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Reducing the Risk of Hypothermia in Neonatal Infants

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Clinical Leadership Theme

This project focuses on the CNL curriculum element of *Clinical Outcomes Management.* The CNL role function is Systems Analyst/Risk Anticipator, in that current systems are being critically evaluated, and risks to patient safety assessed to improve quality of client care delivery. The roles of Educator and Team Manager are also critical to this process as the improvement initiative requires staff teaching and interdisciplinary and interdepartmental coordination. A competently-trained leader is required to seamlessly manage the efforts of front-line clinical staff in order to reach patient safety goals.

Statement of the Problem

Neonates are prone to rapid heat loss and consequent hypothermia because of their high surface area to volume ratio, which is even higher in low-birth-weight neonates. Persistent hypothermia can result in hypoglycemia and metabolic acidosis and increases the risk of late-onset sepsis and mortality (Gibson and Nawab, 2015). According to Manani, Jegatheesan, DeSandre, Song, Showalter, and Govindaswami in their 2013 study, temperature instability in preterm infants is a serious condition that is associated with significant risks as well as mortality, but that is also potentially preventable (Manani, et. al., 2013, Abstract). Although the NICU team of our medical center has met with initial success in its hypothermia efforts, nursing turnover and a transient team of temporary staff members threaten to weaken the impact of previous training. A coordinated effort of education and culture change is necessary to sustain the positive outcomes achieved. This initiative aims to sustain reduced rates of neonatal hypothermia (defined as an axial temperature of < 36.5 degrees Celsius) achieved in very low birthweight (VLBW) infants at one hour of life and at 24 hours of life, and to build on previous success in order to reach a neonatal hypothermia rate of less than 5% by December 2017.

Project Overview

Core temperatures of less than 36 degrees Celsius are associated with numerous complications including increased risk of infection, coagulation defects, metabolic acidosis, hypoglycemia, and respiratory distress (Leadford, Warren, Manasyan, Chomba, Salas, Schelonka, and Carlo, 2013). This widely-known, medically proven testament is the basis for the quality improvement initiative that my team and I are proposing for implementation in the NICU. According to an Institute for Healthcare Improvement White Paper, using a bundle of evidence-based interventions to address a need for a particular patient population and care setting produces superior outcomes as opposed to implementing individual measures (Resar, Griffin, Haraden, and Nolan, 2012). It was therefore determined that a coordinated bundle of innovative measures based on evidence based practice must be put in place to address this serious threat to the well-being of our patients. The project aim is to sustain the success of hypothermia reduction at one hour of life in the target population of preterm neonates weighing less than 1500 grams with a gestational age less than 32 weeks by reducing the current rate of 9.5% to < 5% through the consistent use of a specific bundle of interventions applied in the labor and delivery setting by December 2017. In the future, the project aims to educate all NICU, labor and delivery, and postpartum nurses on the importance of neonatal hypothermia prevention, and the steps that need to be taken to in order to reduce the NICU admission rate of high risk infants due to hypothermia.

Literature Review

The articles included in this review describe unique thermoregulation challenges facing preterm infants, and recommendations to address these issues in order to avoid escalated morbidities that could result in complication and potential mortality. A search of the CINAHL database was conducted using the PICO strategy, with key words *preterm, infant, late preterm, hypothermia*, and *prevention.* Six articles were selected with dates ranging from 2008 to 2016. All were timely and appropriate, and were selected for this literature review.

A significant body of literature supports that elevated temperatures in the operating room can prevent hypothermia in preterm infants immediately after birth. Jia, Lin, Lv, Li, Green, and Lin (2013) conducted a prospective randomized controlled trial in order to determine whether increasing operating room temperatures to a range between 24 to 26 degrees Celsius (75.2 to 78.8 degrees Fahrenheit), which is the range recommended by the World Health Organization, would result in increased admissions temperatures in infants less than 32 weeks' gestational age. Kent and Williams (2008) included the variable of operating room temperature in their study of NICU admission temperatures of preterm, low birthweight infants as well. Both studies concluded that increasing ambient temperature contributed to improved core temperatures in these fragile infants. Using the Johns Hopkins Nursing Research Evidence Appraisal Tool, the study design by Jia, et. al. is rated as a Level II with a quality rating of B, while the Kent and Williams study is rated as a Level III in terms of study design, with a quality rating of B (Newhouse, et. al., 2005).

There is strong evidence to support the use of a bundle of interventions in hypothermia prevention, as opposed to individual changes being made. Trevisanuto et. al. (2010) performed a prospective randomized controlled study in which they found that a combination of conventional drying, use of a polyethylene-lined hat, and a polyethylene occlusive wrapping proved successful in preventing heat loss after delivery. McCarthy et. al. (2013) found that using a combination of an exothermic mattress to protect against conductive heat loss, and a polyethylene bag to prevent hypothermia through evaporation and convection, contributed to a reduction in low infant core temperatures on admission to the NICU. They warned however that careful monitoring of the infant was necessary in order to prevent hyperthermia, which can also have dangerous implications to neonates, especially those who are born preterm. Kent and Williams (2008) also championed the use of a bundle of multiple interventions in their retrospective analysis of data in which NICU admission temperatures of preterm infants were measured, while the ambient temperatures of the operating room and polyethylene wraps were independent variables. The study concluded that by increasing the operating room temperature, as well as wrapping the infant in polyethylene in order to reduce heat loss by evaporation and convection, NICU admission temperatures were increased. The study proved that these specific interventions could successfully combat neonatal hypothermia, and added that a multidisciplinary education program can be an effective component in an overall program to improve outcomes in clinical practice. In rating strength of evidence of these additional studies, McCarthy, et. al. (2013) rate as a Level III in terms of study design, with a quality rating of B; Trevisanuto, et. al. (2010) rate as a Level II in terms of study design, with a quality rating of B (Newhouse, et. al., 2005).

As we look ahead to improving care for an increased neonatal patient population that includes late pre-term infants, a literature search was initiated with this broader focus in mind. The unique physiological requirements of infants who are born within late preterm parameters of 35 to 37 weeks' gestational age require attention, as this demographic is often overlooked due to physical attributes that resemble term neonates. Cooper, et. al. (2012) concluded that this patient population remains at significant risk for multiple health risks for the first 48 hours of life, including hypothermia, hypoglycemia, hyperbilirubinemia, sepsis, respiratory distress, and feeding difficulties. In terms of hypothermia specifically, they determined that nurses may be able to address this increased risk through early identification, and with simple, inexpensive interventions such as supporting early skin-to-skin care and avoiding early bathing. This study design is rated as a Level III with a quality rating of B (Newhouse, et. al., 2005).

A retrospective cross-sectional study by Bulut, et. al. (2016) focuses on communication between the obstetrician and neonatologist when determining best outcomes for both mother and infant in a late preterm pregnancy. They advocate for caution in the care of late preterm infants, warn against care in a low-risk setting, and of discharging baby from the hospital too soon. They also strongly support attentive follow-up post-discharge. Their study concluded that 17.5% of late preterm infants were admitted to the NICU due to short-term medical complications such as hypothermia, respiratory distress, hypoglycemia, and sepsis, compared to only 6.5% of term infants. This points to the fact that late preterm infants have a higher risk for morbidity and mortality than term infants, and therefore require close monitoring and specialized care. This study design is rated as a Level III with a quality rating of B (Newhouse, et. al., 2005).

Rationale

Multiple studies support that, by preventing hypothermia, the infant is at significantly lower risk for the harmful sequelae of this condition. What may not be as evident initially is the financial significance in terms of cost avoidance that this project will have on the medical center. Kornhauser and Schneiderman state, "…the cost of an average NICU admission [is] similar to that of patients admitted for spinal cord injury and heart valve disorders" (2010). The finance team of the medical center has placed the daily average for care in the NICU at $3,000. With average length of stay ranging from two to four days for rule-out sepsis diagnoses, to upwards of twenty to forty days for prematurity, it is apparent that an intervention having the ability to impact admission and length of stay in this unit is worthy of consideration (see Table 3 for estimated costs of NICU admission and hospitalization).

The proposed neonatal hypothermia prevention initiative has its foundation in evidence based practice. A pilot study of a bundle of interventions aimed at the specific patient population of very low birthweight, premature infants was implemented in our NICU in 2016. This pilot program met with great success, and a reduction of hypothermia rates by nearly 50% over the previous year (see Figure 1 for data based on the California Perinatal Quality Care Collaborative, 2017). The aim of this current initiative is to sustain the success of the pilot program by adding improvement measures, and by revisiting and increasing education efforts. This will decrease drift in practice by existing nursing staff, while also including new and temporary staff in the initiative, ultimately increasing the clinical and financial impact of the project.

An analysis of the strengths, weaknesses, opportunities, and threats (SWOT) reveals an environment in which a quality improvement project will succeed (see Figure 5). The strengths that can be used to maximize this improvement plan include a strong commitment among all team members to optimize the level of care provided to our patients on delivery. This commitment can be utilized in ensuring that training and educational programs will not only be completed, but will also be incorporated into the workflow and culture of the unit. Weaknesses center around a more-recently transient nursing staff, a result of recent retirements and resignations. This has caused inconsistency in awareness and training regarding hypothermia prevention goals and interventions. The opportunity is ripe for a cohesive effort to retrain those who may not have been included in the initial roll-out of hypothermia prevention strategies.

Potential obstacles to our success could include a lack of commitment to neonatal hypothermia goals by Labor and Delivery physicians, in deference to their own priorities of reduced site infection rates, or comfort levels in the operating and delivery rooms. Staff nurses only temporarily part of our team could negatively impact success through inconsistent levels of understanding and/or commitment as well. These weaknesses in the system can be overcome with a comprehensive and thorough training and education plan, while focusing all of our combined efforts on what is best for our patients: both mother and baby.

Finally, external threats that could compromise the neonatal hypothermia prevention initiative include a political climate in which the future of accessible healthcare is not secure. Limitations placed on the existing Affordable Care Act could impact the ability of current health plan members to afford insurance coverage through this facility, thereby potentially decreasing the quality of their prenatal, delivery, and postpartum care. Such a change could also have a negative financial impact on the healthcare organization, affecting the availability of nursing resources for elevated levels of patient education and potentially resulting in missed opportunities for identifying infants in need of increased interventions. It is critical for Clinical Nurse Leaders to remain active as patient advocates in the political arena, urging government representatives to fight for the preservation of health care as a basic human right. By making the strong voices of nurses known, a significant impact to our elected officials' action can be made.

The Clinical Nurse Leader is in a unique position to positively contribute to this quality improvement initiative in a variety of roles. Working as a patient advocate and educator, the CNL is able to mobilize the interdisciplinary team to work towards improved patient outcomes, and to inform families on the optimal care of their infant, keeping them involved in the care plan. As a member of the nursing profession, the CNL can work towards positive change in health care practice as the demographic of our newborn population evolves towards one including a greater number of preterm infants. Seeking out and sharing new knowledge that incorporates evidence based practice demonstrates the traits of a lifelong learner as well. Finally, the skills of a risk anticipator and team manager are needed in order to ensure that the unique needs of the late preterm infant population are understood and addressed in a timely manner, and that appropriate interventions are effectively communicated to and carried out by the members of the interdisciplinary team.

Methodology:

In order to solidify this data in our clinical site, a root cause analysis has been conducted (see Figure 6 for fishbone diagram), and will be expanded on with the following data collection strategy: Chart audits of patients in the target population, noting temperatures taken within the first hour of life, and in 4-hour intervals for the first 24 hours; data collection sheets will be completed and collected for these infants so that patterns can be collected and recorded (see Figures 8.1 and 8.2). This project has three distinct segments:

- Renewal of nursing education efforts to assure clear understanding of the risks of hypothermia in high risk infants among all NICU nursing staff.
- Reinforcement of the bundle of interventions utilized successfully throughout the past year, ensuring that effective hypothermia prevention in the target population is sustained, and that goals are met.
- Added hypothermia prevention interventions: During delayed cord-clamping, utilizing polyethylene wraps or sterile drapes; if the infant is stable enough, the promotion of skin-to-skin contact in the delivery room will also be encouraged before transport to the NICU.

Axillary temperature will be taken by the admitting nurse within one hour of admission to the NICU, with follow-up at three or four-hour intervals, depending on unit protocol and the patient’s condition, for a period of 24 hours. The temperature will be recorded on data sheets specifically designed for this project, as well as being charted in Health Connect. The data sheet will also reflect which of the following interventions were used during the delivery.

Data Definitions:

Data Element:	**Definition:**
Ambient temperature of the OR and the sub-sterile space of the operating suite	Temperature set at 72 degrees F in the OR, and at 74 degrees F in the sub-sterile space.
Resuscitation bed temperature	Equipment turned up to 100% heat capacity.
Polyethylene wrap used to cover baby during delayed cord clamping	Polyethylene wrap to cover infant to prevent heat loss due to evaporation and convection.
Heated mattress pad	"Porta Warmer" activated and used with warmed blankets on resuscitation bed and during transport to prevent heat loss due to conduction.
Neo Wrap	Polyethylene wrap used to cover baby, along with warmed blankets during resuscitation activities.
Polyethylene cap	Polyethylene cap used to cover baby's head immediately after delivery, instead of using a traditional cloth cap.
Giraffe Shuttle	Use of heated giraffe incubator with shuttle attachment to transport baby from OR suite to the ICN if needed.
Skin-to-Skin Contact (if indicated)	Indicate time initiated, length of time spent.
Staff Compliance	Are staff members educated/trained on required components of the change process, and compliant in their documentation?
Additional Interventions or Influencing Factors	Opportunity for admitting RN to explain any extraneous factors that may have had an influence on baby's temperature.

It is critical to carefully monitor and document these practices and individual case outcomes on forms provided (see Appendix L for sample data collection sheets used), as well as in Health Connect, to ensure uniformity of data. There will be no comparison or control group to these interventions; past cases will be the reference point. The anticipated outcome is a rate of < 5% neonatal hypothermia in the high risk infant population in the NICU by December 2017.

The project will begin with an educational overview presented to the NICU nursing staff, focusing on newly hired and travel nurses, including verbal and written learning tools (see Figure 8.3). Overview and monitoring of initiatives presented will be provided by nurse champions.

Timeline:

The original neonatal hypothermia prevention project began in January of 2016, and is ongoing as we continue to evaluate the most effective interventions targeting NICU admission temperatures in very low birth weight infants. The additional focus on re-education began in late June 2017, with anticipated preliminary evaluation of results in late July 2017. Although this is a fairly short time frame, I anticipate the ability to determine early conclusions on the project's affect on patient outcomes by this point in time (see Figure 2 for more detailed information).

Expected Results

In preterm infants, the challenges in preventing hypothermia begin in the operating room, where a cascade of morbidities can begin if caregivers are not alert to its prevention. The use of a bundle of interventions has proven successful in past trials, and can continue to result in improved outcomes if all team members are properly educated on the rationale behind and execution of its components. With interdisciplinary collaboration, well-designed quality improvement initiatives, and continuous education sustaining change, hypothermia prevention in high risk neonates can be achieved. Avoiding moderate hypothermia is possible and should be the focus of all providers caring for newborns (Fanaroff & Fanaroff, 2016). Introducing this concept to new staff members, and reinforcing education among those who have been a part of the care team for longer time periods, I have confidence that this quality improvement initiative will have a positive impact on the health of our high risk infant population, which in turn will contribute to the overall health of our organization and its staff.

Nursing Relevance

Improving the care provided for all of our preterm infants, regardless of gestational age, will have far-reaching implications for the nurses in our institution, and for the nursing profession in general. Neonatal nurses take especially great pride in the ability to care for this fragile patient population; having the tools to address a risk factor so prevalent in preterm neonates which causes such significant morbidities, yet is completely preventable will empower nurses to excel in the care that they provide, not only in this specific area, but in their general practice as well. Excellence in nursing care is a key element contributing to the Institute for Healthcare Improvement's (IHI's) Quadruple Aim. Following health of the population, improving patient experience, and reducing costs, the final aim, care team satisfaction, is critically important in achieving success in the healthcare arena. "The positive engagement, rather than the negative frustration, of the health care workforce is of paramount importance in achieving the primary goal of the Triple Aim—improving population health" (Bodenheimer & Sinsky, 2014). We hope to achieve this by working with the interdisciplinary care team to create clear, standardized workflows, providing complete education, ensuring access to appropriate equipment and supplies, and maintaining open communication as we finalize processes to achieve our hypothermia prevention goals.

Summary Report

Through the efforts, collaboration, and persistence of the NICU Clinical Nurse Leader, internal nursing unit leaders, and supportive physician and management team stakeholders, the bundle of neonatal hypothermia prevention interventions was put into place, evaluated, revised, and ultimately adopted into the practice and culture of the unit. This has led not only to preliminary results, but to sustained improvements in the neonatal hypothermia rate in the preterm, very low birthweight infant population of the medical center from an initial rate of 20% in 2015, to less than 4% at the midway point of 2017 (see Table 2 and Figure 1 for data).

Maintaining the discussion of neonatal hypothermia among clinical leaders in the medical center is paramount to sustaining success with this initiative. Progress made in the area of neonatal hypothermia prevention was reported at the quarterly Hospital Quality Council meeting on June 29, 2017, where awareness among physician and quality department leaders was ensured, along with continued support of the initiative. Yet continued efforts within the ever-changing microsystem of the NICU are needed in order to ensure the sustainability of the successful improvement initiative as well. These will take form in several ways. The Golden Hour, a protocol to improve the stabilization of very low birthweight infants in the first hour of life, is in the preliminary stages of introduction to the NICU team. Hypothermia prevention is a crucial part of this protocol, and the bundle of hypothermia prevention initiatives already proven effective will be adopted into the Golden Hour practice, thereby reinforcing its importance and ensuring its continued relevance and use.

Due to ongoing staffing challenges, travel nurses and newly hired staff nurses will join the core team of nurses in the NICU, introducing the challenge of ongoing and updated education efforts to ensure comprehension of the unit's hypothermia prevention protocols. Preliminary steps taken to address this staff population include the introduction of hypothermia prevention criteria in the orientation packets presented to staff on arrival (see Figure 8.3 for a sample of preliminary information provided to these new nurses), and a discussion of its importance to all new hires. Ongoing monitoring and reinforcement of educational efforts are planned.

Finally, based on the success of these interventions and the recognition of the grave risks associated with hypothermia in all high risk infants, plans are currently being formulated to expand hypothermia prevention quality improvement measures to the late preterm infant population, or those infants born between 32 and 35 weeks' gestational age. Educational materials have been prepared by the Well Baby physician team, and data collection sheets for nursing documentation of interventions and results have been drafted and introduced to internal leaders in the post-partum units (see Figure 8.2). Discussions on this important topic have been initiated with outpatient nursing and physician leadership as well, with plans to further develop a quality improvement initiative and process in the next several months to improve patient outcomes and reduce infant readmissions due to risks associated with hypothermia.

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Table 1.1:

Cooper, B., Holditch-Davis, D., Verklan, M. T., Fraser-Askin, D., Lamp, J., Santa-Donato, A., ... & Bingham, D. (2012). Newborn clinical outcomes of the AWHONN late preterm infant research-based practice project. *Journal of Obstetric, Gynecologic, &Neonatal Nursing*, *41*(6), 774-785. Retrieved from http://onlinelibrary.wiley.com/doi/10.1111/j.1552-6909.2012.01401.x/full

Conceptual Framework	Design/ Method	Sample/ Setting	Variables Studied and Their Definitions	Measurement	Data Analysis	Findings	Appraisal: Worth to Practice
None	**Descriptive analysis of prospective data** obtained as part of the AWHONN Late Preterm Infant (LPI) Research-Based Practice Project. **Purpose:** To describe the neonatal health risks (hypothermia, hypoglycemia, hyperbilirubinemia, respiratory distress, the need for a septic workup, and feeding difficulties) experienced by late preterm infants (LPIs) from a large multisite study and determine how these risks were affected by gestational age at birth.	**Sample:** Late preterm infants (802) born at gestational ages between 34 0/7 and 36 6/7 weeks. **Setting:** Fourteen hospitals located through the United States and Canada	**IV1:** GA 34 wks **IV2:** GA 35 wks **IV3:** GA 36 wks **DV1:** temperature of baby **DV2:** hypoglycemia **DV3**: hyperbilirubinemia **DV4:** respiratory distress **DV5:** need for septic work up **DV6:** feeding difficulties	Care based on standard practices was observed and documented in NICU, special care nursery, and postpartum units.	Hypothermia: Overall: 32.4% 34 wks: 37.6% 35 wks: 43.2%b 36 wks: 25.9% $p < 0.001$	**More than one half of LPIs experienced hypothermia**,	This study highlights that there continues to be a significant risk of complications in the LPI throughout the first 48 hours of life. In terms of hypothermia specifically, nurses may be able to ameliorate health problems through early identification and simple, inexpensive interventions such as avoiding early bathing and promoting kangaroo care. L III, B.

Table 1.2:

Kent, A., Williams, J. (2008). Increasing ambient operating theatre temperature and wrapping in polyethylene improves admission temperature in premature infants. *Journal of Paediatrics and Child Health.* 44(6):325-31. doi: 10.1111/j.1440-1754.2007.01264. Retrieved from https://www.ncbi.nlm.nih.gov/pubmed/18194198.

Conceptual Framework	Design/ Method	Sample/ Setting	Variables Studied and their Definitions	Measurement	Data Analysis	Findings	Appraisal: Worth to Practice
Not specified	Retrospective Analysis of Data Cochrane Review A review of admission temperature of infants GA 31 weeks from January 2000 to July 2002 was performed. Between October 2002 and 2003 the ambient OR temperature was increased to 26–28°C for deliveries 27 weeks gestation and to 25°C for deliveries 28 weeks gestation. From September 2004 to December 2005 the ambient theatre temperature was increased along with wrapping infants in polyethylene. A clinical audit cycle review of admission temperatures and early morbidity and mortality was undertaken.	n=156 42<28 wks GA 114 28-31 wks GA For infants 28–31 weeks the mean admission temperatures in the three epochs were 36.3°C, 36.5°C and 36.6°C, respectively (P = 0.002). The Canberra Hospital and 2 Australian National University Medical School, Canberra, ACT, Australia	DV: axillary temp on admission to the NICU IV1: ambient temperature of OR IV2: polyethylene wrap	Axillary Temp on Admission To NICU	A retrospective review of admission temperatures of infants admitted to the Neonatal Intensive Care Unit was performed over three epochs. 299 babies less than 32 weeks gestation were admitted during these three epochs, 156 (52%) of which were delivered by c-section. There were no significant differences in the infants between the three epochs. A subanalysis of groups was performed with infants between 24 and 27 weeks gestation and between 28 and 31 weeks gestation.	Increasing the ambient operating theatre temperature and wrapping in polyethylene improves the admission temperature of premature infants, particularly those less than 28 weeks gestation. Larger studies are required to determine whether this results in long-term benefit in respect to mortality and morbidity.	Key Points 1 Increasing ambient operating theatre temperature and wrapping infants in polyethylene wrap improves admission temperature in premature infants. 2 A multidisciplinary education program can successfully achieve an improvement in clinical practice. 3 Further large studies are required to determine whether improving admission temperature improves mortality and morbidity. L III B

Table 1.3:

Bulut, C., Gursoy, T., Ovali, F. (2016) Short-term outcomes and mortality of late preterm infants. *Balkan Medical Journal*. 33(2):198-203. doi: 10.5152. Retrieved from https://www.ncbi.nlm.nih.gov/pubmed/?term=late+preterm+infant+Bulut.

Conceptual Framework	Design/ Method	Sample/ Setting	Variables Studied and Their Definitions	Measurement	Data Analysis	Findings	Appraisal: Worth to Practice
None	**Retrospective Cross-Sectional Study** Medical records of late preterm and term infants who were managed at the referral center were analysed.	**Sample:** 41,752 births were analyzed in three years. 71.9% of all births were between 37-42 gestational weeks (i.e. term) and 16.1% were between 34-37 weeks (i.e. late preterm). **Setting:** Zeynep Kamil Maternity and Children's Diseases Training and Research Hospital, İstanbul, Turkey,	**IV1:** GA 34 wks **IV2:** GA 35 wks **IV3:** GA 36 wks **DV1:** temperature of baby **DV2:** hypoglycemia **DV3**: hyperbilirubinemia **DV4:** respiratory distress **DV5:** need for septic work up **DV6:** feeding difficulties	Care based on standard practices was observed and documented in NICU, special care nursery, and postpartum units.	Late preterm infants constituted 59.9% (n=6741) of all preterm infants. 1179 (17.5%) of late preterm infants and 1941 (6.5%) of term infants were admitted to the NICU (p=0.001).	This study demonstrated the need that late preterm infants who have higher risk for morbidity and mortality, compared to term infants require close monitoring. The rate of mortality and hospitalization increased with decreased gestational age	Results indicate that late preterm infants are prone to many medical short-term complications such as respiratory distress, hypoglycemia, sepsis and mortality. Obstetricians should be cautious when deciding on the timing of birth, and should not be tolerant to interrupt pregnancy when there are maternal or fetal complications after 34 gestational weeks, whereas neonatologists should not tend to keep these newborns in low-risk nurseries or rooming in care and discharge infants early (33). A discussion between the obstetrician and the neonatologist about the outcome of the mother and the fetus and the optimal timing of delivery is crucial. Since late preterm infants have increased rate of problems, they should be followed up for a longer time in the hospital or should be called for close follow-up after the first days of discharge from the hospital. L III, B. Limitations: single site study

Table 1.4:

Trevisanuto, D., Doglioni, N., Cavallin, F., Parotto, M., Micaglio, M., & Zanardo, V. (2010). Heat loss prevention in very preterm infants in delivery rooms: a prospective, randomized, controlled trial of polyethylene caps. *Journal Of Pediatrics*, *156*(6), 914-917. Retrieved from https://clinicaltrials.gov/ct2/show/NCT01671241

Conceptual Framework	Design/ Method	Sample/ Setting	Variables Studied and their Definitions	Measurement	Data Analysis	Findings	Appraisal: Worth to Practice
Not specified	**Prospective, Randomized, Controlled Trial** **Purpose:** to evaluate in preterm infants whether polyethylene caps prevent heat loss after delivery better than polyethylene occlusive wrapping and conventional drying	**N=96 infants <29 weeks' gestation** (32 caps; 32 wrapped; 32 control) **Setting:** Pediatric Department, Medical School, University of Padua, Azienda Ospedaliera di Padova, Padua, Italy, from December 2007 to February 2009.	**IV1:** polyethylene caps **IV2:** polyethylene occlusive wrapping **IV3:** conventional drying **DV:** temperature of baby	Axillary temperature in degrees Celsius upon admission to the ICN	Continuous data were expressed as means plus or minus SD. Analysis of covariance was performed to check the relation between temperature and groups, adjusting for birth weight. A *P* value <.05 was considered to be significant.	The 96 infants randomly assigned (32 covered with caps, 32 wrapped, 32 control) completed the study. Mean axillary temperature on NICU admission was similar in the cap group (36.1 degrees C +/- 0.8 degrees C) and wrap group (35.8 degrees C +/- 0.9 degrees C), and temperatures on admission to the NICU were significantly higher than in the control group (35.3 degrees C +/- 0.8 degrees C; P < .01). Infants covered with polyethylene caps (43%) and placed in polyethylene bags (62%) were less likely to have a temperature <36.4 degrees C on admission to the NICU than control infants (90%). In the cap group, temperature 1 hour after admission was significantly higher than in the control group.	For very preterm infants, polyethylene caps are comparable with polyethylene occlusive skin wrapping to prevent heat loss after delivery. Both these methods are more effective than conventional treatment. L II, B

Table 1.5:

Jia, Y.S., Lin, Z.L., Lv, H., Li, Y.M., Green, R, Lin, J. (2013). Effect of delivery room temperature on the admission temperature of premature infants: a randomized controlled trial. *J. Perinatol*; April;33(4);264-7. Doi: 10.1038/jp.2012.100. Epub 2012 Aug 2. PMID: 22858889 [PubMed – indexed for MEDLINE]. Retrieved from http://www.nature.com/jp/journal/v33/n4/abs/jp2012100a.html?foxtrotcallback=true.

Conceptual Framework	Design/Method	Sample/Setting	Variables Studied	Measurement	Data Analysis	Finding	Appraisal: Worth to Practice
None specified	Prospective Randomized Controlled Trial done in 2011: **Purpose:** To determine if increasing delivery room temperature to that recommended by the World Health Organization results in increased admission temperatures of preterm infants. Admission rectal temperatures of newborns ≤32 weeks' gestation delivered in rooms with temperature set at 24 to 26 °C were compared with those of similar newborns delivered in rooms with temperature set at 20 to 23 °C.	Infants <32 weeks gestational age born between March 1, 2010 and February 28, 2011. Warm group n=43 Control group n=48 Setting: Second Affiliated Hospital and Yuying Children's Hospital of Wenzhou Medical College, a perinatal center located in eastern China with over 7000 annual deliveries. The 90 bed level III NICU also serves as the major referral center for the region of over 8 million people.	Independent Variable: Delivery room temperatures set 24 to 26 degrees Celsius Control: Delivery room temperature 20 to 23 degrees Celsius Dependent Variable: Infant rectal temperature on admission to NICU	Infant temperature on admission to ICN, measured rectally. NICU nurses were not made aware of group assignment of the infants (i.e., warm vs control)	A P value of 0.05 was considered statistically significant in all cases. All statistical analysis was performed by using PASW Statistics 18 (SPSS, IBM, Armonk, NY, USA).	Premature newborns delivered in rooms with mean temperature 25.1±0.6 °C (n=43), compared with those delivered in rooms with mean temperature 22.5±0.6 °C (n=48), had a lower incidence (34.9% vs 68.8%, P<0.01) of admission rectal temperature <36 °C and higher admission rectal temperatures (36.0±0.9 °C vs 35.5±0.8 °C, P<0.01). This difference persisted after adjustment for birth weight and 5 min Apgar score.	Increasing delivery room temperatures to that recommended by the World Health Organization decreases cold stress in premature newborns. L II, B

Table 1.6:

McCarthy, L. K., Molloy, E. J., Twomey, A. R., Murphy, J. F., & O'Donnell, C. P. (2013). A randomized trial of exothermic mattresses for preterm newborns in polyethylene bags. *Pediatrics*, *132*(1), e135-41. Retrieved from https://www.researchgate.net/publication/239942244_A_Randomized_Trial_of_Exothermic_Mattresses_for_Preterm_Newborns_in_Polyethylene_Bags

Conceptual Framework	**Design/ Method**	**Sample/ Setting**	**Variables Studied and Their Definitions**	**Measurement**	**Data Analysis**	**Findings**	**Appraisal: Worth to Practice**
Not specified	**Randomized Trial** Infants <31 weeks were randomly assigned before birth to treatment with or without an EM. All infants were placed in a PB and under radiant heat immediately after birth and brought to NICU in a transport incubator. Infants randomly assigned to EM were placed on a mattress immediately after delivery and remained on it until admission. Randomization was stratified by gestational age. Rectal temp was measured w/ digital thermometer on NICU admission.	**N=72 infants <31 weeks GA** 37: PB & EM 35: PB alone **Setting:** Level 3 NICU National Maternity Hospital, Dublin, Ireland February 2011 to February 2012	**DV1:** Rectal temperature on arrival in the ICN **IV1**: polyethylene bag (PB) **IV2**: exothermic mattress (EM)	Rectal temperature on admission to ICN.	Significantly fewer infants in the PB+EM group had a rectal temperature of 36.5 to 37.5°C on NICU admission (15/37 [41%] vs 27/35 [77%], *P* = .002. The mean rectal temperature on admission was within the normal range for both groups but was higher in the PB+EM group (37.4 vs 37.0°C, *P* = .017). The mean axillary temperature was also higher in the PB+EM group (37.3 vs 36.9°C, *P* = .011). More infants treated with a PB+EM had admission temperatures >37.5°C (17/37 [46%] vs 6/35 [17%], *P* = .009). There was no significant difference in the incidence of hypothermia between the 2 groups.	In very preterm newborns, using EMs in addition to PBs in the DR resulted in more infants with temperatures outside the normal range and more hyperthermia on NICU admission.	In newborn, very preterm infants, using EMs in addition to PBs in the DR results in more infants with temperatures outside the normal range and more hyperthermia on admission to NICU. L III B

Table 2:

NICU Hypothermia Rates by Year

YEAR	RATE (%)	NUM	DEN
2011	16.7	8	48
2012	20.8	10	48
2013	34.9	15	43
2014	22.0	9	41
2015	20.0	8	40
2016	9.5	4	42
2017**	**3.8**	**1**	**26**

**2017 preliminary data

Note. Data represent percentage of NICU admissions in target Population of neonates < 32 weeks GA, weighing < 1500 grams, with documented temperatures within first hour of life < 36.5 degrees Celsius. Adapted from Walsh, E., Mancera, R., Parker, S. (2016, September). *Annual neonatal data review*.

Table 3:

ROI Analysis

	Cost per Day	Average LOS	Base cost estimate	*Estimate 3 infants per month x 12 months (Total Benefit)*	*Benefit-Cost Ratio (benefit per every $1 spent)*	*Cost-Benefit Ratio*
NICU infant: cost per add'l 3 days length of stay	$3,000	3 days	$9,000.00	$324,000	$23.80/$1	4.2%
NICU infant requiring higher level of care	$3,5000	7 days	$24,500.00	*Estimate 1 infant/month x 12 months* $294,000	*$21.60/$1*	*5.6%*
Potential Return on Investment				**$618,000***	**$45.40/$1**	

* Not including cost of additional therapies and interventions due to complications.

Table 4.1:

Initial Start-Up Costs

Initial Start Up Costs for Planning and Education:				
CNL, ANM, CNS, RN @ $80/hour	**20-minute Educational Module**	**5-minute Pre-Shift Huddles x 2 weeks, 5 days/week 3 shifts (avg 30 mins./RN)**	**Team coaching, debriefs, PDSA cycles X avg. 10 minutes/RN**	**TOTALS**
Est. 150 RNs	$4,000	$6,000	$2,000	**$12,000**
CNL	$640 (8 hrs prep)	$200	$317	**$1,157**
CNS	$160 (2 hrs prep)	---	$317	**$477**
		Total Labor Investment:		**$13,634**

Table 4.2:

Initial Start-Up Costs

Neonatal Hypothermia Prevention Project **Estimated Costs for Labor and Materials**		
Materials:	**First Year Costs:**	**Second Year Costs:**
CNS, ANM/CNL wages needed to initiate project	$1,634	N/A
Nursing team wages	$12,000	N/A
Equipment: Giraffe warmer, giraffe shuttle, used in delivery room and NICU for high-risk, premature infants	Using existing equipment	N/A
Supplies, including warm linens, sterile drapes, infant hats, thermometers, Neo-wraps, and heated mattress pads.	Using existing equipment	Ongoing costs incorporated into unit supply budget
Skin-to-Skin care	N/A	N/A
Charting tools	Using existing KP HealthConnect software	N/A
Printer/Computer	Using existing computers and printers	N/A

Figure 1: Percentage of NICU Admissions with initial temperatures of < 36.5 degrees Celsius

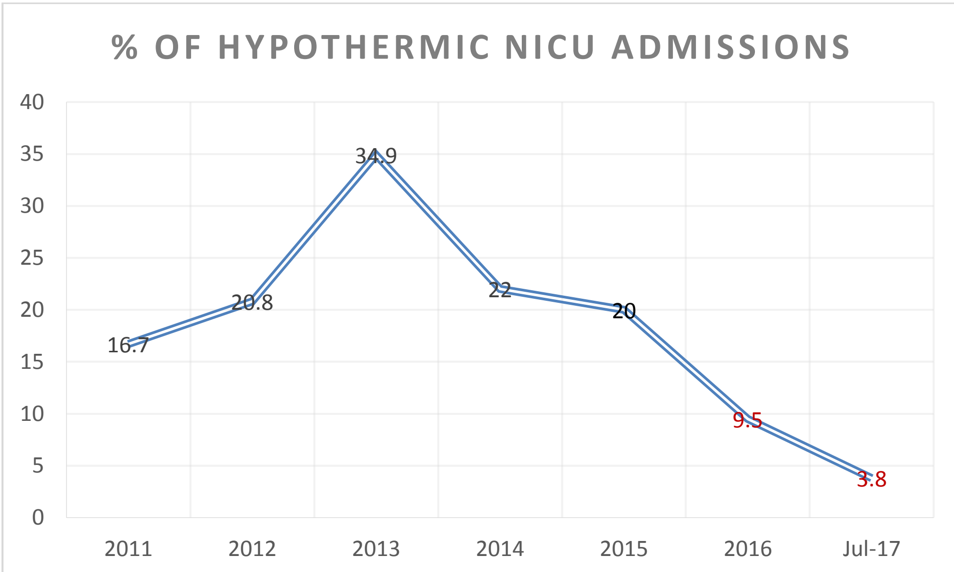

Figure 1. Run chart depicting percentage of NICU admissions in target Population of neonates < 32 weeks GA, weighing < 1500 grams, with documented temperatures within first hour of life < 36.5 degrees Celsius. Adapted from Walsh, E., Mancera, R., and Parker, S. (2016, September). *Annual neonatal data review*.

Notes:

2015: Introduction of Preliminary Bundle of Hypothermia Prevention Interventions

2016: Results after initial year of interventions incorporated into practice

July 2017: Year to Date Data, n= 26 deliveries in target population

Figure 2: Timeline

Intervention:	6/22	6/29	7/6	7/24	7/27	8/1	8/3
Definition of Topic/Problem and Presentation to KPSF MCH Nursing Staff							
Introduction of Educational Modules and Training Materials for Nursing Team.							
Status check of Nursing Compliance on Educational Modules and Training.							
Roll-Out of New Interventions.							
Revision of Intervention Strategies and Practices Based on Preliminary Trials							
Team Communication, Education and Consultation							
Secondary Trial of Interventions							
Assessment of Impact of Interventions Continues							
Continued Training for any New Staff Members							
Presentation of Preliminary Results to Senior Leadership							

Figure 3. Driver Diagram

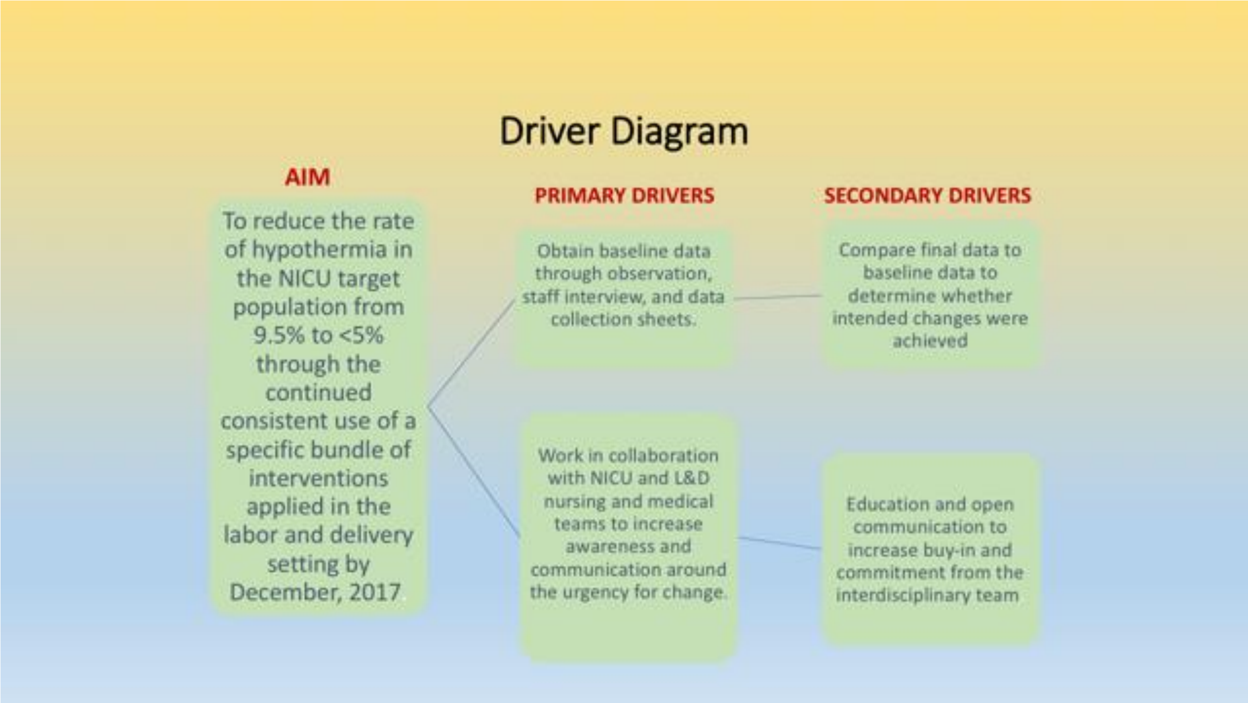

Figure 4: Stakeholder Diagram

Influence of Stakeholders		
	Meet The Needs of Nursing and Physician Teams: • Engage and consult on interest area • Try to generate interest • Aim to move into right hand box	**Key Players: Nurses, Physicians, Ancillary Staff** • Key players focus on interest in this group • Involve in governance/decision-making bodies • Engage and consult regularly
	Least Important: • Inform via general information (newsletters, websites, etc.) • Aim to move in to right-hand box	**Show Consideration:** • Make use of interest through involvement in low-risk areas • Keep informed and consult on interest area • Potential supporter/goodwill ambassador
	Interest of Stakeholders	

Figure 5: SWOT ANALYSIS

INTERNAL	• Strong commitment among nursing team members to optimize level of care to patients. • Cooperation from physician team • Support of leadership team • Parallel CNL project focused on skin-to-skin contact post-delivery will support hypothermia project goals	• Difficulty maintaining clear communication between nursing units • Staff turnover • Travel nurses • Inconsistency in awareness of program goals • Labor and delivery physician team reluctant to maintain optimal OR temperature levels • Necessity to prioritize other lifesaving interventions in acute deliveries
	Opportunities	**Threats**
EXTERNAL	• Support from outpatient clinic to continue education post-discharge • Patient demographic open to learning • Support from Regional Senior Leadership to continue to improve neonatal hypothermia prevention measures	• Potential political changes to current health care system which may limit access to current health plan members.

Figure 6: Fishbone Diagram

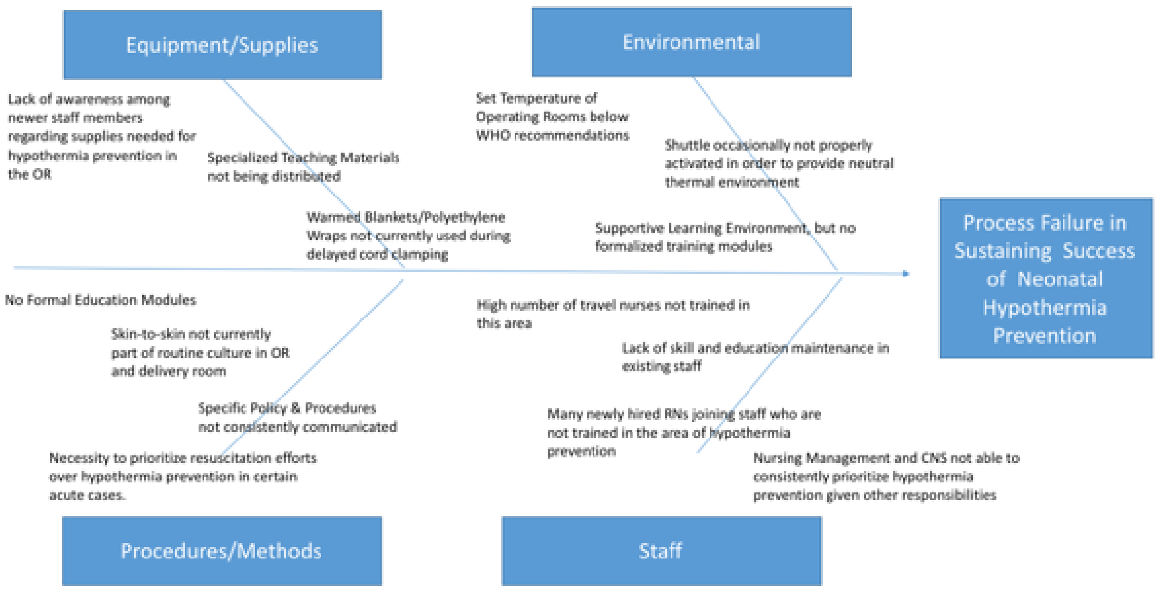

Figure x: Fishbone diagram depicting challenges in various areas facing the NICU in their pursuit of success in the neonatal hypothermia prevention initiative.

Figure 7: PDSA Cycles

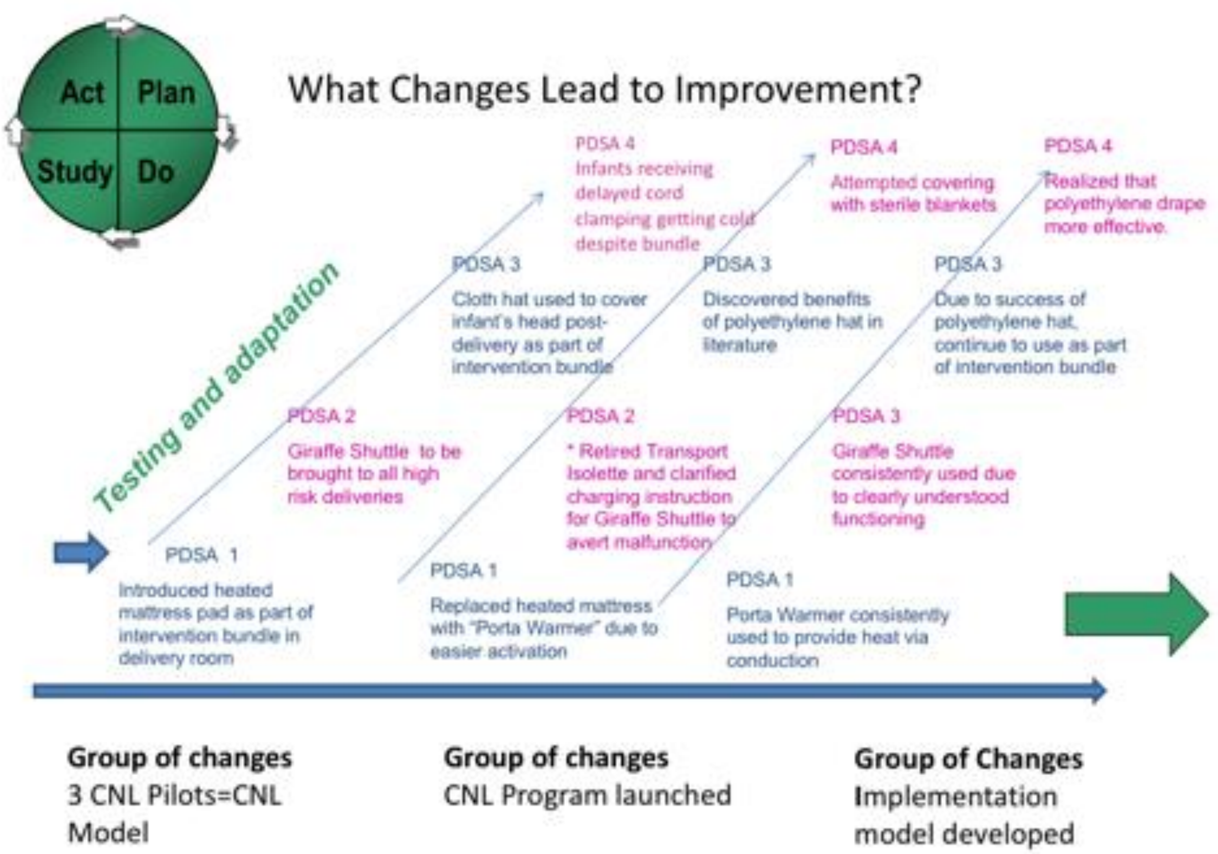

Figure x: The process used in the development of this initiative is as follows:

- A gap was identified in nursing practice in the delivery room in preterm, very low birthweight infants, resulting in high incidence of hypothermia on arrival to the NICU in this target patient population.
- Evidence search was initiated to determine elements that could lead to better outcomes.
- Of these, three primary changes were tracked through PDSA cycles:
    - Effectiveness of heated mattress pad (PortaWarmer)
    - Use of the Giraffe Shuttle to provide a source of heat during transport from labor and delivery OR to the NICU
    - Most effective hat to prevent heat loss
    - Most effective covering method for infant during delayed cord clamping
- Changes were made based on data tracking via data collection sheets and verbal feedback from members of the nursing and physician teams.
- Those elements of the bundle that proved successful were incorporated into standard processes.

Figure 8.1: Tools developed: Data Collection Form for Target Population

Heat Loss Prevention (HeLP) in the Delivery Room
For Very Low Birthweight Infants

Criteria for Hypothermia Prevention:

- Any delivery ≤ 32 weeks' gestational age
- Any infant weighing ≤ 1500 grams

Upon notification of an anticipated delivery, the following steps must be performed:

- Turn heat on resuscitation bed up to 100%.
- Set up resuscitation bed with Porta Warm mattress and NeoWrap with warm blanket in between. Have warm polyethylene hat and thermometer available.
- RT to check tanks and O2 equipment on Giraffe Shuttle. Make sure shuttle is turned on and heat activated.
- Ensure that polyethylene wrap is available in the case of delayed cord clamping.
- RT and RN to move Giraffe Shuttle and park outside of OR. (Safety First: this is a two-person job --- DO NOT MOVE ALONE).

Temperature charting:

Temp at 15 minutes of life:	Temp at 45 minutes of life:
Temp at 30 minutes of life:	Temp at 60 minutes of life

Please list any additional interventions provided to improve baby's temperature:

Please complete the following:

Were the Porta Warm Mattress and NeoWrap used during resuscitation? YES / NO
If not, please explain:

Was the Giraffe Shuttle used to transport the baby back to the NICU?
If not, please explain:

Additional comments useful to analyze temperature results for this delivery:

Please be sure to chart accurate temperature data in Health Connect as well!

Figure 8.2: Tools developed: Data Collection Form for Expanded Initiative

Heat Loss Prevention (HeLP) For Late Preterm Infants	
Criteria for Hypothermia Prevention: ○ Any delivery 35 to 36.6 weeks' gestational age	
Upon notification of an anticipated delivery, the following steps must be performed:	
○ Turn heat on resuscitation bed up to 100%. ○ Set up resuscitation bed with Porta Warm mattress and NeoWrap with warm blanket in between. Have warm polyethylene hat and thermometer available. ○ If C-section have sterile NeoWrap ready for delayed cord clamping. ○ If vaginal delivery, have warm blankets ready for delayed cord clamping. ○ Discuss if skin-to-skin care will be an option post-delivery with the interdisciplinary team. ○ Consult with labor and delivery nursing team to determine whether benefits of skin-to-skin have been discussed	
Temperature charting:	
Temp at 60 minutes of life:	Temp at 16 hours of life
Temp at 4 hours of life	Temp at 20 hours of life
Temp at 8 hours of life	Temp at 24 hours of life
Temp at 12 hours of life	
Please list any additional interventions provided to improve baby's temperature:	
Please complete the following:	
Please explain which heat-preserving interventions were used in the OR or delivery room:	
Was infant wrapped during delayed cord clamping? YES/NO If not, please explain:	
How long was infant a patient prior to discharge?	
Was NICU admission required at any time during hospital stay? YES/NO If so, please explain: ***Please be sure to chart accurate temperature data in Health Connect as well!***	

Figure 8.3: Tools developed: New Staff Nurse Information (adapted version)

WELCOME TO OUR NICU!

We're excited to have you join our team. Along with all of the information on our unit practices that your preceptors will advise you on, here are a few that we are currently focusing on that we want to make sure you are aware of:

NEONATAL HYPOTHERMIA PREVENTION

Temperature instability in preterm infants is a serious condition that is associated with significant risks as well as mortality, but that is also potentially preventable. In our NICU, we've worked hard to overcome barriers to keeping our fragile infants warm, and continue to improve our hypothermia statistics!

Once you begin attending high risk deliveries, please be aware of the bundle of interventions that we've integrated into practice. These include:

- Heated Giraffe Shuttle to transport infants from the delivery room to the NICU;
- Use of polyethylene wrap (during resuscitation as well as delayed cord clamping, if applicable);
- Use of polyethylene-lined hat;
- Use of heated mattress (porta-warmer);

To make sure that all of these are ready for use, we have a Pre-Delivery Preparation Checklist (see attached sample). Make sure to ask your preceptor where to find this, where to locate the appropriate supplies, and how to use them when attending the delivery of a VLBW infant.

Once baby arrives in the NICU, documentation is critical! Chart the first temperature within 15 minutes of admission to the NICU, within first hour of life.

Throughout their stay in the NICU, please be aware of the importance of preventing babies from getting cold. If you chart an abnormal temperature, take appropriate action. And remember that skin-to-skin contact with mom and dad benefit both baby and parents, and is helpful for thermoregulation!

Project Charter:

Neonatal Hypothermia Reduction

Monika Klett-Dunbar

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Table of Contents

Introduction: The Neonatal Intensive Care Unit (NICU) team is made up of dedicated professionals who share the common goal of providing excellent care for high risk neonates, with the utmost respect for their long-term health and dignity. Family involvement is prioritized, and parents are active partners in the care of their infant. Treatment provided integrates evidence-based, interdisciplinary, and family-centered approaches.

As a Level III NICU, the patient population is composed of newborn infants ranging from 23 to 41 weeks' gestational age: 43% are aged 37 weeks and greater, 40% are in the range of 32 to 36 weeks, 12% are 28 to 31 weeks, and 5% are less than 28 weeks on admission. 92% of these babies were inborn, while 8% were born in other facilities. Discharge disposition consists of approximately 11% of the infants being re-appropriated back to the organization's facilities closer to the parents' homes once stable enough for transport; 5% are transferred to higher acuity facilities. The remainder are discharged to home. The average daily census in the ICN is 15 patients. Top diagnoses include extreme prematurity, respiratory distress, hyperbilirubinemia, hypoglycemia, hypothermia, and failure to thrive.

The NICU has a medical staff of four attending physicians, additional on call pediatricians and hospitalists from UCSF, and a medical resident. Nursing staff is made up of a budgeted core of ten nurses per shift, adjusted based on patient need as indicated by GRASP. A Clinical Nurse Specialist ensures that policies and procedures are relevant and current, and oversees nurse education. A team of dedicated respiratory and physical therapists, nutritionists, lactation consultants, social workers, and medical specialists such as surgeons and cardiologists are available as needed. A unit assistant coordinates miscellaneous patient, nurse, and physician needs. The nursing management team consists of an assistant nurse manager for each shift, and a nurse manager, who interpret hospital policy and ensure smooth operation of the unit.

Improvement Theme: The theme of this clinical performance improvement project is based on the Institute for Healthcare Improvement's (IHI's) Quadruple Aim. Don Berwick, MD coauthored the Triple Aim in 2008, as a vision for reforming the United States health care system through the simultaneous pursuit of three dimensions of performance: improving the health of populations, enhancing the patient experience of care, and reducing the per capita cost of health care (Berwick, D., 2008). Of principle concern is the health of the population, which in this case is the well-being of all neonates born in the medical center. "The two secondary goals in the Quadruple Aim, improving patient experience, and reducing costs, contribute to the achievement of the primary goal" (Bodenheimer, T., & Sinsky, C., 2014). When neonatal thermoregulatory goals are met, the neonate's family has a more seamless care experience with fewer complications, and lower acuity level. Term infants can avoid potential admission to the NICU, while preterm infants may avoid additional interventions and increased length of NICU stays, which in turn decrease overall costs.

The final aim, care team satisfaction, is critically important in achieving success in the Triple Aim. "The positive engagement, rather than the negative frustration, of the health care workforce is of paramount importance in achieving the primary goal of the Triple Aim—improving population health" (Bodenheimer & Sinsky, 2014). We hope to achieve this by working with the interdisciplinary care team to create clear, standardized workflows, providing complete education, ensuring access to appropriate equipment and supplies, and maintaining open communication throughout PDSA cycles as we finalize processes to achieve our hypothermia prevention goals.

Global Aim: To improve infant thermoregulation within the first 24 hours of life of the high risk preterm and very low birth weight (VLBW) infant population in the NICU, thereby reducing rates of morbidity and mortality due to complications influenced by infant hypothermia.

Project Aim: To reduce the rate of hypothermia at one hour and the first 24 hours of life in the target population of preterm neonates weighing less than 1500 grams with a gestational age less than 32 weeks from 9.5% to < 5% through the consistent use of a specific bundle of interventions applied in the labor and delivery setting, by December 2017. Future goals include educating all NICU, labor and delivery, and postpartum nurses on the importance of neonatal hypothermia prevention for all infants, especially those at high risk, at one hour and the first 24 hours of life, and the steps that need to be taken to in order to reduce the NICU admission rate of term and late preterm infants due to hypothermia to < 5% of this patient population by December 2017.

Background: The World Health Organization classifies neonatal hypothermia as mild 35.9°C – 36.4°C (96.8°F–97.5°F), moderate 32°C –35.9°C (89.6°F –96.6°F), and severe (<32°C/89.6°F) (World Health Organization, 2016). Hypothermia is a major factor in morbidity and mortality of low-birth-weight (LBW) premature infants. Ideally the temperature of a newborn infant should be maintained within the narrow range of 36.7 to 37.3 degrees Celsius, the neutral thermal environment in which metabolic expenditures for thermoregulation are lowest (Gibson & Nawab, 2015). Neonates are prone to rapid heat loss and consequent hypothermia because of a high surface area to volume ratio, which is even higher in low-birth-weight neonates. Although term neonates do have compensatory mechanisms to combat hypothermia, such as brown fat metabolism, these are limited, particularly in low birthweight infants, and those with risk factors for hypothermia. These include maternal hypertension, c-section deliveries, low Apgar scores, sepsis, intracranial hemorrhage, and drug withdrawal. Environmental factors such as convection, evaporation, radiation, and conductive heat loss greatly add to the risk of hypothermia.

Infants' self-regulating attempts at compensating for hypothermia increase their metabolic rates, thereby intensifying oxygen and glucose demands. Therefore, in neonates with respiratory insufficiency which is common in preterm infants, cold stress may also result in tissue hypoxia and neurologic damage. Activation of glycogen stores can cause transient hyperglycemia. Persistent hypothermia can result in hypoglycemia and metabolic acidosis and increases the risk of late-onset sepsis and mortality. Thermal protection of the newborn remains a global health concern and a challenge to health care providers despite advances in technology that provide warmth and minimize hypothermia after birth (Gibson & Nawab, 2015).

According to Manani, Jegatheesan, DeSandre, Song, Showalter, & Govindaswami in their 2013 study, temperature instability in preterm infants is a serious condition that is also potentially preventable (Manani, et. al., 2013, Abstract). Cordaro, Phalen, and Zukowski concur in their 2012 literature review, stating, "Hypothermia on admission to the NICU of the LBW premature infant is not a complication of prematurity; it is a consequence of health care provider inattentiveness" (Cordaro, T., et. al, 2012). The Neonatal Intensive Care Unit (NICU) of our urban medical center has historically had the organization's highest rate of hypothermia in babies 22 to 29 weeks' gestational age admitted to the NICU, based on temperatures taken at the first hour of life (Walsh, Mancera, Parker, 2015), indicating that a coordinated strategy of innovative measures based on evidence based practice must be put in place to address this serious threat to the optimal well-being of our patients.

The research shows that routine measures used in the prevention of hypothermia in term newborn infants are not sufficient for maintaining core temperature within prescribed ranges for preterm and VLBW infants (Fawcett, 2014). Select additional interventions in the delivery room are needed in order to ensure positive outcomes in this area. In an effort to determine which bundle of interventions are most effective, numerous research articles were consulted. Trevisanuto, Doglioni, Cavallin, Parotto, Micaglio, and Zanardo (2010) conducted a prospective, randomized, controlled, trial to determine whether polyethylene caps prevent heat loss in preterm infants after delivery better than polyethylene occlusive wrapping and conventional drying. The authors concluded that both polyethylene occlusive wrapping and polyethylene hats are equally effective in improving temperature stability in preterm neonates in the immediate post-birth time period, over traditional drying methods alone. The researchers explain the importance of covering the head with a non-cloth cap based on the heat-generating capacity of the brain, and the surface area of the neonate's head in comparison to the body.

In their 2013 research study, McCarthy, Molloy, Twomey, Murphy and O'Donnell sought to determine whether the warming benefits of placing preterm infants in polyethylene bags (PB) immediately after delivery, and concurrently placing the infant on an exothermic mattress (EM) would further reduce hypothermia. They also questioned whether the combined interventions would increase the rates and risks of hyperthermia. The study found that in preterm newborns born at less than 31 weeks gestational age, using EMs in addition to PBs in the delivery room resulted in more infants with temperatures outside the normal range, and more hyperthermia on admission (McCarthy, et. al, 2013). This condition poses a serious health risk as well: In extreme cases, "Hyperthermia occurs when the infant is overheated beyond its ability to rid body heat leading to brain protein structural changes and potentially resulting in seizures or death" (Baumgart, 2008).

In term and late preterm infants, the challenges in preventing hypothermia extend to the care that the baby receives from nurses and parents in the recovery and postpartum patient rooms. Therefore, hypothermia prevention relies primarily on the education and attentiveness of the caregivers. Its incidence along with harmful sequelae is surprisingly common, resulting in preventable admissions to neonatal intensive care units, and in some cases in death (British Journal of Midwifery, 2014). With interdisciplinary collaboration, well-designed quality improvement initiatives, and continuous education sustaining change however, hypothermia prevention in term neonates can be achieved. Avoiding moderate hypothermia is possible and should be the focus of all providers caring for newborns (Fanaroff & Fanaroff, 2016).

Summary: In an effort to align with the IHI Quadruple Aim in our goal of improving neonatal hypothermia in our medical center, this quality improvement project will devise and implement a standardized bundle of interventions for use by the interdisciplinary team in the labor and delivery setting to ensure that newborn infants maintain temperatures > 36.5 degrees Celsius within the first hour of life, and for the first 24 hours. The nursing and medical teams in the NICU will determine which hypothermia interventions are most appropriate and effective for our particular facility, and implement a specific bundle of these interventions to affect positive change in our VLBW hypothermia statistics, as well as the thermoregulatory outcomes of all high risk infants born in the medical center.

Goal: To provide a standardized bundle of interventions for use by the interdisciplinary team in the labor and delivery and setting to ensure that newborn infants in the target population of < 1500 grams and < 32 weeks, as well as all high risk neonates born in the medical center maintain temperatures > 36.5 degrees Celsius within the first hour of life, as well as the following 24 hours.

Family of Measures:

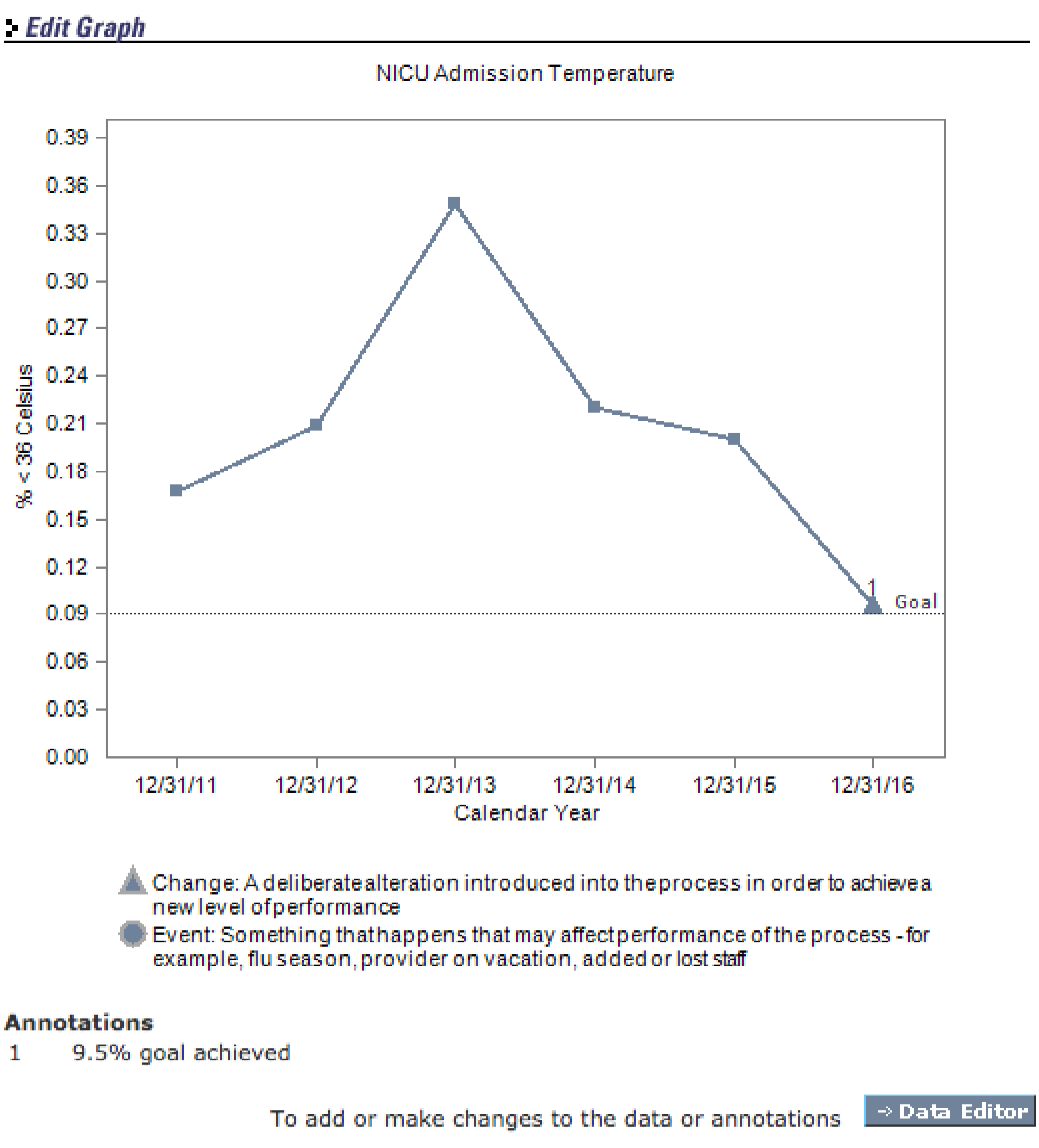
Measure:	Data Collection Source:	Goal:
Outcome:		
Percentage of babies in the initial target population who have temperatures within the normal range (> 36.5 degrees Celsius) within one hour of life, and throughout the first 24 hours of life.	• Data collection sheets • Health Connect charting.	~~90%~~ updated goal: 95%
Process #1:		
Consistent use of the NICU bundle of interventions, including: • Heated Giraffe Shuttle to transport infants from the delivery room to the NICU; • Use of polyethylene wrap; • Use of polyethylene hat; • Use of heated mattress;	• Data sheets completed by the admitting NICU nurse.	~~80%~~ updated goal: 90%
Balancing #1:		
Hyperthermia on NICU admission.	• Data collection sheets • Health Connect charting.	< 1 per month
Process #2:		
Warm blanket/sterile wrap for infants in OR and delivery room during delayed cord clamping.	• Health Connect Charting • Data collection sheets	80%
Balancing #2		
Lack of compliance by physician and nursing teams in OR/DR due to various factors including safety measures, insufficient training, and lack of communication.	• Health Connect Charting • Data collection sheets	<20%
Process #3:		
Adequate staff training and buy-in to ensure compliance with increased temperature monitoring in both NICU and non-NICU infants.	• Data sheets completed by the nursing staff. • Health Connect Charting by NICU, L&D, and OB nurses	80%
Balancing #3:		
Lack of staff compliance due to insufficient training could result in poor outcomes and lack of sufficient data.	• Data collection sheets • Health Connect charting.	< 20%

Measurement Strategy: Preliminary data within our NICU was collected in two ways: first, by auditing Health Connect charting for patients within the targeted population, and by data collection sheets completed by the admitting nursing team (see Appendix L for example). Data for the regional reports are collected only from chart audits. This measurement strategy proved successful during initial PDSA cycles, and will be continued.

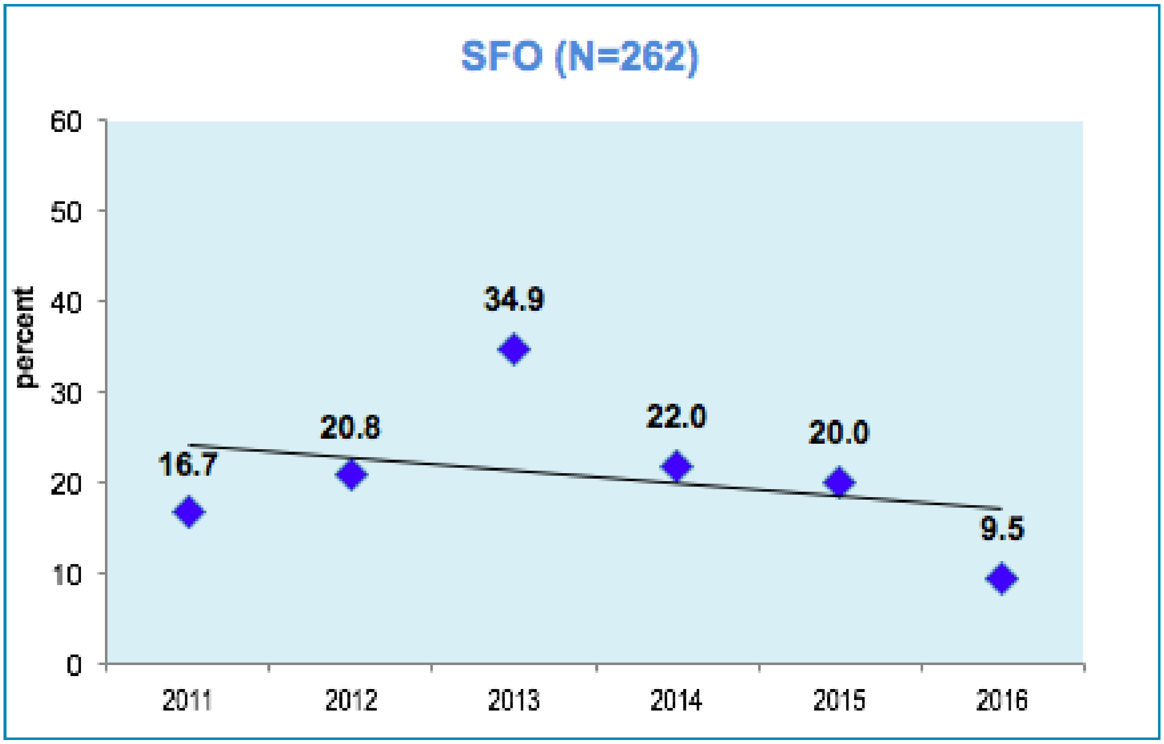
As the focus of our quality improvement initiative broadens to include term and late pre-term infants, data collection strategies will be revised as follows:

- Temperatures taken within the first hour of life will be recorded in all high-risk deliveries, regardless of gestational age;
- Data collection sheets will be completed and collected for these infants, so that patterns can be recorded and tracked
- Temperatures recorded for the first 24 hours of life in Health Connect charting will be audited on all newborn infants born in the medical center;
- In future PDSA cycles, admissions of infants to the NICU from ORs, LDRs, and the Postpartum (OB) unit will be tracked to determine whether admission diagnosis is linked to hypothermia.

Baseline Run Chart – NICU Admission Temperatures in NICU Target Population of Neonates < 32 weeks GA, weighing < 1500 grams:



Additional View of the Baseline Data – NICU Admission Temperatures in Initial Target Population of Neonates < 32 weeks GA, weighing < 1500 grams:



For the upcoming phase of the expanded quality improvement project, the following patient populations will be added:

- **Preterm neonates 32 to < 36 weeks of all weights;**
- **High Risk late pre-term infants (36-38 weeks' GA);**
- **High Risk term infants (38 to 40+ weeks' GA).**

Sufficient data for these patient populations has not yet been collected, since this portion of the quality improvement project has not yet been introduced to the nursing staff. Chart audits done to date do not show enough consistent information to result in reliable data.

Baseline Data: The baseline data for this neonatal hypothermia prevention performance improvement initiative was originally derived from regional annual data compilations from the medical organization, presented in 2015. The statistics in this report reflect data collected by the Division of Research, Perinatal Research Unit from 2012 to 2014. The Risk-adjusted metrics from the California Perinatal Quality Care Collaborative (CPQCC) and the Vermont Oxford Network (VON) reports show trends over time for key Neonatal Intensive Care Unit (NICU) outcomes, and were referred to in the preparation of the data review. In it, our rate of hypothermia in very low birthweight (VLBW) infants was the highest in the region, with a rate of 25.8% of all births that fit the patient population parameters of infants weighing less than 1500 grams, and of less than 29 weeks' gestational age (Walsh, E., Mancera, R., & Parker, S., 2015). This data provided the starting point for this project.

It is important to note that the data published is a collective average over a 5-year period; therefore, careful examination of the actual annual totals was necessary in order to obtain an accurate assessment of hypothermia figures. In analyzing the data as reflected in the run chart, it is evident that San Francisco experienced the highest number of VLBW infants born with temperatures < 36 degrees C between 2013 to 2015, and specifically in 2013, when 34.9% of infants fitting study parameters were admitted to the NICU with temperatures < 36 degrees C. The following two years, 2014 and 2015, while not optimal, were more in line with the results seen at other facilities profiled. The California Perinatal Quality Care Collaborative (CPQCC) published data reflecting final figures for these years at 22.0 and 20.0, respectively (CPQCC, 2016).

As preliminary interventions were put into place in December of 2015, the data for hypothermia in the VLBW population in the NICU showed a marked improvement, with preliminary figures from CPQCC of 9.5% for the year. The reduced rate of hypothermia in this specific patient population reflects the change that can be affected with targeted interventions. Additional improvement is needed in order to fully protect the VLBW infants born in our medical center, and is shown to be within our grasp since other facilities in our region with comparable neonatal demographics have been able to reduce hypothermia rates to levels as low as 1.7% (Walsh, E., et. al., 2015), prompting our new goal of a hypothermia rate of < 5% by December, 2017.

Data for infants outside of the parameters of the initial quality improvement initiative is not yet reliable, as its collection is still in progress, and clear definitions of demographics most relevant to the project have only recently been finalized. Preliminary, exploratory data collection to date has been exclusively through Health Connect Chart Audits, which indicates 20% of high risk term infant deliveries result in initial hypothermia, while 20% of high risk late preterm infants admitted to the NICU also reflect low initial temperatures at the first hour of life.

Recommendations for Change: As noted by Batalden, Godfrey, and Nelson, "Change concepts can help you clarify your thinking about where in a process a change can be made to result in substantive improvement" (2007, p. 333). Referring to the Neonatal Hypothermia Initiative that I have been working on throughout the past year, our neonatal intensive care unit (NICU) has hit a plateau in terms of progress. In addition, I have identified areas that we could target beyond the initial patient population that we've focused on, which would broaden the scope, and ultimately the positive impact of our efforts.

Based on Langley's Change Concepts, as referenced by Batalden, et. al., (2007, pp. 334-335) I propose to address the following categories: Improve work flow, change the work environment, enhance the producer/customer relationship, and manage variation. Improving workflow begins by evaluating current systems to locate obstacles and identify opportunities for improvement.

This will involve synchronizing the efforts of multiple team members in the delivery and operating rooms to allow for interventions such as immediate skin-to-skin contact for baby, and warming measures during delayed cord clamping. Changing the work environment will require ensuring that all team members from labor and delivery, postpartum, and the NICU are clear on and invested in the purpose and goals of the systems change. It will be critical to develop and maintain cooperative and mutually beneficial relationships across disciplines and departments. Updated information must be available to all members of the team, and education and training modules must be provided.

By listening to the needs and concerns of our team members as well as our patients, and incorporating their feedback into the focus of our goals, we will be enhancing the producer/customer relationship, which is critical in gaining their trust and cooperation. Finally, throughout the change process, it will be necessary to manage variation in order to ensure success.

CNL Competencies: In pursuing this quality improvement initiative, a Clinical Nurse Leader would assess the NICU's operations, measurable metrics, and patient population in the microsystem, and determine systems changes that could be implemented to improve patient outcomes. In this particular case, interdisciplinary workflows in labor and delivery as well as in the NICU need to be examined, and changes made in order to ensure that infants' temperatures are protected from the point of delivery, through resuscitation, transport, and recovery phases. Educational needs and modes of delivery require evaluation, as well as material requirements, documentation protocols, and data collection methods. Each of these interventions requires the skills inherent to the fundamental aspects of CNL practice, including advocacy for patients, stewardship and leveraging of resources, information management, risk anticipation, clinical leadership, and the accountability for evaluation and improvement of point-of-care outcomes (AACN, 2013).

A Clinical Nurse Leader would also analyze which additional patient populations could ultimately benefit from the quality improvements implemented for the target patient population. In the case of the KPSF NICU, although the preliminary data applied to infants < 29 weeks' gestational age, we soon determined that infants < 32 weeks were suffering from hypothermia on admission as well as those in the VLBW category, and therefore broadened the focus of our interventions to address these infants. Following the most recent microsystem assessment, the parameters of patient populations affected by neonatal hypothermia have been broadened once more, to include interventions to positively affect late preterm and term infants born in the medical center. Adequate data from this expansion of the project has not yet been collected; however, the same process of documentation and data collection as is currently being used for the VLBW population will be applied, and education is ongoing among staff nurses to ensure that, despite staff turnover, quality improvement interventions are consistently applied.

An added intervention recently discussed with the interdisciplinary Maternal Child Health leadership team was hypothermia prevention during delayed cord clamping in the delivery room and operating suites. The fact that this concern was raised by a labor and delivery physician gives credence to the progress being made in interdisciplinary communication, and critical thinking occurring across departmental boundaries in order to advocate for patients. According to the 2007 American Association of Colleges of Nursing (AACN) 2007 White Paper on the Education and Role of the Clinical Nurse Leader, essential skills of the CNL include, "communication, collaboration, negotiation, delegation, coordination, and evaluation of interdisciplinary work, and the application, design and evaluation of outcome-based practice models" (2007). This aspect of CNL responsibility will be especially critical as we pursue improvement of neonatal hypothermia for all infants in the in the Maternal Child Health setting in the months ahead.

Lessons Learned: Several lessons were learned thus far in relation to this project. The first surrounds the need to investigate explanations behind aberrations in data to correctly interpret the results. For instance, when initial baseline NICU hypothermia admission data was published, the assumption was made that the high hypothermic admission rate for the target population as consistently at a level close to 25.8%. With closer examination however, it became clear that this was a five-year average, during which there was an abnormal spike of 34.9%. The more realistic mean was closer to 21%. The success of the first year of targeted intervention at 9.5% was dramatic, but slightly less so when viewing the trends of the previous years.

The other lesson learned in terms of data was the diligence that is required in maintaining education and compliance of new practice measures among nursing staff, before these measures become part of the normalized work flow. Given the challenges encountered among the NICU staff, I anticipate an even more significant effort will be required in order to establish buy in and revision to work flows in the expanded nursing staff of labor and delivery and postpartum units

Refinement of the target patient population to be integrated into the project also posed a challenge, and presented a valuable lesson. Although it was an understandable goal to apply hypothermia prevention interventions to all infants born in the medical center, I ultimately realized that this scope may be a bit too broad until proven teaching methods and interventions can be refined. By expanding only to high risk term and preterm infants for the upcoming cycle of the project, my focus can be more direct, and the impact to our patients more meaningful.

Throughout the planning process, I have learned about the flexibility, patience, and resolve needed to ensure successful collaboration of interdisciplinary teams, especially through numerous changes in leadership and their corresponding unit-specific priorities. Over the past several years, it has been difficult to gain agreement from Labor and Delivery leadership to increase the operating room temperatures above 72 degrees Fahrenheit. As noted in a 2016 journal article in ACTA Paediatrica, “While both the Neonatal Resuscitation Program (NRP) and the World Health Organization (WHO) want the temperature in the delivery room at 25.1°C (77° F), this recommendation is largely ignored. In developed countries, the priority has been the comfort of the mother and medical staff rather than the critically important thermal environment of the preterm infant” (Faranoff, A. & Faranoff, J., 2016).

The team at KPSF is experiencing similar obstacles. In addition to these hurdles however, a credible patient-related issue arose as well: Months after a compromise was reached with the Labor and Delivery physician leadership team resulting in an increased operating room temperature of 74 degrees Fahrenheit, internal department data showed an increase in surgical site infections (SSI’s) related to c-sections, prompting a request to return the Labor and Delivery operating room temperatures to their original settings of 72 degrees Fahrenheit. Whether this increase in SSI’s is directly attributable to the temperature of the operating rooms is being investigated by the Quality and Infection Control teams. According to the Association of Perioperative Nurses (AORN), the recommended temperature range in an operating room is between 68°F and 75°F (2015). As of this writing, discussions are set to continue with Quality, Infection Control, Labor and Delivery, the NICU, and the engineering leads in an effort to arrive at a solution that will best benefit and protect our both mothers and babies.

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