An Educational Intervention to Reduce Hypothermia in Preterm Infants

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Table of Contents

Abstract

Purpose The purpose of this scholarly project is to improve nurses' knowledge levels regarding methods of preventing hypothermia in preterm infants upon admission to the neonatal intensive care unit (NICU).

Design and Methods A teaching module was developed for NICU registered nurses on thermoregulation of premature infants in the NICU and preventing hypothermia on admission. A pretest was given to test the baseline knowledge of 50 NICU nurses, education was provided, and a post-test was administered six weeks later. The pre-and post-test results were compared to determine if knowledge levels improved.

Results Among nurses who participated in the educational intervention (N=50), paired t-test results indicated a significant association between the pre-and post-intervention hypothermia test scores, with participants in the post-intervention group having significantly higher mean test scores (Mean = 93.5, SD = 8.3) than participants in the pre-intervention group [(Mean = 71.5, SD = 15.1), $t(49) = 9.76$, $p < .0001$] indicating an increase in knowledge from pre- to post-intervention.

Discussion The statistically significant test scores support that a periodic educational module for nurses on hypothermia in the NICU can increase hypothermia knowledge, which may help to prevent hypothermia in preterm infants upon NICU admission.

Practice Implications This project's outcome demonstrated the efficacy of a teaching module for increasing nurses' knowledge regarding preventing hypothermia in premature infants.

Keywords: preterm, premature, low birth weight, golden hour, hypothermia

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Introduction and Background

According to the World Health Organization (WHO), globally, approximately 15 million preterm babies are born annually, with an estimated one million deaths every year due to preterm birth complications (*Preterm Birth*, 2018). Preterm birth occurs when an infant is born before 37 completed weeks of gestation, a condition that places an infant at significant risk of developing physical and neurodevelopmental disabilities and death (Centers for Disease Control and Prevention [CDC], 2021). Worldwide, prematurity is the leading cause of infant morbidity and mortality and the leading cause of death in children under five years, making it a global health problem (*Preterm Birth*, 2018). From birth, the goal for all preterm infants is to maintain normothermia through arrival to the NICU. The presence of hypothermia upon admission to the NICU is significantly associated with early neonatal death (De Siqueira Caldas et al., 2019). Neonatal hypothermia is a highly preventable condition; however, lack of caregiver knowledge regarding prevention strategies puts infants at risk of developing serious complications, such as necrotizing enterocolitis (NEC), intraventricular hemorrhage (IVH), patent ductus arteriosus (PDA), retinopathy of prematurity (ROP), and bronchopulmonary dysplasia (BPD) (De Siqueira Caldas et al., 2019; Ting et al., 2018). This project aims to improve nurses' knowledge levels regarding methods of preventing hypothermia in preterm infants admitted to the NICU (*Preterm Birth*, 2018).

The body temperature upon admission to the neonatal intensive care unit (NICU) reflects the care process for thermoregulation in the delivery room and during transport from the delivery room to NICU (Sharma, Murki, Oleti, et al., 2020). The “Golden Hour” of neonatal life is the first hour of post-natal life in both preterm and term neonates (Sharma, 2017). Due to inadequate

brown fat, subcutaneous adipose tissue, and a high surface area-to-body mass ratio, preterm infants have difficulty maintaining normothermia (Verklan et al., 2020). The World Health Organization defines hypothermia as a body temperature below 36.5℃ (97.7°F). Mild hypothermia is 36-36.5℃ (96.8-97.7°F), moderate hypothermia is 32-36℃ (89.6-96.8°F), and severe hypothermia is less than 32℃ (89.6°F) (WHO, 1997). A neonate's brain is proportionally larger and more metabolically active than an adult's, contributing between 60-80% of resting heat production. Neonates produce thermal energy from the metabolism of brown fat, known as non-shivering thermogenesis (Riviere et al., 2017).

Problem Statement

Although maintaining normothermia is crucial to an infant's survival, warming maneuvers during neonatal resuscitation and in-hospital transfer are often lacking and/or ineffective (Yu et al., 2020). As a result, nurses need education and training regarding current best practices for preventing hypothermia and maintaining normothermia in this patient population.

Objectives and Aims

The objective is to implement and evaluate the effectiveness of an educational module regarding preventing hypothermia among preterm infants. The aim is to improve hypothermia rates among premature infants from birth through admission to the NICU.

Review of the Literature

Search Strategy

The literature review search strategy included randomized control trials (RCTs), cohort studies, and quasi-experimental designs with a level of evidence of I, II, and III. A systematic search of published literature used online databases, specifically the Cumulative Index of

Nursing and Allied Health Literature and MEDLINE-Ovid, to gather pertinent evidence-based research data from peer-reviewed articles published from 2017 to 2022. MESH terms included "golden hour" and "preterm." This search resulted in 64 articles; after removing the duplicates, 55 articles remained. Forty-six articles were unrelated to hypothermia, and eight showed data comparing the golden hour to admission hypothermia (Appendix A).

A prospective, multicenter, observational cohort study was done in China to investigate mortality and morbidity in the setting of hypothermia. The study found that infants with hypothermia had high death rates. Hypothermia is associated with increased mortality and necrotizing enterocolitis (NEC), an inflammatory disease of the intestine in premature infants (Tay et al., 2018). A similar study by Yu et al. concluded that hypothermia results because of inadequate standard thermoregulation techniques in the delivery room. Both studies highlight the importance of a thermoregulation bundle to maintain a normal temperature in these infants at delivery and during transfer to NICU.

Prevention of Hypothermia

A study by Sharma et al. (2020) included the implementation of a thermoregulatory intervention to reduce admission hypothermia. The study participants ranged in birth weight from 500 to 1499 grams and included gestations >25 weeks without major congenital malformations. Interventions included using a double-layered head cap, radiant warmer, an embrace sleeping bag that can maintain a constant temperature of 98°F during transport, wraps, warm towels, and plastic bags. Radiant warmers were maintained at 100% heat output for at least 10 minutes prior to delivery. The delivery room temperature was increased to >25°C (77°F), and infants were wrapped immediately following delivery. Through these thermoregulatory interventions, the incidence of moderate hypothermia in very low birth weight (VLBW) neonates

decreased from 89.6% to 11.2% in the post-intervention period. Similar findings were demonstrated by Peleg et al., who, after initiating a comprehensive warming protocol for infants ≤ 32+6 weeks gestational age, found significant improvement in rates of normothermia upon admission to the NICU ($p < .001$). They performed simulations with NICU staff before initiating the protocol in the resuscitation room, which the study by Sharma et al. did not mention (2019). Furthermore, Harer et al. concluded that implementing a multidisciplinary guideline to improve admission temperatures was effective at decreasing hypothermia rates in preterm infants (2017).

Need for Hypothermia Education

A study by Caldas et al. (2018) focused on preventing admission hypothermia in very low birth weight infants before and after an educational program. Medical and nursing staff were provided ongoing education about preventing admission hypothermia. They found a decrease in rates of admission hypothermia and a higher mean admission temperature after the implementation of a thermoregulation protocol. The thermoregulation protocol was derived from Neonatal Resuscitation Program guidelines (Caldas et al., 2018). This study is consistent with the results of a quality improvement (QI) project by Gest (2021) in which a web-based educational activity increased nursing knowledge levels about thermoregulation techniques.

Hanna et al. (2020) conducted a study whereby a multidisciplinary team was created in the NICU, staff members were educated, and a checklist was implemented to prevent perioperative hypothermia in premature infants. The study concluded that frequent re-education and enforcement of the hypothermia checklist decreased the overall incidence of perioperative hypothermia in the NICU. A systematic review by Donnellan et al. demonstrated that having a multidisciplinary team and providing ongoing education to the staff were necessary components in regulating the admission temperatures of premature infants in the NICU (2020). This result

supports the study by Adam and Elssayed in Sudan, in which implementing a training program on neonatal hypothermia increased nurses' knowledge and practices (2022). Furthermore, numerous studies have shown that training interventions can improve learning and knowledge of thermoregulation techniques and that ongoing staff education can improve thermal management outcomes in preterm and low birth-weight infants (Purnamasari et al., 2017; Singh et al., 2022; Yip et al., 2017).

The articles in this literature review demonstrate improved admission temperature outcomes after initiation of the “Golden Hour” protocol (GHP) for preterm infants in the NICU. Four articles involved collecting data before and after a practice change (Choi et al., 2018; Harriman et al., 2018; Peleg et al., 2019; Sharma et al., 2020). All study populations were preterm infants in the first hour after birth, but there was an inter-study variance in the inclusion criteria. The gestational age inclusion criteria varied from <34 weeks gestation to 23-28 weeks gestation across the studies. All the studies statistically analyzed the quantitative data. Three of the studies were conducted as QI projects. The sample sizes ranged from 17 to 194 infants in the pre-protocol cohorts and 7 to 194 infants in the post-protocol cohorts. The other two studies measured admission temperatures and short- and long-term outcomes (Tay et al., 2019; Yu et al., 2020). Few published studies discussed outcomes following the GHP in preterm infants. Birth weight inclusion criteria were evaluated in only three of eight studies. The inclusion criteria for gestational age varied from <34 weeks to 23-28 weeks. Furthermore, the GHP in each of these studies differed. These findings suggest that implementing a GHP positively influences short-term outcomes in preterm infants, and educating staff in the NICU improves hypothermia rates among premature infants.

Evidence-based Practice: Verification of Chosen Option

Standardizing evidence-based care requires ongoing education. As evidenced by Gest (2021), a web-based educational intervention can improve nurses' knowledge levels significantly. Therefore, an educational intervention regarding hypothermia prevention for preterm infants <32 weeks gestation and /or <1500 grams was performed. Changes in knowledge levels from pre- to post-intervention were evaluated.

PICO(T)

For neonatal nurses (P), will the implementation of an educational module (I) increase the knowledge levels (C) regarding the prevention of hypothermia in premature infants (O) over a six-week period (T)?

Theoretical Framework or Evidence-based Practice Model

Theory helps to explain or predict the relationships around the phenomenon of interest. A theoretical framework helps guide and inform the project (Moran et al., 2019). The theoretical framework appropriate for this model is Kurt Lewin's middle-range change theory, developed in 1951. According to Lewin, there should be a motivation for change before change can occur and an understanding of why a change is needed. He describes implementing change in three stages: unfreezing, change, and refreezing (Tuyet & Gandolfi, 2020). Lewin's change theory is relevant to this project because an improvement in knowledge is required to keep neonates consistently warm at birth, and this begins with recognizing the need for change.

In the first stage of unfreezing, the problem is identified. According to Vermont Oxford Network (VON) analysis tool called Nightingale, nearly 4 in 10 infants are cold when admitted to the neonatal intensive care unit (NICU) (Vermont Oxford Network, 2017). Data obtained for this project was retrieved from the VON database. Historical data showed that 17.6% of neonates admitted to the St. Luke's Hospital NICU were hypothermic upon arrival in 2020. Hypothermia

rates improved to 9.3% in 2021 after an initiative to maintain a delivery room temperature between 74-77°F. Despite this initiative, 8.3% of infants continued to experience hypothermia. This observation shows that despite attempts to improve the problem, the existing process requires improvement. Nursing education should provide evidence that supports why a change is necessary.

The second stage identifies where change is needed and outlines what must change. This step consists of brainstorming, planning, and implementation. Change should be viewed as a process. Changes include increasing the delivery room temperature, ensuring that the radiant warmer is set to provide 100% heater output prior to the delivery, and utilizing prewarmed blankets when receiving the newborn infant. Additional changes include placing a thermal mattress on the resuscitation bed and covering the infant in a Neowrap™ (or any other medical-grade polyethylene occlusive wrap), plastic cap, and prewarmed hat. The infant's temperature is measured at three points: immediately after birth, immediately prior to departing from the delivery room, and upon admission to the NICU. Measuring at various points provides useful information about how and when infants lose body heat.

The final stage is refreezing the change when achieving the desired outcome, such as celebrating success, re-training, and monitoring key performance indicators (KPIs). The neonatal staff must consistently follow the newly established guidelines and feel confident and comfortable in this stage. Changes must be consistent to continually improve outcomes. There should be open communication between the education department and nursing staff to ensure that the staff feels empowered to provide feedback throughout the practice change. After completion, the results will be shared with hospital administration and the nursing research

committee. Successful results will be celebrated, helping staff believe that future practice changes will be successful.

Outcome and Lewin's Theory of Change

The primary outcome of adopting structured thermal care guidelines in the NICU is to consistently achieve normothermia on admission. The literature review conducted on this topic supports an adverse relationship between admission temperatures and major neonatal morbidities. Early and effective interventions are essential in the delivery room to avoid hypothermia. Thermoregulation outcomes improve when a systematic strategy is implemented (Wilson et al., 2018). The factors most likely associated with hypothermia are delivery room temperatures, inconsistent use of supplemental methods of thermoregulation, and lack of temperature monitoring in the delivery room. Using Lewin's theory of change, the three steps of unfreezing, changing, and refreezing can provide a framework to identify and implement a change in practice. The neonatal staff have varying knowledge levels regarding evidence-based care and require education about factors contributing to hypothermia.

Project and Study Design

The study was a non-randomized pre-/post-test study with an educational module. Following enrollment, the participants were asked to complete a pretest. The pretest included 20 questions meant to ascertain information about baseline knowledge regarding infant thermoregulation prior to engaging with the educational module. The educational module consisted of a pre-recorded PowerPoint presentation with a voice-over explanation of the material. Immediately after completing the pretest, participants were encouraged to complete the educational module. Participants were advised to complete a post-test six weeks after reviewing the module.

Project Site and Population

The study was done in a level III neonatal intensive care unit (NICU) in an urban hospital in Pennsylvania. The NICU is a 26-bed specialty unit with approximately 12-18 admissions per month. Eligible participants included 50 licensed registered nurses currently employed in the NICU. All eligible nurses were recruited for the project. Immediately following the University of Alabama Institutional Review Board approval, nurses were invited to participate in this project via email. A compilation of email addresses from the project facility was used to recruit and inform participants of the project.

Measurement Instruments

Demographic information was collected from each participant, including gender, age, ethnicity, educational level, employment status, years of nursing experience, and shift(s) worked (day and/or night). The pre and post-tests consisted of the same 20 multiple-choice questions. (Appendix D).

Methods and Data Collection

The project commenced with the distribution of a recruitment email containing instructions, access information, and a secure link to an online Qualtrics pre-interventions survey. The email was distributed via the facility's internal and secure Outlook email server. The survey was distributed using Qualtrics, and the data was secured in a password-protected account. At the end of the pretest, the participants received instructions on accessing the educational module. All eligible participants received a reminder email encouraging them to complete the educational module, which was available for six weeks. Participants received an email containing instructions about how to complete the post-test survey six weeks after viewing

the educational module. Participants were invited to complete surveys and view educational materials during non-busy times while working in the NICU.

Cost-Benefit Analysis/Budget

The Project did not incur any costs. As a DNP student, the PI had access to Qualtrics and UA Box.

Timeline

The total timeline for this project was 12 weeks from the project's initiation to the dissemination of the findings. Participant recruitment took place for four weeks. Participants were informed of the following time requirements for participation: 30 minutes for completion of the demographic survey and pretest; 60 minutes for completion of the educational module; and 20 minutes for completion of the post-test. During a rolling enrollment period of 10 weeks, participants completed the pretest, educational module, and post-test. Participation lasted six weeks per individual. Two weeks were dedicated to collecting and analyzing data, interpreting outcomes, and disseminating findings.

Ethical Considerations/Protection of Human Subjects

The project was reviewed and approved by the University of Alabama Institutional Review Board and the St. Luke's University Health Network Review Board prior to implementation. An explanation of consent was attached to the introductory email sent to all potential participants (Appendix B). An individual’s consent was implied through the completion of the pretest survey. At the beginning of the demographic survey, participants were asked to create a unique identifier code. Instructions for creating this code were provided, along with an example. Participants were instructed to include their unique codes on all completed surveys/tests. The educational activity was administered using a secure hospital server. All data

were collected via UA Qualtrics and stored in a secure, password-protected UA Box drive accessible by the PI and the faculty advisor. Prior to consenting to participation, participants received written notification of the following:

1. Participation is voluntary.
2. Participants may withdraw from participation at any time.
3. Participants shall receive no monetary or other compensation for participating.
4. Neither participation nor non-participation shall impact the individual's employment, professional, or social status within the NICU or the institution.
5. There are no risks related to participation or non-participation.

Data Analysis

Descriptive statistics were used to describe the pre-and post-test data, including mean, frequency, and standard deviation (SD). The significance of the difference between the pretest and post-test knowledge scores was calculated using a paired t-test. Statistical significance was set at a *p*-value of 0.05 or less. Participants consisted of all female nurses who were mostly 31 to 35 years of age (32%) or 36 years and older (32%). Most participants were white (92%), possessed a Bachelor of Science in Nursing (BSN) degree (62%), were employed full-time (88%), and worked day shift (52.1%). Regarding RN experience, 36% of participants possessed eight or more years of overall nursing experience, and 54% of participants reported having less than one year of non-NICU nursing experience.

Among nurses who participated in the educational intervention (N=50), paired t-test results indicated a significant association between pre-and post-intervention knowledge scores, with higher post-intervention mean scores (Mean = 93.5, SD = 8.3) than pre-intervention (Mean

= 71.5, SD = 15.1), t (49) = 9.76, p <.0001 (See Table 2). Statistical analyses were completed using JMP Pro 15, with p-values ≤ .05, which is statistically significant.

Interpretation/Discussion

The current study's findings demonstrate that the educational module was effective and significantly increased nurses' knowledge of neonatal hypothermia prevention measures. Knowledge regarding neonatal hypothermia improved from 71.5% pre-intervention to 93.5% post-intervention with a p-value of <0.001 (see Table 2). The PI found that implementing an educational module increased the knowledge scores of participants regarding hypothermia prevention in preterm infants on admission to the NICU.

Limitations

One limitation of this project is that it did not track and compare the baseline temperature data from preterm infants to the post-education data to monitor for sustained improvement. This information would be useful to gauge the need for re-education. Another limiting factor was the restricted availability of the educational module, which was accessible only through the institution's data drive, thereby limiting participants to viewing the material from the hospital campus only. The limited ability to view the material during working hours only may have negatively impacted their learning. The study was limited to only female participants. The findings are similar to another study in Sudan, in which all participants (NICU nurses) were female (Adam & Bassyonie Elssayed, 2022). Another potentially limiting factor is the study's sample size. Our study included 50 participants, a sample much smaller than that of a study by Gest, which included 121 RNs (2021).

This study did not incorporate a variety of learning methods. A pre-recorded PowerPoint presentation with a voice-over explanation of the material was provided, unlike the study by

Liaqat et al., who evaluated how nursing students learned neonatal resuscitation through "Learn, See, Practice, Prove, Do, Maintain Pedagogy" (LSPPDM) (2021). Liaqat et al. found higher levels of knowledge acquisition among those who learned via LSPPDM as compared to traditional learning methods (2021). The current study limited the practice scope of participants to NICU nurses only. However, the NICU delivery team is comprised of neonatologists, neonatal nurse practitioners, respiratory therapists, NICU nurses, operating room nurses, and nursery nurses. Lastly, the timeline for this study was limited to six weeks. Hence, the post-test was given relatively soon after participants reviewed the educational module, possibly limiting the retention effect of the intervention over time.

Recommendations

An educational module is valuable for orientation, training, and on-demand reference for neonatal staff. This project focused on hypothermia. Future projects can be done for other topics of interest in the NICU. Analyses of long-term outcomes in additional studies would provide greater insight into preventing long-term morbidities using the GHP. A future recommendation includes hypothermia education for the entire delivery team since nurses are not the only providers who attend and impact the incidence of hypothermia after delivery and on admission to the NICU.

Conclusion

While this project demonstrated improvement in knowledge levels after six weeks, there is still a need for ongoing staff education to reduce the incidence of admission hypothermia after delivery and improve morbidity and mortality in infants. Delivery room management must emphasize pre-delivery preparedness and post-resuscitation efforts to maintain normothermia.

Standardizing delivery room management to improve thermoregulation can be achieved by promoting teamwork.

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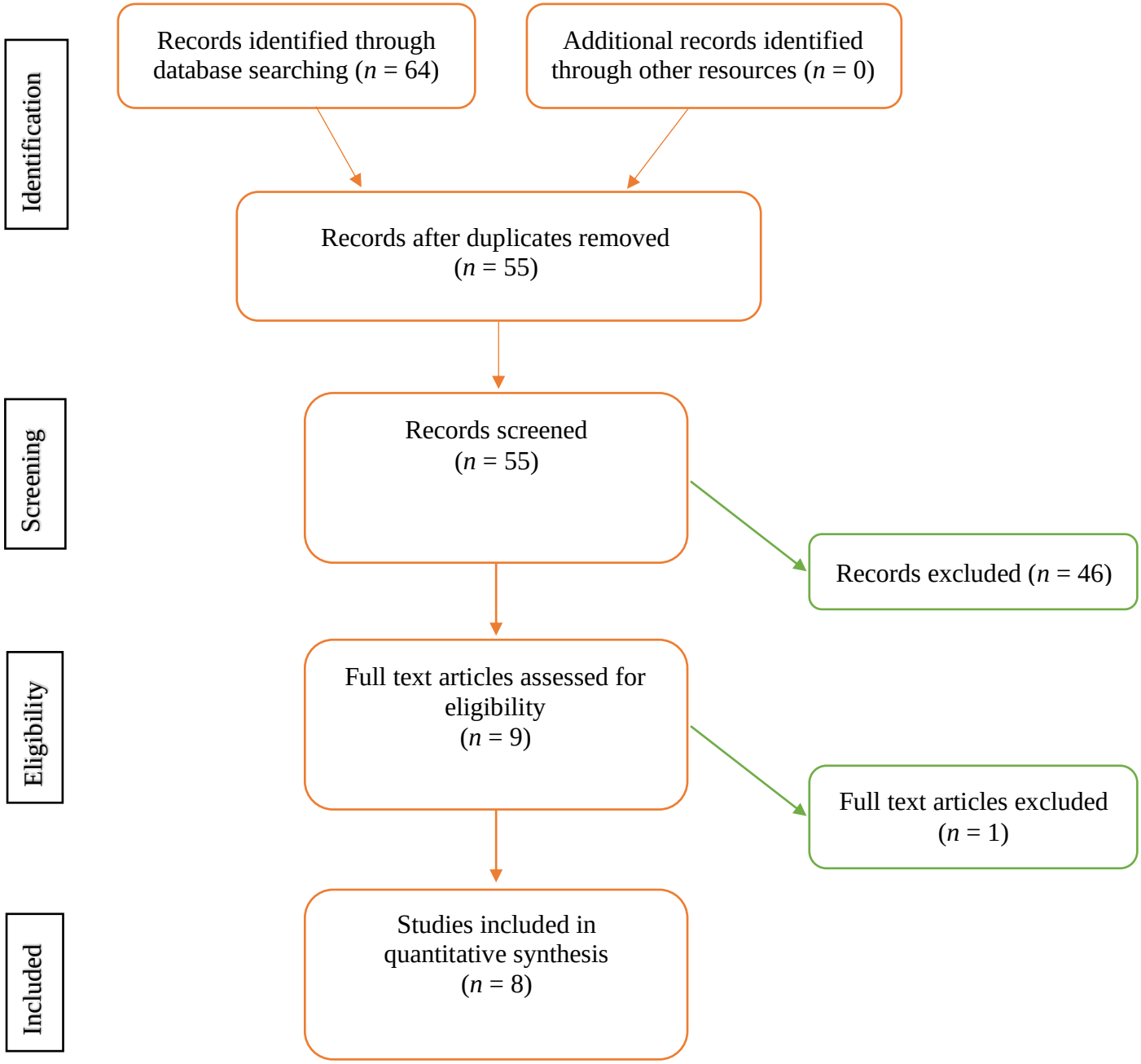
Appendix A

PRISMA Flow Diagram

A systematic review to evaluate if implementing an educational module would reduce hypothermia on infants' admission ≤ 32 weeks gestation.



Adapted from Moher, Liberati, Tetzlaff, & Altman, The PRISMA Group (2009).

Appendix B

Participant Demographic Survey

Dear Participants,

I am preparing an education module as a part of my DNP project. My project aims to determine if an educational module will improve nurses' knowledge on preventing hypothermia in preterm infants. Your participation is both voluntary and anonymous. Your responses will be used only for this project. If you choose not to participate in the project, you are allowed to do so. However, once you have submitted a survey, we cannot remove your responses from the data as it is anonymous, so we will not know which responses you provided.

Sincerely,

Suzanne Bijou, DNP student

Appendix C

Participant Demographic Survey

Your participation is voluntary and anonymous

Participant Enrollment Number:_____ Date Completed: _____

Gender: Female ☐ Male ☐ Other ☐

Age: 20-25 years ☐ 26-30 years 31-35 years ☐ 36 and older ☐

Ethnicity: White ☐ African American ☐ Hispanic ☐ Asian ☐ Wish not to answer ☐

Education Level: Associates ☐ Bachelors ☐ Masters ☐ Doctorate ☐ Other ☐

Employment Status: Full-time ☐ Part-time ☐ Per-diem ☐

Length of time working as a registered nurse:

< 1 year ☐ 1-2 years ☐ 2-4 years ☐ 4-6 years ☐ 6-8 years ☐ 8+ years ☐

Length of time working in the NICU:

< 1 year ☐ 1-2 years ☐ 2-4 years ☐ 4-6 years ☐ 6-8 years ☐ 8+ years ☐

Length of time worked as an RN in other departments: years ☐ months ☐

Location _____ Role _____

The current shift worked: Day ☐ Night ☐

For office use only:

☐ Completed Pretest _____
☐ Reviewed education module _____
☐ Completed Post-test _____

Appendix D

Structured Questionnaire (Pre-Test/Post-Pest)

Instructions:

Kindly answer all the questions

Your responses will be kept confidential and will be used for research purposes only

Every question has four alternative responses. Choose the best answer among the option provided.

Questions

1. The purpose of the neutral thermal environment is to
    a. Prevent overheating a baby
    b. Individualize an infant's care
    c. Minimize the oxygen and calories infants needs
    d. Increase a baby's metabolic rate
2. Preterm infants are challenged in maintaining effective heat production by nonshivering thermogenesis (NST) for many reasons, the most important being:
    a. Minimal subcutaneous fat
    b. Immature glucose metabolism
    c. Minimal brown adipose tissue
    d. Immature thermal receptor communication with the hypothalamus
3. An axillary temperature of 35.8°C (96.4°F) in a preterm newborn represents
    a. Severe Hypothermia
    b. Normal body temperature

c. Hyperthermia

d. Moderate hypothermia

4. Preterm infants lose heat by all of the following mechanisms EXCEPT?

   a. Convection

   b. Radiation

   c. Evaporation

   d. Translocation

5. A preterm infant is placed on the glass weighing scale for weight and length measurement in the delivery room. The infant is at risk for heat loss by which of the following mechanisms?

   a. Conduction

   b. Convection

   c. Radiation

   d. Evaporation

6. Evaporative heat loss can be controlled by using

   a. Non-humidified oxygen

   b. Humidified oxygen

   c. Nasal cannula

   d. Oxygen masks

7. Preterm neonates are prone to hypothermia due to

   a. Large surface area

   b. Decreased thermal insulation due to lack of subcutaneous fat

   c. Reduced amount of brown fat

d. All of the above

8. All the methods can be used for rewarming the baby except
    a. Radiant warmer
    b. Placing in an incubator
    c. Over a cloth placed on a hot water bottle
    d. Skin-to-skin contact with the mother
9. The function of brown fat is to:
    a. Generate heat when it is metabolized
    b. Provide a rapidly available source of glucose in the first day of life
    c. Provide an insulating layer of fat in the first month of life
    d. Protects newborns from injury during the birth process
10. Factors that affect insensible water loss include all EXCEPT
    a. Use of ambient humidity
    b. Use of a radiant warmer
    c. Use of phototherapy
    d. Lower gestational age
11. Which one of the following is true of thermoregulation in the neonate?
    a. Preterm infants have little subcutaneous fat but can autoregulate their temperature well using thermogenesis from brown fat.
    b. The normal newborn baby has a core temperature of 36-36.5 ℃
    c. Shivering is an effective treatment for hypoxic-ischemic brain injury
    d. Infants should be placed in a thermoneutral environment to promote energy conservation and growth

12. You are preparing for a delivery of a 25-week gestation infant. In addition to the equipment the nurse usually prepares, which of the following will the nurse include to prevent or reduce hypothermia, specifically in the ELBW?
    a. Knit hat
    b. Heat lamps
    c. Polyethylene wrapping (Neowrap)
    d. Preheated radiant warmer
13. Which of the following statements is true?
    a. Using polyethylene occlusive wraps for extremely preterm infants can help maintain body temperature.
    b. Preterm infants lose a significant amount of heat from their heads,
    c. A warm environment in the delivery room can help maintain body temperature in preterm infants.
    d. All of the above
14. Warming an infant is effective when the
    a. The infant is placed in a warm bath
    b. The infant is first placed in a heat-gaining environment to prevent further heat loss
    c. An infant's skin temperature is a minimum of 2°C warmer than the rectal temperature
    d. The infant is placed in an environment where the air temperature is 2°C warmer than the infant's temperature
15. A preterm neonate's head is covered in the delivery room with plastic-lined hats because
    a. Hats prevent heat loss from convection
    b. The neonate's head is the largest body surface area for heat loss

c. Hats are effective with radiant warmers and incubators to prevent loss of heat

d. Protection of the head from cold reduces the need for blood shunted to the brain

16. The infant at the highest risk of hypothermia is a

a. 40-week term infant with respiratory distress

b. A 32-week preterm infant that is small for gestational age (SGA) and hypoglycemic

c. A 37-week infant with neonatal abstinence syndrome

d. A 38-week infant with hyperbilirubinemia

17. Problems associated with hypothermia in newborns include

a. Hypoglycemia, hypoxia, increased activity

b. Lethargy, hypoglycemia, metabolic alkalosis

c. Hypoglycemia, bradycardia, metabolic acidosis

d. Hypoxia, increased activity, metabolic alkalosis

18. To help maintain a neutral thermal environment at the birth of a 29-week gestation infant, the nurse would

a. Avoid excessive handling

b. Bathe the infant immediately after birth

c. Weigh the infant immediately on a scale

d. Heat the delivery room to 82 degrees Fahrenheit

19. Very low birth weight (VLBW) infants should be placed in which type of NICU incubator?

a. Humidified, single-walled

b. Dry, single-walled

c. Humidified double-walled

d. Dry, double-walled

20. In VLBW infants, cold stress can be associated with

a. Respiratory acidosis

b. Metabolic alkalosis

c. Hyperglycemia

d. Hypoglycemia

Table 1. Summary statistics of nursing cohort

Characteristic	N = 50[1]
Age (years)	
20-25	11.0 (22.0)
26-30	7.0 (14.0)
31-35	16.0 (32.0)
36 and older	16.0 (32.0)
Gender	
Female	50 (100.0)
Ethnicity	
African American	2.0 (4.0)
Hispanic	1.0 (2.0)
White	46.0 (92.0)
WNA	1.0 (2.0)
Education	
Associate	10.0 (20.0)
BSN	31.0 (62.0)
Masters	2.0 (4.0)
MSN	1.0 (2.0)
Other	6.0 (12.0)
Employment (Full/Part-time/Per-diem)	
FT	44.0 (88.0)
PT	6.0 (12.0)

RN Experience	
<1 year	7.0 (14.0)
1-2 years	8.0 (16.0)
2-4 years	3.0 (6.0)
4-6 years	5.0 (10.0)
6-8 years	9.0 (18.0)
8 or more years	18.0 (36.0)
NICU Experience (years/months)	
<1 year	7.0 (14.0)
1-2 years	8.0 (16.0)
2-4 years	7.0 (14.0)
4-6 years	9.0 (18.0)
6-8 years	3.0 (6.0)
8+ years	16.0 (32.0)
RN Experience (other)	
<1 year	27.0 (54.0)
1-3 years	13.0 (26.0)
4-6 years	6.0 (12.0)
7+ years	4.0 (8.0)
The shift worked (day/night)	
Day	25.0 (52.1)
Night	23.0 (47.9)

[1]n (%). WNA = Wish Not to Answer, FT= Full Time, PT = Part Time.

Table 2. Hypothermia test scores pre- and post-educational intervention, N = 50

	Pre-Intervention	Post-Intervention	p-value
Mean (SD)	71.5 (15.1)	93.5 (8.3)	p<.0001

P-value from paired t-test.