another facility during the observational period, regardless of the reason for transfer. Due to the inability to ensure the infant received feedings consistent with the Mercy NICU

feeding policy and the difficulty in obtaining those records, infants transferred to the Mercy NICU from another facility during the study were also excluded.

Clinical Implications and Further Recommendations

An improvement in our nutritional care was proven, but additional areas can be evaluated and adjusted. Though the policy change significantly improved the time to achieve full feedings for infants receiving NV, additional guidelines on the course of action if feeding intolerance occurs would be beneficial. Specific guidance is needed regarding how to define feeding intolerance and how to decide how and when feeding volumes should be decreased, when feeding additives such as liquid protein or high caloric oil supplements should be removed, when lab work and radiographs should be obtained, and when feedings should be withheld.

During the data collection for this project, determining if KUB ordering decreased as abdominal distention decreased was difficult due to inconsistent charting and ordering practices among providers. Therefore, this data was not collected. Improving specificity and consistency among providers in abdominal radiograph ordering is necessary. Developing a standardized approach to documenting rationales for obtaining the radiographs may prove beneficial in tracking the frequency of these studies. By streamlining the approach, fewer instances of radiographic studies may occur, thereby benefiting infants by reducing their exposure to harmful radiation. Furthermore, ordering fewer studies may lead to reduced healthcare costs.

Prior to this policy change, enteral feeding of infants on nasal ventilation in the Mercy NICU was not standardized and varied between providers and nursing staff. Creating a standardized hospital policy with very specific instructions improved the consistency in administering feedings. The size of the enteral feeding tube is detailed in the policy based on weight. Still, more research is needed to determine if the size of the gavage tube should be

dictated solely by weight or if gestational age should also be considered. Another detail that warrants further research pertains to the rate and method by which feedings are administered, either by gravity or as a timed infusion on a feeding pump. The current policy has no set criteria but allows the provider to decide on the method, which is usually chosen based on the feeding volume. If a feeding is less than 10 milliliters, the bedside nurse may decide to give the feeding via either gravity or slow push rather than on an infusion pump over 30 minutes. Further follow-up is needed to determine if there is a correlation between the feeding volume and the method by which it is administered.

Conclusion

Infants that require NV in the NICU may experience abdominal distention and delayed feeding advancement. While the literature review did not yield a consensus on the most effective way to achieve decompression of the stomach, the Mercy NICU enteral feeding policy was amended based on evidence. The policy changes involved altering not only the size and length of enteral feeding tubes but also the rate at which the feedings were administered in order to allow for ventilation of the stomach between feedings. The data collected before and after the policy change indicated an improvement in abdominal distention for infants receiving NV ultimately allowing for quicker advancement to full enteral feeds. It is safe to say that these infants also received more optimal nutrition, less exposure to IV fluids, and a shorter hospital length of stay. Conclusions of this program evaluation were noted both statistically as well as clinically, with an improvement in abdominal distention and the ability to advance enteral feedings post-policy change in infants receiving nasal ventilation. The findings from this program evaluation may also be beneficial to other patient populations that require nasal ventilation.

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Tables

Table 1
Summary statistics of cohort

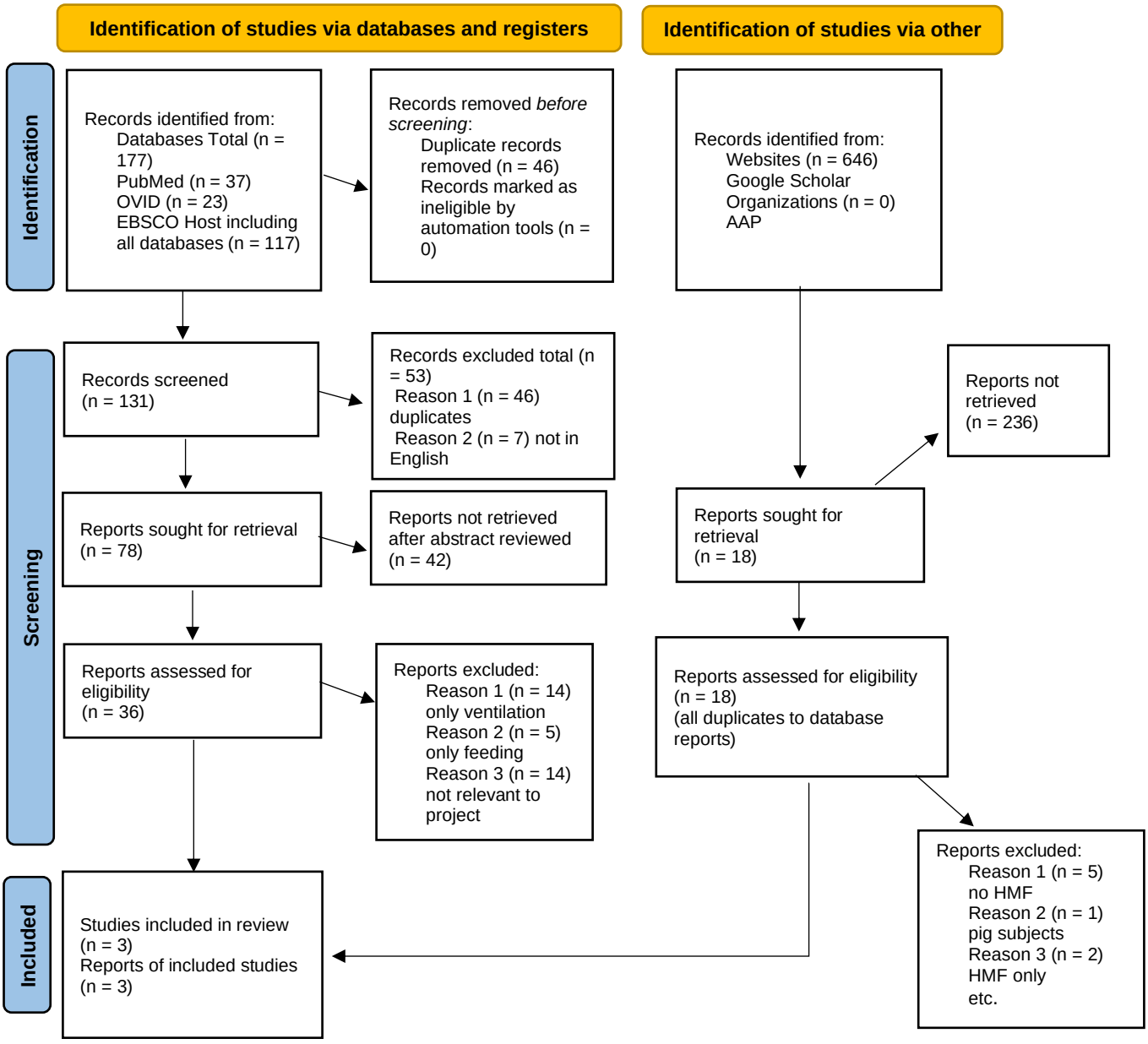
Characteristic	**Total** N = 250	**Pre-Protocol** N = 130	**Post-Protocol** N = 120	**p-value**
Gestational Age, Mean (SD), weeks	34.0 (3.9)	33.5 (3.8)	34.5 (3.9)	**.031**[a]
Birth Weight, Mean (SD), grams	2,299.0 (917.7)	2,194.6 (885.5)	2,412.0 (942.1)	.062[a]
Days of Life First Feed, Median (IQR)	1.0 (1.0, 2.0)	1.0 (1.0, 2.0)	1.0 (1.0, 2.0)	.4207[b]
Days of Life Full Feed, Median (IQR)	5.0 (3.0, 10.0)	6.0 (4.0, 12.8)	4.0 (2.0, 10.0)	**.006**[b]
Days of Life First Feed to Full Feed, Median (IQR)	4.0 (2.0, 9.0)	4.0 (2.0, 11.0)	3.0 (1.0, 8.0)	**.0026**[b]
Met Full Feed, N (%)	250.0 (100.0)	130.0 (100.0)	120.0 (100.0)	-
Discharge Weight, Mean (SD), grams	2,686.3 (570.1)	2,625.8 (514.0)	2,751.8 (620.7)	0.083[a]
Length of Stay, Median (IQR), days	16.0 (7.0, 34.0)	16.5 (8.0, 37.0)	13.0 (6.0, 31.5)	.0886[b]
NPO status, N (%)				.7[c]
Yes	25.0 (10.0)	14.0 (10.8)	11.0 (9.2)	
No	225.0 (90.0)	116.0 (89.2)	109.0 (90.8)	
NP times, Mean (SD)	1.3 (0.7)	1.3 (0.7)	1.4 (0.7)	.8[a]
Nasal Ventilation, Median (IQR), days	4.0 (2.0, 8.0)	5.0 (3.0, 10.8)	3.5 (2.0, 7.0)	**.0043**[b]

a, Independent t-test; b, Wilcoxon test; c, Chi-square test. Bold = statistically significant at the 5% level.

Figures

Figure 1

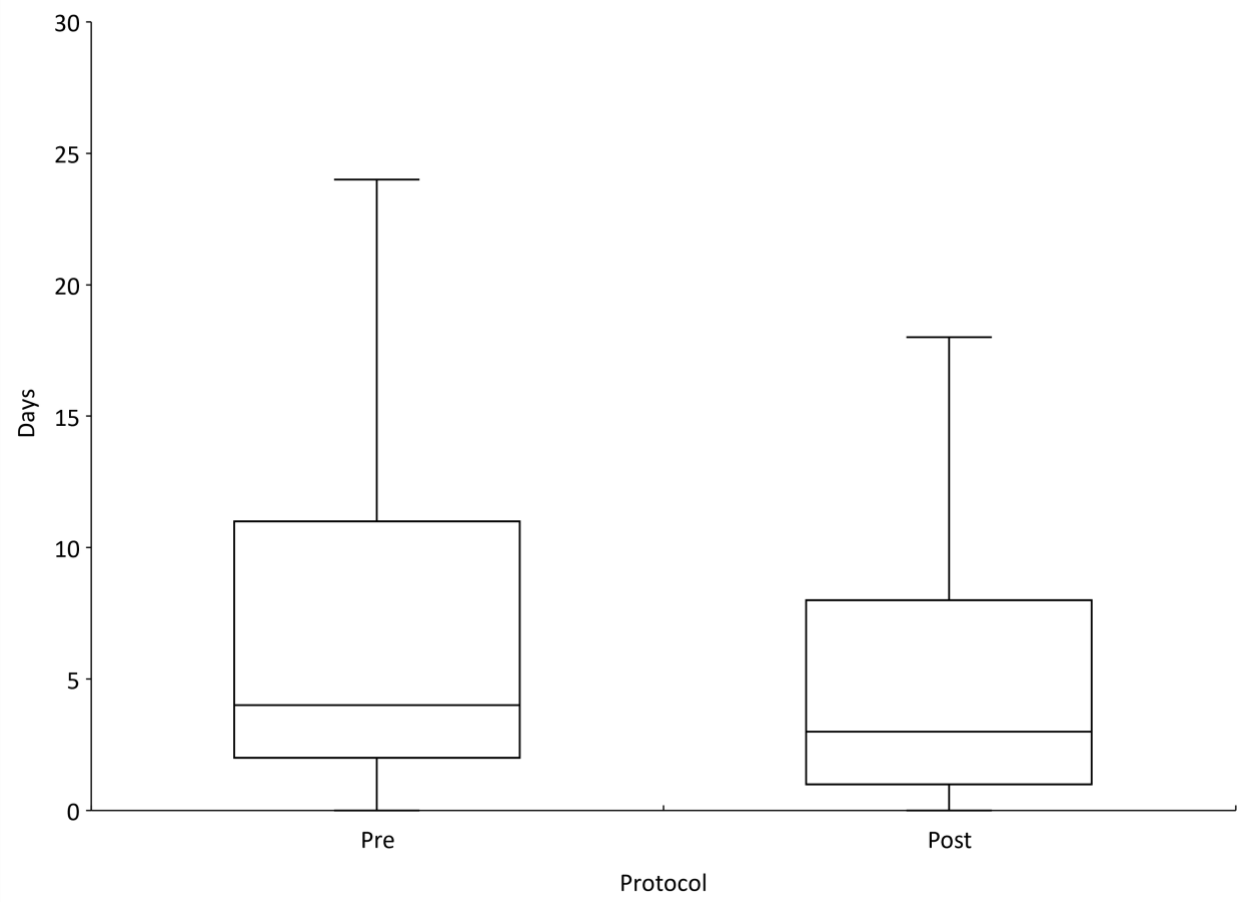
PRISMA 2020 flow diagram for new systematic reviews, which included searches of databases, registers, and other sources



From: Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ 2021;372:n71. doi: 10.1136/bmj.n71. For more information, visit: http://www.prisma-statement.org/

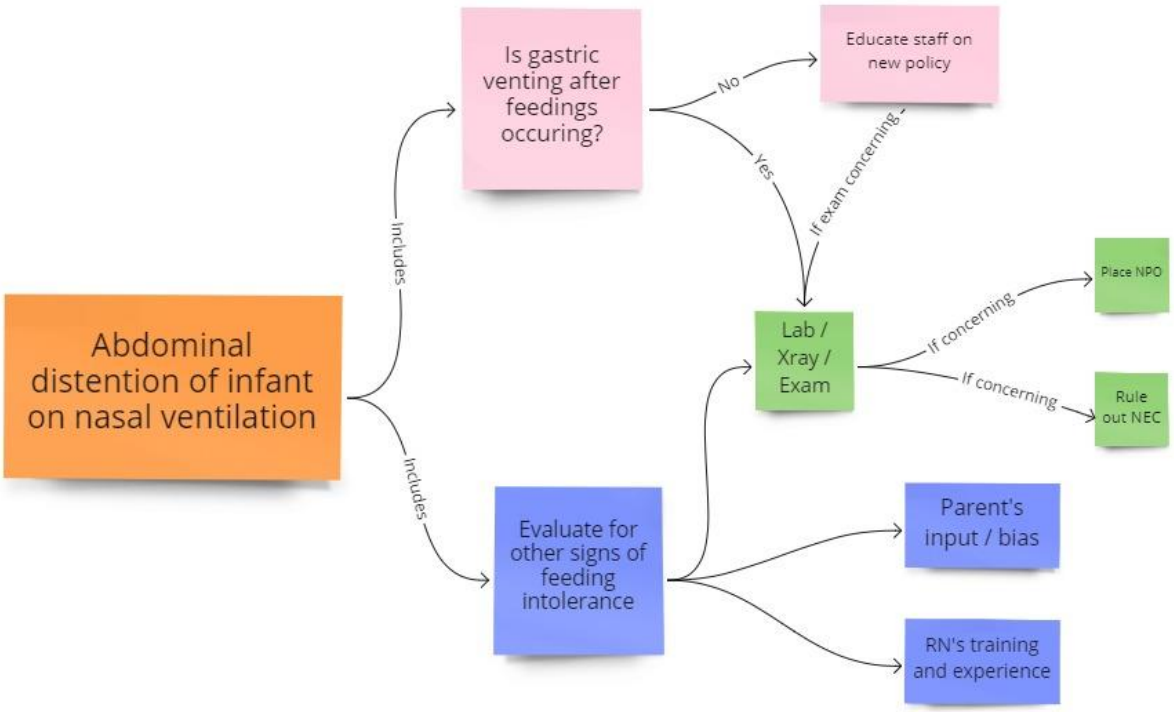
Figure 2

Box plot days from first feed to days to full feed pre and post protocol



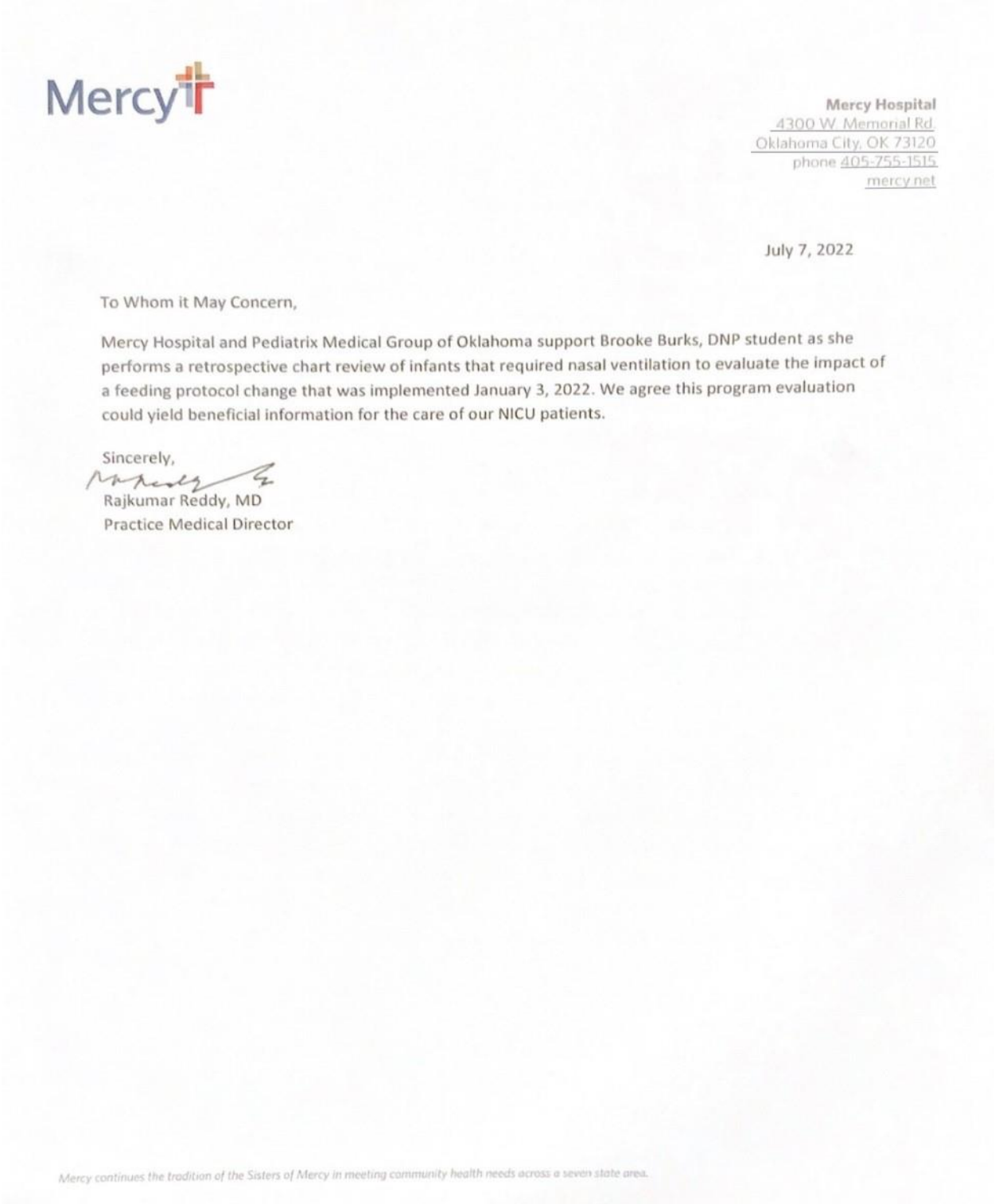
Appendix A

Theoretical Concept Map



Appendix B

Letter of Support



Mercy

Mercy Hospital
4300 W. Memorial Rd.
Oklahoma City, OK 73120
phone 405-755-1515
mercy.net

July 7, 2022

To Whom it May Concern,

Mercy Hospital and Pediatrix Medical Group of Oklahoma support Brooke Burks, DNP student as she performs a retrospective chart review of infants that required nasal ventilation to evaluate the impact of a feeding protocol change that was implemented January 3, 2022. We agree this program evaluation could yield beneficial information for the care of our NICU patients.

Sincerely,

Rajkumar Reddy, MD
Practice Medical Director

Mercy continues the tradition of the Sisters of Mercy in meeting community health needs across a seven state area.

Appendix C

Mercy IRB Approval Letter

MERCY
INSTITUTIONAL REVIEW BOARD
14528 South Outer 40, Suite 100 St. Louis, MO 63017 phone 417-520-4647

DATE:	August 8, 2022
TO:	Brooke Burks, APRN
FROM:	Mercy Institutional Review Board
Project Title:	[1947296-1] Program Evaluation of Enteral Feeding Policy for NICU Patients Receiving Nasal Ventilation
SUBMISSION TYPE:	New Project - Submission for Determination of Research
ACTION:	ACKNOWLEDGED - Determined to NOT be human subjects research
EFFECTIVE DATE:	August 8, 2022

Thank you for your submission of New Project materials for this project. The Mercy Institutional Review Board has ACKNOWLEDGED your submission.

This project has been determined to NOT be human subjects research and does not require MIRB review or approval. Access to protected health information (PHI), however, is overseen by the Mercy Privacy Department. Please contact them at MercyPrivacyConcerns@mercy.net to request information about submitting a Limited Data Set Request to use PHI for your project.

The following items are acknowledged in this submission:

- Application Form - 23-011 DOR 28Jul2022.docx (UPDATED: 08/4/2022)

If you have any questions, please contact Mercy IRB at (417) 520-4647 or MercyIRB@mercy.net. Please include your project title and reference number in all correspondence with this committee.

This letter has been electronically signed in accordance with all applicable regulations, and a copy is retained within Mercy Institutional Review Board's records.

Appendix D

The University of Alabama IRB Approval Letter

THE UNIVERSITY OF ALABAMA® | Research & Economic Development
Office for Research Compliance

September 23, 2022

To: Brooke Burks
Capstone College Nursing
The University of Alabama
Box 870358

From: Carpantato T. Myles, MSM, CIM, CIP
Director & Research Compliance Officer

Re: **Notice of Approval**

IRB Application #:	e-Protocol 22-07-5767
Project Title:	"Program Evaluation of Enteral Feeding Policy for NICU Patients Receiving Nasal Ventilation"
Submission Type:	New
Approval Date:	September 23, 2022
Expiration Date:	September 22, 2023
Funding Source:	None
Review Category:	EXEMPT
Approved Documents:	Waiver of Consent, Waiver of HIPPA Authorization

Dear Brooke Burks:

The University of Alabama Institutional Review Board has approved your proposed research . Therefore, your application has been approved according to 45 CFR part 46 *as outlined below:*

(4)Secondary research for which consent is not required: Secondary research uses of identifiable private information or identifiable biospecimens, if at least one of the following criteria is met:
able private information or identifiable biospecimens, if at least one of the following criteria is met:
(iii) The research involves only information collection and analysis involving the investigator's use of identifiable health information when that use is regulated under 45 CFR parts 160 and 164, subparts A and E, for the purposes of "health care operations" or "research" as those terms are defined at 45 CFR 164.501 or for "public health activities and purposes" as described under 45 CFR 164.512(b)

The approval for your application will lapse, as noted above. If your research will continue beyond this date, please submit the Continuing Review to the IRB as University policy requires before the lapse. Please note any modifications made in research design, methodology, or procedures must be submitted to and approved by the IRB before implementation. Please submit a final report form when the study is complete.

All the best with your research.

166 Rose Administration | Box 870127 | Tuscaloosa, AL 35487-0127 | 205-348-8461
Fax 205-348-7189 | Toll Free 1-877-820-3066 | rscompliance@research.ua.edu

Appendix E

Timeline for Program Evaluation