# Increasing Ambient Operating Room Temperatures to Decrease Hypothermia in Preterm Neonates

Destiny M. Jones, BSN, RN, FNE-A

Under the Supervision of

Barbara Van de Castle, DNP, RN-BC, ACNS-BC, OCN

Second Reader

Harsana Showunmi, DNP, CPNP

Clinical Site Representative

Claudia Williams, BSN, RN

A DNP Project Manuscript
Submitted in Partial Fulfillment of the Requirements for the
Doctor of Nursing Practice Degree

School of Nursing, University of Maryland at Baltimore
May 2023

## Abstract

**Problem:** Preterm neonates (≤32 weeks postmenstrual age [PMA] or ≤1500 grams [g]) frequently experience hypothermia or cold stress at time of delivery because of the low ambient air temperatures in the operating room (OR). There is a correlation between an admission temperature below 36.5°C and neurological injury, retinopathy of prematurity, intraventricular hemorrhage, and mortality. Evidence demonstrates that an OR temperature 73°F-77°F prevents hypothermia and cold stress of preterm neonates. A chart audit performed in 2022 illustrated that between 2/12/2022 and 3/23/2022, six preterm neonates within criteria had an average admission temperature of 36.1°C, with the ambient OR temperature being 68°F-72°F. The purpose of this quality improvement (QI) project is to increase the ambient temperatures of both ORs to at least 73°F-77°F to prevent neonatal hypothermia in preterm neonates <32 weeks' GA or <1500g.

**Methods**: The temperatures of both ORs were preset to 73°F by the building operations center (BOC) and consistent for all births. The day shift charge nurse recorded both daily OR temperatures from the temperature display in the OR. During the first seven weeks of implementation and for the remaining weeks the BOC provided both OR temperatures because they were more accurate. The temperatures were updated retroactively. A "Temperature Collection" Survey was completed by the charge nurse when a neonate within criteria was born to assess the OR temperature at delivery and the neonatal admission temperature.

**Results:** There were 14 births within the 15 weeks of implementation. Over 92% of the neonates were euthermic (36.5°C–37.5°C).

**Conclusion:** Increasing the ambient temperatures of both ORs to at least 72-73°F decreased neonatal hypothermia in 92 percent of the preterm neonates ≤32 weeks PMA or ≤1500g.


*Keywords*: Preterm neonate, operating room, hypothermia, cold stress, mortality

# Increasing Ambient Operating Room Temperatures to Decease Hypothermia in Preterm Neonates

According to Harriman et al. (2018), infant prematurity is the second leading cause of neonatal death in the United States, with over half of the infant deaths occurring in infants born less than 32 weeks PMA. In the first few minutes of life, premature, low birth weight (<1500 gs) neonates are vulnerable to developing hypothermia, hypoglycemia, infection, respiratory failure, and there is a substantial risk for morbidity and mortality (Glass et al., 2015; Harriman et al., 2018). Neonatal hypothermia at the time of delivery is common because of: the transition from the warm intrauterine environment to a cool, drafty environment, such as a low ambient delivery and operating room (OR) temperature (convection), the inability to produce the non-shivering mechanism to promote thermogenesis, limited ability for peripheral vasoconstriction, and increased evaporative heat loss and water loss (evaporation) through their immature skin (Duryea et al., 2016; Harriman et al., 2018; Jia et al., 2013). According to Lyu et al. (2015), there is a statistically significant association between low admission temperature and increased morbidity, such as neurological injury, retinopathy of prematurity (ROP), intraventricular hemorrhage (IVH), and mortality in premature infants born less than 32 weeks (Abiramalatha et al., 2021).

The practice problem was identified by a chart audit performed in 2022 in a level III Neonatal Intensive Care Unit (NICU) within a suburban community hospital that manages critically ill neonates. The chart audit yielded six preterm neonates that were born between 2/12/2022 and 3/23/2022 at an average age of 29 weeks, weight of 1145gs, temperature of 36.1°C, and an OR ambient temperature between 68°F-72°F. The average temperature of 36.1°C, is defined as cold stress and hypothermia (<36.5°C) by the World Health Organization (WHO) (Duryea et al., 2016). According to the World Health Organization (WHO) the ambient

OR temperature should be 23°C-26°C (73°F-77°F) (Duryea et al., 2016). The practice change implemented were: increasing the ambient OR temperatures to at least 23°C-25°C (73°F-77°F) to reduce hypothermia in neonates ≤1500gs or ≤32 weeks and to be consistent for all births, the charge nurse recording both OR temperatures daily, and the charge nurse documenting the OR temperature at delivery and the neonatal admission temperature when a neonate is within criteria.

**Available Knowledge**

Neonatal hypothermia is related to mortality, respiratory distress syndrome, necrotizing enterocolitis (NEC), and IVH (Lyu et al., 2015). According to Lyu et al. (2015), neonatal admission temperature has an inverse relationship with mortality (28% increase in mortality per 1°C decrease) and late-onset sepsis (11% increase per 1°C decrease). Duryea et al. (2016) and Jia et al. (2013) (Level I, Grade B) conducted a prospective non-blinded randomized controlled trial (RCT) that discovered increasing the delivery and operating room to 23°C-26°C (73°F-78°F) promoted euthermia in preterm neonates. Duryea et al. (2016) revealed that there was a decreased amount of hypothermia (<36.5°C) in the study group compared to the standard management group ($P$ <0.001) and Jia et al. (2013) concluded that the increase in ambient OR temperature had a direct relationship with the improvement of admission rectal temperatures ($p$ <0.01). Three quality improvement studies were examined (Level V, Grade A). Ashmeade et al. (2016) reports that increasing the temperature of the OR (72-76°F) increased the body temperature of the study population. The study population in Bhatt et al. (2020) showed less than 10% hypothermia in their extremely low birth weight (ELBW) neonates for the last two consecutive years whilst increasing the delivery room (DR)/OR temperature to 74°F. Manani et al. (2013) reported that increasing the DR/OR up to 25°C (77°F) reduced the overall percentage of hypothermia in very low birth weight neonates.

### Rationale

The Knowledge to Action Framework (KTA), developed by Graham and colleagues, helps contextualize the knowledge gained after evidence-based research and how to implement it (Figure 3). It encompasses two components, knowledge creation and the action cycle (Field et al., 2014). Knowledge creation includes knowledge inquiry, synthesis, and tools/products, while the action cycle illustrates the process and activities needed to apply knowledge into practice (e.g., problem identification and appraisal and the known research, identification of barriers and success, planning and executing, and monitoring, evaluating, and adjusting) (Field et al., 2014). In summary, this framework was utilized to facilitate knowledge generation into actuality, develop planning strategies, and to implement the project. KTA helped identify barriers and facilitated knowledge use such as lack of education about the importance of ambient OR temperatures. In addition, the action cycle provided a foundation and framework for the PL to initiate leadership and tailor interventions and implementations, education (seminars or presentations), and chart audits. Knowledge has been monitored by compliance to the intervention and sustaining knowledge was evaluated by monitoring ongoing adherence.

## Methods

### Context

The setting of this QI project was in a NICU within a suburban community hospital. This level III NICU manages the care of critically ill neonates, ranging from 23 weeks to full term with prematurity, congenital heart disease, respiratory distress, genetic syndromes, and metabolic disorders. The criteria for this QI were any neonates that were born in one of the two labor and delivery ORs, and were ≤32 weeks or ≤1500gs. The only exclusion criteria were neonates that

were >32 weeks or >1500gs, born in the delivery room (DR), or had major congenital anomalies, including neural tube defects, and congenital hypothyroidism.

QI projects are unique because there is limited control over contextual factors that may influence outcomes goals, yet one must be vigilant in addressing potential barriers. The contextual factors considered before implementation were provider buy-in in addition to approval from infection control, and the building operations center (BOC). A challenging accomplishment was to gain support from the lead obstetrician as she manages all procedures in both ORs in labor and delivery. An email was sent to the lead obstetrician by the project lead (PL) to illustrate the importance of increasing the ambient temperatures in the OR using an evidence review table (Table 1). The senior coordinator for infection prevention was contacted about the project, and their primary concern was the potential risk for infection. An increased OR temperature can increase the risk of surgical wound infections and compromise the surgical supplies causing disposal and waste of product. Infection control suggested that the OR temperatures should not be above 75°F, but the goal temperature of 73°F was permissible. In conclusion, all stakeholders agreed to the intervention in the interest of preventing hypothermia for the preterm neonates.

**Intervention**

The ABCDE Framework was utilized to identify strategies and tactics for project implementation (Table 3). The first strategy and tactic was the creation of a PowerPoint presentation using evidence-based research. CINAHL and PubMed databases were utilized to identify evidence-based research supporting that an OR temperature of 23°C-25°C (73°F-77°F) reduces hypothermia in preterm neonates. The other strategies and tactics included identifying the NICU clinical educator and clinical site representative (CSR) as the unit champion, sending

weekly reminders via email and a secure texting application about the intervention and how to document data. It was expressed that daily OR temperature documentation was expected on dayshift, and this was reiterated in the daily shift huddle. The first week of documentation of daily temperatures for the two ORs was at 40 percent compliance (Figure 4). Weekly reminder emails about the project and the daily huddles announcements were shown to be successful because after week one, there was 100 percent compliance. The updated process map (Figure 1) illustrates the post-implementation process performed by the project site. With permission from the lead obstetrician and infection control, the BOC increased the ambient temperature of both ORs to the goal of 73°F on August 29, 2022. The project was conducted for 15 weeks.

**Measures**

REDCap is a web-based application created by Vanderbilt University called Research Electronic Data Capture (REDCap) that was used to log data for this QI project. REDCap is a HIPAA compliant, password protected. A 'Post Presentation Survey' was created using REDCap and sent electronically to the staffs' emails and via a secured messaging system that is encrypted, and password protected to measure the number of staff that attended the PowerPoint presentation via WebEx in July 2022 (Appendix A). The survey was distributed after the PowerPoint presentation using an online survey generator because it can be sent to staff using a uniform resource locator and it automatically measured feedback based on the questionnaire. The survey was available for about a month for staff to complete. When a link was created using REDCap and sent to the staff, the link was not working and showing that the survey was not available, thus this is why an online survey generator was used instead.

Originally, the two printed data collection surveys, Pre-Op Checklist' and the 'Temperature Collection Survey,' helped measure the process and outcome change. These

surveys were created using REDCAP. The ‘Pre-Op Checklist’ was to be completed by the assigned charge nurse every day during dayshift. The ‘Pre-Op Checklist’ consists of the date, the temperature of OR 1 and OR 2, and the name of the charge nurse (Appendix B). The ‘Temperature Collection Survey,’ is to be completed by the charge nurse when a neonate meets criteria (Appendix C). It includes the date of birth, week of implementation, OR temperature at delivery, and the neonatal admission temperature. The project data collection was on paper using these surveys and provided to the staff by the PL instead of using a quick response code or an email link because it was easily accessible for the staff, and the staff did not have to use a computer when in the OR as computers are primarily used by the labor and delivery staff. In addition, the use of electronic devices are discouraged within the unit and are not used in the OR due to the increased risk of infection from cross contamination. There is a decreased concern for infection while using paper. Once they were completed, the surveys were placed in a binder labeled ‘OR Temperatures’ that was in a locked drawer of the charge nurse desk to protect patient information and confidentiality. The PL manually logged the data into REDCap after completion. The logged data was checked twice by the PL to decrease the risk for data entry errors. REDCap was only able to be accessed by the PL, which was password protected using Cisco AnyConnect Secure Mobility Connect.

After week seven of implementation, the ‘Pre-Op Checklist’ was no longer used for data collection because there was a discrepancy in temperature between the thermostat display in the OR and the controller point within the BOC. The discrepancy was identified by the PL when collecting data that the OR temperature being collected was not reflecting what was agreed amongst stakeholders, 73°F. The average temperature for OR 1 and OR 2 was 72.07°F for the first seven weeks of implementation. The building operations control center (BOC) of the

institution was contacted about the temperature discrepancy and they stated that the room display showing 72°F was an error related to the thermostat display in both ORs because the controller point, which measures the OR accurately, within the BOC was reading both ORs at of 73°F. To prevent discrepancy, since week 7, the BOC provided printed data called the 'Trend Interval Report' every Sunday by emailing it to the PL using an encrypted work email. The report illustrated the date, time, and temperature of both ORs. The PL calculated the average temperature of both ORs for the week and placed it into REDCap every Sunday.

An axillary temperature was collected as the neonatal admission temperature when the neonate was brought to their room in the NICU. An axillary temperature was chosen as the measurement because this is the primary way to assess temperature in this NICU, which increased compliance. In addition, an axillary temperature was used by Bhatt et al. (2020), Duryea et al. (2016), and Manani et al. (2013) during literature review. This increased reliability and validity because the temperature was being measured using the same method, and at the same time during the admission process. Another process measure was assessing documentation compliance amongst the charge nurses. Compliance with completing documentation was measured from week one to seven, by evaluating if the daily OR temperatures were being documented on the 'Pre-Op Checklist,' and if the 'Temperature Collection Survey' was being completed with every neonate that meets criteria.

**Ethical Considerations**

This QI project has been conducted ethically in accordance with beneficence, nonmaleficence, and justice. Research had been performed analyzing the research burdens and benefits, and research supported that increasing the OR temperatures would not cause interference of the rights of the patients, and it could maximize benefits and minimize harm

(Kim, 2012). To confirm safety, Non-Human Subject's Research Determination from the Human Research Protections Office (HRPO) of the University of Maryland School of Nursing (UMSON) Institutional Review Board (IRB) was obtained prior to project implementation. All of the surveys that were completed were discarded using a shredding machine every Sunday when the PL collected the data to ensure that any patient health identifiers (date of birth) were not able to been seen. These surveys were never taken home due to HIPAA.

## Results

The 'Post Presentation Survey' was completed by 12 NICU nurses, representing 75 percent of the recipients of education, the other 25 percent represented nurse practitioners, physicians, nurse manager, and clinical educator. This survey was used to verify that education was received via the PowerPoint on Webex in July 2022. A majority of the NICU staff did not respond to the survey, for reasons that are unknown; however, the PowerPoint presentation was presented at a mandatory meeting that all nurses had to attend. At the time of presentation, there were 40 nurses at the meeting, and we had 47 staff nurses employed on this unit. This concludes that 40 out of the 47 nurses received education in comparison to the 12 nurses that filled out the survey at the time of education. Participation could have been encouraged by The PowerPoint presentation was emailed to all staff within the NICU, mother baby, and labor and delivery to continue education and be a resource. To increase compliance of the survey, a reminder message was sent once using our secure texting app, however, there was not any improvement.

Daily documentation of both ORs using the 'Pre-Op Checklist' ranged from 40% to 100% from week two to week seven. Since the reminder was implemented in week two, documentation occurred every day, 100% compliance. After week seven, the remaining weeks of implementation, the BOC provided interval reports that were collected by the PL and were

placed into REDCap. As mentioned previously, due to the inaccuracy of temperature readings, the OR temperatures were updated retroactively to give more accurate and precise data. This unexpected situation could be viewed as a barrier; however, the temperature discrepancy was addressed before the end of implementation, and it was favorable to the charge nurse as it took the burden off them to check OR temperatures every day. Documenting the OR temperature during a preterm delivery and the neonate's temperature on admission was at 100% compliance (Figure 4).

The temperature range of both ORs were 72°F to 73.5°F throughout the 15-week implementation. The mean for both ORs was 72.86 °F, with a median of 73°F. It is to be addressed that the OR temperature did not meet the goal of a consistent temperature of 73°F, although the mean was 72.86 °F and the median was 73°F as recommended by various sources, including WHO (Duryea et al., 2016). There were 14 neonates that met the criteria. Despite the temperature not consistently meeting goal, 13 of the 14 were euthermic at 36.5°C–37.5°C (92.9% percent), and the one neonate that was not euthermic had a temperature of 36.4°C, right below goal. The range of the neonatal temperatures was 36.4-37.1 °C with a mean and median was 36.8°C (Figure 5). As previously mentioned, the 'Temperature Collection Survey' was to be completed by the charge nurse when a neonate meets criteria and it included the date of birth, week of implementation, OR temperature at delivery, and the neonatal admission temperature. The 'Temperature Collection Survey' was collected by the PL every Sunday and placed in REDCap while in the institution, and not at home, and to decrease the risk of inaccuracy, it was checked twice by the PL before it was absolutely admitted within REDCap (Appendix C).

## Discussion

As previously stated, 92.9 percent of the neonates met the set temperature goal when the OR temperature was increased from the previous 68-72°F. There were three runs and five consecutive points present above the median and goal line demonstrating consistency with the temperatures being above goal (Figure 5). The results were comparable to the literature analyzed. Duryea et al. (2016) conducted an open, non-blinded RCT that showed that increasing the delivery and operating room to at least 73°F promoted euthermia in the same population as this QI. Duryea et al. (2016) revealed that there was a decreased amount of hypothermia (<36.5°C) in the study group compared to the standard management group ($P < 0.001$), and there was a decrease in moderate to severe hypothermia (<36°C) ($P < 0.001$) (Table 1).

The vitals of all 14 neonates were stable throughout admission and this is important to note because if a neonate was experiencing hypothermia or cold stress it would be reflected in their vital signs. Their blood pressure and heart rate can decrease, the respiratory rate could be too elevated, and their oxygen saturation can be too low leading to respiratory distress (Bröring et al., 2017). In addition, these neonates did not experience any significant long-term effects like ROP or IVH. This shows that sustainability of this intervention would be potentially beneficial for the short-term and long-term.

This project positively impacted the staff because when a preterm neonate is delivered and admitted to the NICU and they are euthermic, it helps prevent the need for further intervention. If the neonate is experiencing hypothermia or cold stress, as discussed previously, they could start to decompensate, needing more staff, and more hands-on attention to the infant. If these stressful situations were able to be prevented by an increase in the OR temperature, the nursing staff will not have to be constantly at the bedside touching the neonate and stimulating them to stabilize their vital signs, place them on respiratory support, or complete invasive

procedures like peripheral intravenous catheters, or umbilical arterial and venous lines. When a preterm neonate is born, it is best evidence-based practice to not constantly touch or stimulate them. According to Bröring et al. (2017), sensory overstimulation with bright lights, excessive noise, repetitive handling, and pain (heel lancing, venipuncture), can affect brain development due to elevated stress markers. Euthermia can help prevent the need for further interventions that can cause stress to the neonate. There should be minimal financial implications due to the following: no need for capital expenses (equipment), no supplemental or specialized staff members to employ, and it limits further complications associated with prematurity previously mentioned. The current HVAC system is sufficient and only needs superficial manipulation, such as touching the thermostat. The BOC does not have to revamp the system, in addition, they already have the required staff and knowledge to maintain hospital equipment. The nurses and staff members who monitor the temperatures are simply doing this as an everyday safety and environmental checks.

A factor that could have limited internal validity were the survey tools that were created to collect temperatures; however, the collection surveys increased reliability as it was consistently used by the same group of rotating charge nurses during implementation. The surveys demonstrated face validity as they were specifically created for this QI project and they were approved by the stakeholders, the medical director of the NICU and the CSR. The surveys were carefully designed to measure what is intended to be measured to decrease imprecision in the project design. The surveys were created to specifically measure the relationship between OR temperatures and neonatal admission temperatures and it explicitly does this by collecting the necessary data (Appendix B, Appendix C).

## Conclusion

The results of this QI project support the literature that OR temperatures of 23°C-25°C (73°F-77°F) decrease neonatal hypothermia in preterm neonates that are ≤32 weeks' PMA or ≤1500g. Although the OR temperatures didn't reach desired values consistently, this QI project does support the evidence-based literature because of the favorable results seen with the increase of OR temperatures. The implication for practice was to maintain appropriate temperatures for safety of the neonates, and to improve staff awareness of the importance of neonatal thermoregulation, and the prevention of cold stress in neonates to prevent long-term effects such as neurological injury, IVH, ROP, sepsis, and mortality. Improving staff awareness and continuing education will also help with sustainability because they will value the importance of the first hour of life in this population. In addition, this project was viewed as important to the medical director and the clinical educator because it is a component of the Golden Hour Protocol that will be implemented in Fall 2023. The Golden Hour Protocol (GHP) is a bundle of evidence-based clinical practice that occurs during neonatal resuscitation that standardizes the care of a premature infant in the first hour of life. It is integral to providing optimal and consistent care in the NICU. The implementation of this QI helped pave the way for GHP, making it a smoother transition in the Fall of 2023.

## References

Abiramalatha, T., Ramaswamy, V. V., Bandyopadhyay, T., Pullattayil, A. K., Thanigainathan, S., Trevisanuto, D., & Roehr, C. C. (2021). Delivery Room Interventions for Hypothermia in Preterm Neonates: A Systematic Review and Network Meta-analysis. JAMA Pediatrics, 175(9), e210775. https://doi-org.proxy-hs.researchport.umd.edu/10.1001/jamapediatrics.2021.0775

Ashmeade, T. L., Haubner, L., Collins, S., Miladinovic, B., & Fugate, K. (2016). Outcomes of a Neonatal Golden Hour Implementation Project. *American journal of medical quality : the official journal of the American College of Medical Quality*, *31*(1), 73–80. https://doi.org/10.1177/1062860614548888

Austvoll-Dahlgren, A., Nsangi, A., & Semakula, D. (2016). Interventions and assessment tools addressing key concepts people need to know to appraise claims about treatment effects: a systematic mapping review. *Systematic reviews*, *5*(1), 1-11.

Bhatt, D. R., Reddy, N., Ruiz, R., Bustos, D. V., Peacock, T., Dizon, R. A., Weerasinghe, S., Braun, D. X., & Ramanathan, R. (2020). Perinatal quality improvement bundle to decrease hypothermia in extremely low birthweight infants with birth weight less than 1000 g: single-center experience over 6 years. *Journal of investigative medicine : the official publication of the American Federation for Clinical Research*, *68*(7), 1256–1260. https://doi.org/10.1136/jim-2020-001334

Bingham, D. & Main, E. (2010). Effective implementation strategies and tactics for leading change on maternity units. Journal of Perinatal and Neonatal Nursing, 24(1), 32-42.

Bonawitz, K., Wetmore, M., Heisler, M., Dalton, V. K., Damschroder, L. J., Forman, J., ... & Moniz, M. H. (2020). Champions in context: which attributes matter for change efforts in healthcare?. *Implementation science*, *15*(1), 1-10.

Bröring, T., Oostrom, K. J., Lafeber, H. N., Jansma, E. P., & Oosterlaan, J. (2017). Sensory modulation in preterm children: Theoretical perspective and systematic review. PloS one, 12(2), e0170828. https://doi.org/10.1371/journal.pone.0170828

Duryea, E. L., Nelson, D. B., Wyckoff, M. H., Grant, E. N., Tao, W., Sadana, N., Chalak, L. F., McIntire, D. D., & Leveno, K. J. (2016). The impact of ambient operating room temperature on neonatal and maternal hypothermia and associated morbidities: a randomized controlled trial. *American journal of obstetrics and gynecology*, *214*(4), 505.e1–505.e7. https://doi.org/10.1016/j.ajog.2016.01.190

Field, B., Booth, A., Ilott, I., & Gerrish, K. (2014). Using the Knowledge to Action Framework in practice: a citation analysis and systematic review. *Implementation science : IS*, *9*, 172. https://doi.org/10.1186/s13012-014-0172-2

Glass, H. C., Costarino, A. T., Stayer, S. A., Brett, C. M., Cladis, F., & Davis, P. J. (2015). Outcomes for extremely premature infants. *Anesthesia and analgesia*, *120*(6), 1337–1351. https://doi.org/10.1213/ANE.0000000000000705

Harriman, T. L., Carter, B., Dail, R. B., Stowell, K. E., & Zukowsky, K. (2018). Golden Hour Protocol for Preterm Infants: A Quality Improvement Project. *Advances in neonatal care : official journal of the National Association of Neonatal Nurses*, *18*(6), 462–470. https://doi.org/10.1097/ANC.0000000000000554

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. *Journal of perinatology : official journal of the California Perinatal Association*, *33*(4), 264–267. https://doi.org/10.1038/jp.2012.100

Kim W. O. (2012). Institutional review board (IRB) and ethical issues in clinical research. Korean journal of anesthesiology, 62(1), 3–12. https://doi.org/10.4097/kjae.2012.62.1.3

Kullgren, J. T., Williams, G. C., Resnicow, K., An, L. C., Rothberg, A., Volpp, K. G., & Heisler, M. (2016). The Promise of Tailoring Incentives for Healthy Behaviors. *International journal of workplace health management*, *9*(1), 2–16. https://doi.org/10.1108/IJWHM-12-2014-0060

Lyu, Y., Shah, P. S., Xiang, Y. Y., Warre, R., Piedboeuf, B., Deshpandey, A., ... & Canadian Neonatal Network. (2015). Association between admission temperature and mortality and major morbidity in preterm infants born at fewer than 33 weeks' gestation. *JAMA pediatrics*, *169*(4), e150277-e150277.

Manani, M., Jegatheesan, P., DeSandre, G., Song, D., Showalter, L., & Govindaswami, B. (2013). Elimination of admission hypothermia in preterm very low-birth-weight infants by standardization of delivery room management. *The Permanente journal*, *17*(3), 8–13. https://doi.org/10.7812/TPP/12-130

Pappas, Y., Atherton, H., Sawmynaden, P., & Car, J. (2012). Email for clinical communication between healthcare professionals. *Cochrane Database of Systematic Reviews*, (9).

Peleg, B., Globus, O., Granot, M., Leibovitch, L., Mazkereth, R., Eisen, I., ... & Strauss, T. (2019). "Golden Hour" quality improvement intervention and short-term outcome among preterm infants. *Journal of Perinatology*, *39*(3), 387-392

Penciner, R. (2013). Does PowerPoint enhance learning? *Canadian Journal of Emergency Medicine, 15*(2), 109-112. doi:10.2310/8000.2013.130756

Powell, B. J., Waltz, T. J., Chinman, M. J., Damschroder, L. J., Smith, J. L., Matthieu, M. M., Procter, E.K., & Kirchner, J. E. (2015). A refined compilation of implementation

strategies: Results from the Expert Recommendations for Implementing Change (ERIC) project. Implementation Science, 10(1), 21. Retrieved from https://implementationscience.biomedcentral.com/articles/10.1186/s13012-015-0209-1

Reynolds, S. (2020). Using audit and feedback to improve compliance with evidence-based practices. *American Nurse*

## Table 1

*Evidence Review Tables*

| | |
|---|---|
| **Citation:** Ashmeade, T. L., Haubner, L., Collins, S., Miladinovic, B., & Fugate, K. (2016). Outcomes of a Neonatal Golden Hour Implementation Project. *American journal of medical quality : the official journal of the American College of Medical Quality*, *31*(1), 73–80. https://doi.org/10.1177/1062860614548888 | Level **V** (Stillwell et al., 2010)<br>Grade **A** (Dang & Dearholt, 2018). |
| **Purpose/Hypothesis** | The purpose of this study was to implement a quality improvement project, the golden hour pathway (GHP), in the Neonatal Intensive Care Unit (NICU) which aims to improve the quality and efficiency of the care provides to low birth weight babies that are under <28 weeks and <1000g during the first hour of life. |
| **Type of Evidence Research Design** | Quality Improvement and retrospective collection of baseline data. |
| **Sample – Population, Size, Setting** | **Sampling Technique:** Convenience—pre and post implementation groups.<br>**Setting:** Level IV NICU, 82 bed in Tampa, Florida.<br>**Population:** Neonates delivered at GA <28 weeks and/or 1000 grams birth weight (BW).<br>**Eligible:** 295<br>**Accepted:** 295; the prospective data was compared with data that was abstracted from a chart review for NICU admissions that met the same GA and birth weight prior to GHP implementation (December 2007 to October 2009).<br>**Control:** 173; Similar infants that were treated before GHP implementation.<br>**Intervention:** 122; Infants who met criteria after GHP implementation.<br>**Power analysis:** No power analysis conducted.<br>**Group Homogeneity:** Baseline demographic and clinical variables were similar between both groups (Appendix 1). |
| **Intervention Procedures** | **Control:** These participants were prior to the GHP implementation. The neonates were placed in a polyethylene wrap; trainees who would make several attempts to intubate for infants requiring intubation, delaying a secure airway; no time schedule to initiate dextrose and amino-acid administration or place access.<br>**Intervention:** These participants were postimplementation of the GHP. The application of a polyethylene occlusive wrap immediately after delivery of the infant; **Delivery rooms (DR) between 72-76°F**; Only proficient practitioners were allowed to intubate in the DR; Umbilical lines were placed immediately after NICU admission—fluids were administered prior to X-ray confirmation of the line placement for umbilical vein catheters (UVC).<br>**Intervention fidelity (describe the protocol):** The team practiced using high-fidelity interprofessional simulation both in the simulation center, DRs, and the NICU. |
| **Primary Outcome/Measures** | **Dependent Variable:** Body temperature in NICU during admission; Time from NICU admission to dextrose and amino acid administration; Time from birth to surfactant administration for infants intubated in the DR.<br>**Dependent Measure:** Visual observation and chart review; No instrument or tool utilized for outcome measure; No reliability data. |
| **Results/Conclusions** | **Statistical Method:** Nominal data was analyzed with $X^2$ or Fisher exact test. Continuous data analyzed by the student *t* test. Ordinal or nonparametric data was analyzed by the Wilcoxon rank sums. A *P* value <0.5 was considered statistically significant. |

| | |
|---|---|
| | **Statistical Results:** Time from birth to surfactant administration was improved ($P < 0.001$); Higher percentage of infants with a body temperature of >97.6°F; Decrease in the amount of time from NICU admission to dextrose and amino acid administration ($P < 0.001$). Post GHP implementation decreased the development of chronic lung disease by 64% and a 48% reduction in the development of ROP.<br>**Clinical Significance and Conclusions:** This study reports that increasing the temperature of the delivery room (72-76°F); increases the percentage of neonates who are euthermic, decreases the time of surfactant administration, and there was a decrease in the amount of time to administered fluids. |
| **Citation:** Bhatt, D. R., Reddy, N., Ruiz, R., Bustos, D. V., Peacock, T., Dizon, R. A., Weerasinghe, S., Braun, D. X., & Ramanathan, R. (2020). Perinatal quality improvement bundle to decrease hypothermia in extremely low birthweight infants with birth weight less than 1000 g: single-center experience over 6 years. *Journal of investigative medicine : the official publication of the American Federation for Clinical Research*, *68*(7), 1256–1260. https://doi.org/10.1136/jim-2020-001334 | Level **V**<br>(Stillwell et al., 2010)<br>Grade **A**<br>(Dang & Dearholt, 2018). |
| **Purpose/Hypothesis** | The purpose of this study was to design a thermoregulation bundle to decrease hypothermia (<36.5°C) in ELBW neonates. |
| **Type of Evidence Research Design** | **Research or Practice:** Quality Improvement with data recorded during the period of January 1, 2014 and December 31, 2019. |
| **Sample – Population, Size, Setting** | **Sampling Technique:** Convenience sample of preterm neonates born <32 weeks' GA.<br>**Setting:** Level III NICU, 25 beds in an non-academic center.<br>**Population:** Neonates <32 weeks' GA at birth and born in the medical center.<br>**Eligible:** 200.<br>**Excluded:** All neonates born <32 weeks' GA were included except for the neonates that died in the DR/OR.<br>**Accepted:** 200.<br>**Intervention:** 200.<br>**Power analysis:** Not stated.<br>**Group Homogeneity:** There was no significant differences between the two groups in regard to GA, weight, or gender. |
| **Intervention Procedures** | **Control:** Pre-protocol, standard practice. The OR was originally before the implementation of the QI was 20°C (68°F).<br>**Intervention:** Dedicated DR/OR for neonates <32 weeks' GA 24/7 at 74°F by the hospital engineering staff in addition to standard practice.<br>**Intervention fidelity (describe the protocol):** Staff education for nurses, labor and delivery and NICU, obstetricians, neonatologist, neonatal nurse practitioner and respiratory care. |
| **Primary Outcome/Measures** | **Dependent Variable:** Axillary temperature of 36.5°C-37.5°C.<br>**Dependent Measure:** Document the temperature of the DR/OR and the neonates first temperature in the NICU. Record the first axillary temperature within 15 minutes of admission and then every 15 minutes until the temperature reaches 36.5°C-37.5°C. No reliability data. |
| **Results/Conclusions** | **Statistical Method:** Not stated.<br>**Statistical Results:** <10% of the neonates were hypothermic after implementation of the thermoregulation bundle.<br>**Clinical Significance and Conclusion:** The authors were able to accomplish their goals of <10% hypothermia in their ELBW neonates for the last two consecutive years whilst increasing the DR/OR temperature to 74°F. |
| **Citation:** Duryea, E. L., Nelson, D. B., Wyckoff, M. H., Grant, E. N., Tao, W., Sadana, N., Chalak, L. F., McIntire, D. D., & Leveno, K. J. (2016). The impact of ambient operating room temperature on neonatal and maternal hypothermia and associated | Level **I**<br>(Stillwell et al., 2010) |

| | | |
|---|---|---|
| morbidities: a randomized controlled trial. *American journal of obstetrics and gynecology*, *214*(4), 505.e1–505.e7. https://doi.org/10.1016/j.ajog.2016.01.190 | | Grade **B** (Dang & Dearholt, 2018). |
| **Purpose/Hypothesis** | The purpose of this study was to determine whether increasing the temperature of the operating room (OR) at a cesarean delivery would decrease the rates of neonatal hypothermia. | |
| **Type of Evidence Research Design** | **Research or Practice:** Open, non-blinded, RCT—cluster randomization. | |
| **Sample – Population, Size, Setting** | **Sampling Technique:** Convenience. Cluster randomization technique.<br>**Setting:** University of Texas Southwestern Medical Center.<br>**Population:** Neonates between 28 weeks' GA to full term.<br>**Eligible:** 846.<br>**Excluded:** 21—excluded for anomalies or emergency deliveries.<br>**Accepted:** 825 randomized.<br>**Control:** 419—term (N=354) (84%) and preterm (N=65) (16%).<br>**Intervention:** 406—term (N=325) (80%) and preterm (N=81) (20%).<br>**Power analysis:** 788 infants or 394 per treatment group would have been required to have 90% power to detect a 25% reduction in hypothermia.<br>**Group Homogeneity:** The GA in the study group was lower than the standard management group (*P*=0.02). There was not a statistically significant in rates of preterm infants. There was not a difference in birthweight between the study group and the standardized management group (*P* =0.06). Maternal demographics were similar in each group.<br>**Randomization:** Cluster randomization was performed with the treatment group on a rotating weekly basis according to the computer-generated random schedule. | |
| **Intervention Procedures** | **Control:** Preexisting standard for OR temperature, 20 °C (67°F)<br>**Intervention:** OR temperature 23°C (73°F).<br>**For Both Control and Intervention groups:** Infants who were >32 weeks GA were resuscitated using a radiant warmer, thorough drying, and placement of prewarmed dry blankets and a knitted hit. Infants born <32 weeks GA the radiant warmers were used for drying, followed by placement of a plastic poncho and hat. Warmed gel mattress was for infants <28 weeks GA. Infants transported to NICU were placed in a transporter that was 38°C (100.4°F).<br>**Intervention fidelity (describe the protocol):** Not stated. | |
| **Primary Outcome/Measures** | **Dependent Variable: The primary outcome:** Neonatal hypothermia on arrival to the admitting nursery (<36.5°C). **Secondary Outcome:** Intubation in the OR, ventilator in the first 24 hours, diagnosis of respiratory distress, surfactant administration, hypoglycemia that required treatment, umbilical artery pH <7.0, Grade III or IV IVH, and positive blood cultures.<br>**Dependent Measure:** The OR temperature was displayed on the room thermostat and was recorded for each patient. A continuous temperature recording was placed in each OR during the duration of the study to be regularly reviewed. Providers were not blinded to the temperatures. The randomization schedule was known only to the investigator, statistician, and building engineering staff. A rectal temperature was measured for every infant in the OR approximately 5 minutes of life and axillary temperatures were measured on arrival to the admitting nursery (primary outcome). No instrument or tool utilized for outcome measure, No reliability data. | |

| | |
|---|---|
| **Results/Conclusions** | **Statistical Method:** Pearson $X^2$ and Fisher exact test for categorical data. Student *t* test for continuous data. Mantel-Haenszel test for trend analysis. *P* values <0.05 were considered significant.<br>**Statistical Results:** There was a decreased amount of hypothermia (<36.5°C) in the study group compared to the standard management group (*P* <0.001), and there was a decrease in moderate to severe hypothermia (<36°C) (*P* <0.001).<br>**Clinical Significance and Conclusion:** Increasing the temperature of the OR to 23°C (73°F) was successful in preventing hypothermia in these neonates. |
| **Citation:** 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. *Journal of perinatology : official journal of the California Perinatal Association*, *33*(4), 264–267. https://doi.org/10.1038/jp.2012.100 | Level **I**<br>(Stillwell et al., 2010)<br>Grade **B**<br>(Dang & Dearholt, 2018). |
| **Purpose/Hypothesis** | The purpose of this study is to determine if increasing the temperature in the DR (as recommended by World Health Organization [WHO]) will increase the admission temperature of the preterm neonates. |
| **Type of Evidence Research Design** | **Research or Practice:** Prospective RCT |
| **Sample – Population, Size, Setting** | **Sampling Technique:** Convenience sample of preterm neonates born <32 weeks' GA.<br>**Setting:** Level III NICU, 90 beds in the Yuying Children's Hospital in Eastern China. The study was performed from March 1, 2010 to February 28, 2011.<br>**Population:** Neonates delivered at a GA <32 weeks.<br>**Eligible:** 89.<br>**Excluded:** Neonates with major congenital anomalies.<br>**Accepted:** 89.<br>**Control:** 48.<br>**Intervention:** 43.<br>**Power analysis:** 42 neonates needed in each group to have 90% power.<br>**Group Homogeneity:** The baseline characteristics of the two groups were nonsignificant (Table 1).<br>**Randomization:** Randomization was performed by opening a sealed preset envelope with either the regular or warm room assignment. |
| **Intervention Procedures** | **Control:** The control DR and ORs were kept at a room temperature of 20°C -23°C<br>**Intervention:** In one DR and one OR, the room temperature was set up to 24°C-26°C<br>**Intervention fidelity (describe the protocol):** After informed consent was obtained, the patient was assigned randomly to deliver in a regular DR or OR or in a warm DR or OR. |
| **Primary Outcome/Measures** | **Dependent Variable:** Rectal temperature (measured with standard mercury thermometer) taken on admission to the NICU along with other vital signs during the first hour of life.<br>**Dependent Measure:** The temperature was recorded in the medical chart by the NICU nurse. No reliability data.<br>**Instrument:** The Clinical Risk Index for Babies (CRIB) is a five-item instrument that can be calculated from the birth weight, GA, sex, admission temperature, and base excess. No reliability data. |
| **Results/Conclusions** | **Statistical Method:** Student's *t* test was used for comparison of the two groups for all normally distributed numerical data. The $X^2$ test was used for categorical data. Simple linear regression was used to identify potential confounding factors that would affect the results. Numerical data was presented as mean or s.d. A *P* value <0.05 was considered statistically significant.<br>**Statistical Results:** The admission rectal temperatures were increased significantly (*p* <0.01). |

| | |
|---|---|
| | **Clinical Significance and Conclusion:** Increasing DR temperature (24°C-26°C), as recommended by WHO decreases cold stress in premature neonates. |
| **Citation:** Manani, M., Jegatheesan, P., DeSandre, G., Song, D., Showalter, L., & Govindaswami, B. (2013). Elimination of admission hypothermia in preterm very low-birth-weight infants by standardization of delivery room management. *The Permanente journal*, *17*(3), 8–13. https://doi.org/10.7812/TPP/12-130 | Level **V** (Stillwell et al., 2010) Grade **A** (Dang & Dearholt, 2018). |
| **Purpose/Hypothesis** | The purpose of this study was to implement quality improvement research to increase admission temperatures to above 36°C by preventing heat loss in the immediate postnatal period in preterm neonates <33 weeks' GA. |
| **Type of Evidence Research Design** | **Research or Practice:** Quality Improvement, pre/post-design, prospective data collection. |
| **Sample – Population, Size, Setting** | **Sampling Technique:** Convenience sample of preterm neonates born <33 weeks and <1500g.<br>**Setting:** Level III NICU, 40 bed country hospital.<br>**Population:** Neonates delivered at a GA <33 weeks and <1500g.<br>**Control:** 59.<br>**Intervention:** 289.<br>**Power analysis:** Not stated.<br>**Group Homogeneity:** The baseline characteristics of the two groups were nonsignificant (Table 2). |
| **Intervention Procedures** | **Control:** Pre-protocol, baseline data. Preterm neonates born at this institution between January 2006 and June 2006 at <33 weeks' GA with a weight <1500g. Ambient air temperatures were based on the comfort of the staff and were frequently less 20°C (68°F). In addition, there was a lack of close monitoring of neonatal temperature, a knowledge gap regarding the neonatal neutral thermal environment among staff, and limited staff training.<br>**Intervention:** The target population was between January 2006 and December 2011 at <33 weeks' GA with a weight <1500g. Increase the ambient delivery room temperature to 25°C or higher, in addition to standard care (prewarmed resuscitation bed, polyethylene occlusive wrap, warming lights, newborn hat, and warming chemical mattress).<br>**Intervention fidelity (describe the protocol):** A multidisciplinary Thermoregulation Committee was created consisting of nurses, physicians, and nurse practitioners to help research and guide implementation. After the guideline was created the committee team members were responsible for staff education. IRB approved of intervention. |
| **Primary Outcome/Measures** | **Dependent Variable: The primary outcome:** Prevention of hypothermia, defined as an axillary temperature <36.5°C on admission to the NICU. **Secondary outcome:** Survival without serious morbidity including necrotizing enterocolitis (NEC), CLD, nosocomial infection, severe IVH, and severe ROP.<br>**Dependent Measure:** Serial temperature measurements in the DR. No reliability data. |
| **Results/Conclusions** | **Statistical Method:** Not stated.<br>**Statistical Results:** The overall percentage of hypothermia in very low birth weight VLBW) infants was reduced from 44% in early 2006 to 0% by 2009.<br>**Clinical Significance and Conclusion:** Hypothermia was prevented in VLBW neonates by increasing the DR temperature to 25°C. |

## Table 2

*Evidence Synthesis Table*

| Category (Level Type) | Total Number of Sources/Level | Overall Quality Rating | Synthesis of Findings |
|---|---|---|---|
| Level 1 - Experimental study · Randomized Controlled Trial (RCT) · Systematic review of RCTs with or without meta-analysis | **2 Non-Blinded RCTs**<br><br>1) Duryea, E. L., Nelson, D. B., Wyckoff, M. H., Grant, E. N., Tao, W., Sadana, N., Chalak, L. F., McIntire, D. D., & Leveno, K. J. (2016). The impact of ambient operating room temperature on neonatal and maternal hypothermia and associated morbidities: a randomized controlled trial. *American journal of obstetrics and gynecology*, *214*(4), 505.e1–505.e7. https://doi.org/10.1016/j.ajog.2016.01.190<br>2) 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. *Journal of perinatology : official journal of the California Perinatal Association*, *33*(4), 264–267. https://doi.org/10.1038/jp.2012.100 | **B** | Duryea et al. (2016) and Jia et al. (2013) found that increasing the delivery and operating room to 23℃ -26℃ as supported by the World Health Organization (WHO) lowered admission hypothermia. |
| Level II · Quasi-experimental studies · Systematic review of a combination of RCTs and quasi-experimental studies, or quasi-experimental studies only, with or without meta-analysis | **0** | | |
| Level III · Non-experimental study · Systematic review of a combination of RCTs, quasi-experimental, and non-experimental studies, or non-experimental studies only, with or without meta-analysis · | **0** | | |

| | | | |
|---|---|---|---|
| Qualitative study or systematic review of qualitative studies with or without meta-synthesis | | | |
| Level IV · Opinion of respected authorities and/or reports of nationally recognized expert committees/consensus panels based on scientific evidence | **0** | | |
| Level V · Evidence obtained from literature reviews, quality improvement, program evaluation, financial evaluation, or case reports · Opinion of nationally recognized expert(s) based on experiential evidence | **3 QIs**<br>1) Ashmeade, T. L., Haubner, L., Collins, S., Miladinovic, B., & Fugate, K. (2016). Outcomes of a Neonatal Golden Hour Implementation Project. *American journal of medical quality : the official journal of the American College of Medical Quality*, *31*(1), 73–80. https://doi.org/10.1177/1062860614548888<br>2) Bhatt, D. R., Reddy, N., Ruiz, R., Bustos, D. V., Peacock, T., Dizon, R. A., Weerasinghe, S., Braun, D. X., & Ramanathan, R. (2020). Perinatal quality improvement bundle to decrease hypothermia in extremely low birthweight infants with birth weight less than 1000 g: single-center experience over 6 years. *Journal of investigative medicine : the official publication of the American Federation for Clinical Research*, *68*(7), 1256–1260. https://doi.org/10.1136/jim-2020-001334<br>3) Manani, M., Jegatheesan, P., DeSandre, G., Song, D., Showalter, L., & Govindaswami, B. (2013). Elimination of admission hypothermia in preterm very low-birth-weight infants by standardization of delivery room management. *The Permanente journal*, *17*(3), 8–13. https://doi.org/10.7812/TPP/12-130 | **A** | Research performed by Ashmeade et al. (2016), Bhatt et al. (2020), and Manani et al. (2013) support that increasing the ambient temperature of the OR to reduce hypothermia in preterm neonates.<br>Ashmeade et al. (2016) studied preterm neonates <28 weeks' GA and/or 1000g, Bhatt et al. (2020) studied preterm neonates <32 weeks' GA, and Manani et al. studied preterm neonates <33 weeks' GA and <1500g.<br>Ashmeade et al. (2016) reports that increasing the temperature of the delivery room (72-76°F) increased the temperature of the study population. The study population in Bhatt et al. (2020) had <10% hypothermia in their ELBW neonates for the last two consecutive years while increasing the DR/OR temperature to 74°F. In addition, Manani et al. (2013) reported that increasing the DR/OR to 25°C reduced the overall percentage of hypothermia in VLBW infants from 44% in early 2006 to 0% by 2009. |
| Recommendations Based on Evidence Synthesis: Recommendations Based on Evidence Synthesis: The studies listed above illustrate good and consistent research supporting the implementation of increasing the OR ambient temperature 23°C-25°C (73°F-77°F). | | | |

## Table 3

*Implementation and Strategies Action Table (ABCDE)*

| Strategies | Tactics | Rationale | Monitoring over 15 Weeks |
|---|---|---|---|
| **Accountability:** Provide Performance Reviews (Bingham & Main, 2010; Powell et al., 2015). | Emails will be sent out about the compliance rate discussing why the intervention was not applied, the barriers, and suggestions about how to increase adherence. | This frequent communication can encourage the staff to give feedback about barriers and how to address them to reach the expectations of the project. Communication is crucial to prevent hinderance of implementation (Bonawitz et al., 2020). | Effectiveness can be tracked based on the intervention compliance that will be audited weekly. Auditing will determine if there is a need for an email to be sent out to the staff about performance. |
| **Buy-In:** Alter incentive/allowance Structures (Bingham & Main, 2010; Powell et al., 2015). | Donuts and coffee will be provided for the day shift and night shift biweekly if there is an 80% compliance rate. | Offering incentives has been used to increase the behavior wanted (intervention implementation) and to ensure the behavior is sustained (Kullgren et al., 2016). | Effectiveness can be based on the correlation between the number of times the intervention is implemented, and the number of incentives given. |
| **Collaboration:** Identify and prepare champions (Bingham & Main, 2010; Powell et al., 2015). | The primary unit champion will be the NICU educator because she is the foundation of providing education and ensuring nursing competency. | Champions are highly influential and can engage colleagues to overcome barriers to change. They are educated and supportive (Bonawitz et al., 2020). | Effectiveness will be tracked by communicating with the unit champion at least weekly to receive feedback about intervention compliance. |
| **Communication:** Remind Clinicians (Bingham & Main, 2010; Powell et al., 2015). | There will be weekly reminder emails about the intervention and how it is progressing. There will also be a one-page paper placed beside the thermostat in each OR to remind clinicians to document the temperature, and the temperature that the OR should be 23°C-25°C (73°F-77°F). | The one-page reminder can increase intervention compliance. Research states that email reminders change health professionals' actions significantly in comparison to not sending emails (Pappas et al., 2012). | Effectiveness can be tracked based on the intervention compliance that will be audited weekly. |
| **Changes in Structures:** Develop and implement tools for quality monitoring (Bingham & Main, 2010; Powell et al., 2015). | A Pre-Op Checklist and Temperature Collection Survey were developed using REDCap software and will be utilized to monitor the OR temperatures and the neonate's admission temperature. | The development and implementation of tools can evaluate the staffs understanding, adherence and success of then intervention (Austvoll-Dahlgren et al., 2016). | The Pre-Op Checklist and Temperature Collection Survey will be audited every week on Sundays to track project implementation. |

| | | | |
|---|---|---|---|
| **Data:** Complete audits and provide feedback (Bingham & Main, 2010; Powell et al., 2015). | The Pre-Op Checklist and Temperature Collection Survey will be collected to summarize clinical performance data over the 15-week implementation period. They will be monitored and evaluated to modify staff behavior to increase project compliance. | Using audit and feedback is effective to improve and sustain compliance with evidence-based practices, particularly when data is shared, and it can be used to improve practice (Reynolds, 2020). | Effectiveness can be tracked based on the intervention compliance that will be audited weekly for 15 weeks. |
| **Education:** Distribute educational materials (Bingham & Main, 2010; Powell et al., 2015). | An informative PowerPoint illustrating the evidence-based research and the importance of increasing the ambient OR temperature to prevent neonatal hypothermia will be created and sent to the staff prior to implementation. In addition, a copy of the PowerPoint will be available in a binder located at the charge nurse desk. | The PowerPoint can be used as a reference. It will reiterate then importance of the intervention and compliance. PowerPoint can be powerful and impactful because it increases learner satisfaction (Penciner, 2013). | Effectiveness can be tracked based on the intervention compliance that will be audited weekly for 15 weeks. |

**Table 4**

*Site Team*

| Site Team | | |
|---|---|---|
| **Team Member Name/Credentials/Title** | **Contact Information** | **Responsibilities** |
| 1. Destiny Jones, BSN, RN, FNE-A (Project Lead) | dmjones@umaryland.edu<br>(240) 904-3337 | • Lead the project planning, implementation, and evaluation<br>• Collect data by performing chart audits to extract internal data to validate the problem identified<br>• Develop a safe intervention<br>• Collect data for the project by performing chart audits and OR temperatures to measure effectiveness of the intervention after implementation<br>• Gather data for evaluation |
| 2. Allison Davis, PhD, RN (Project Faculty) | amdavis@umaryland.edu<br>(410) 706-2351 | • Help guide the project development to ensure success<br>• She can act as a resource to how to implement the project efficiently and safely |
| 3. Claudia Williams, BSN, RN, NICU Educator (CSR) | Claudia.Williams@umm.edu<br>(410) 337-1150 | • As the NICU educator she was able to help me identify a practice/project site problem that can better the quality of care and life of our neonatal patients<br>• She was able to provide input on the development of the project proposal.<br>• Develop a proposal for this project<br>• Facilitate the IRB process<br>• Gather data, provide guidance, and offer recommendations<br>• She can give advice on who to talk to increase the temperatures in the OR because there isn't a way to change the thermostat in the OR<br>• She can be support to the change if there is push back |
| 4. Sara Carter, BSN, RN, NICU Manager (Sponsor) | Sara.Carter@umm.edu<br>(410) 337-1290 | • Initiate unit approval and reinforce education on the unit as she is the unit manager<br>• Help build connections with other staff that can be helpful to this project implementation, like informatics and infection control<br>• Provide support of the CSR and student |

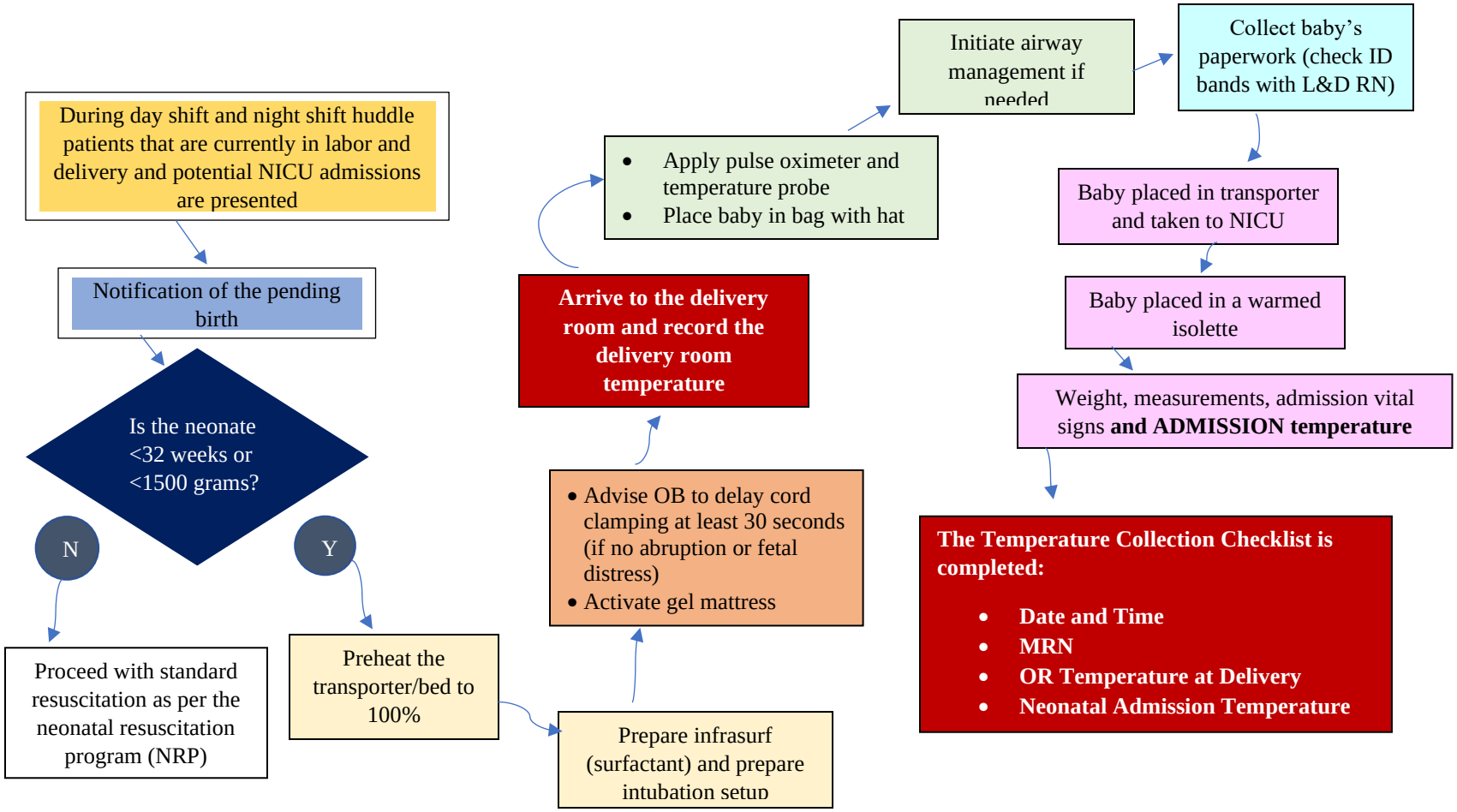
## Table 5

*Measures*

| Measures | | |
|---|---|---|
| **Project Structure Goals** | **Project Process Goals** | **Outcome Goal(s)** |
| 1. Gather a meeting with all the stakeholders (e.g., the medical director of the NICU, the lead obstetrician, NICU educator, NICU manager, Clinical Practice Specialist of Maternal Child Health, Senior Coordinator of Infection Control, and maintenance) to discuss the measurement plan and the project go live date.<br>2. Develop a presentation illustrating the evidence-based research and the importance of increasing the ambient OR temperature to prevent neonatal hypothermia completed by July 27, 2022.<br>3. Give the presentation between July 1, 2022-August 1, 2022.<br>4. 100% of the staff on the unit, including nurses, neonatal nurse practitioners, neonatologists, labor and delivery nurses, and obstetricians will receive education about the increase in ambient OR temperatures by August 1, 2022. | 1. OR temperatures on dayshift, OR temperature at delivery, and the neonate's admission temperature will be documented in the "OR Temperatures" binder by the assigned NICU nurse starting August 29, 2022.<br>2. OR's thermostat will be set to at least 23°C-25°C (73°F-77°F) starting August 29, 2022. | 1. 100% of the OR temperatures will be at least 23°C-25°C (73°F-77°F) with any preterm neonate that is <32 weeks' GA or <1500 grams.<br>2. 100% of the neonates will be euthermic (36.5°C–37.5°C).<br>3. Documentation of the dayshift OR temperature, the OR temperature during delivery, and the neonate's admission temperature will be documented 100% of the time. |

**Figure 1**

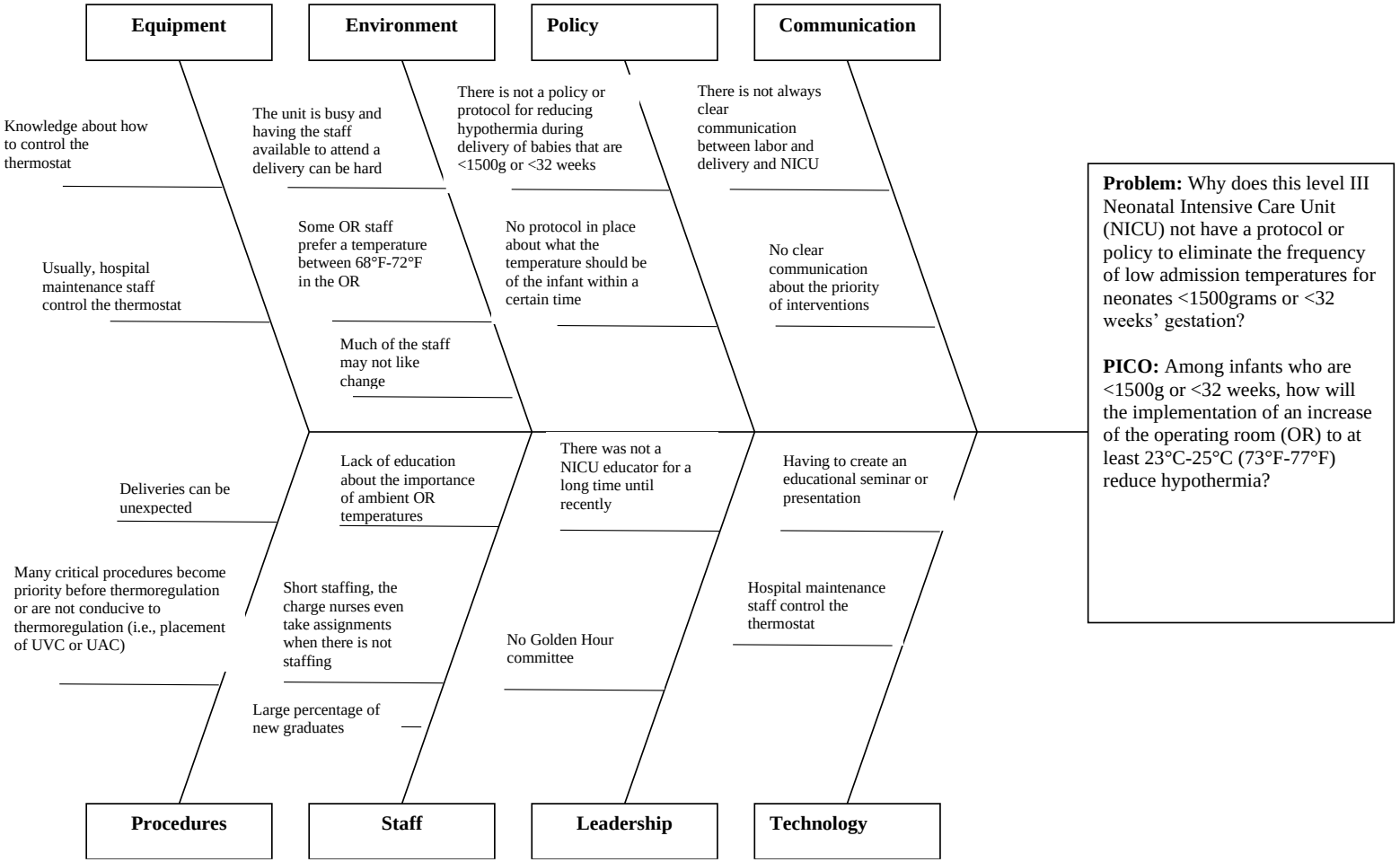
*Updated Process Map*




*Note.* A map illustrating the current process performed by the project site—only the OR temperature and the neonatal admission temperature are measured.

**Figure 2**

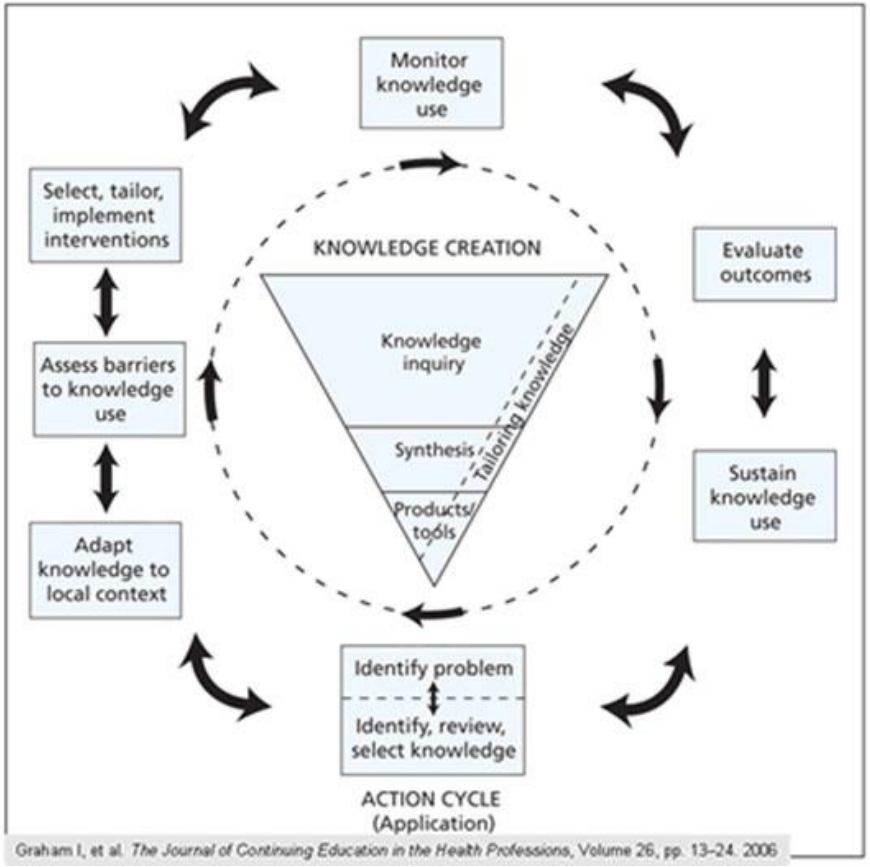
*Root Cause Analysis /Fishbone Diagram*




*Note.* A figure displaying the root cause analysis that was influential to developing the practice problem.

**Figure 3**

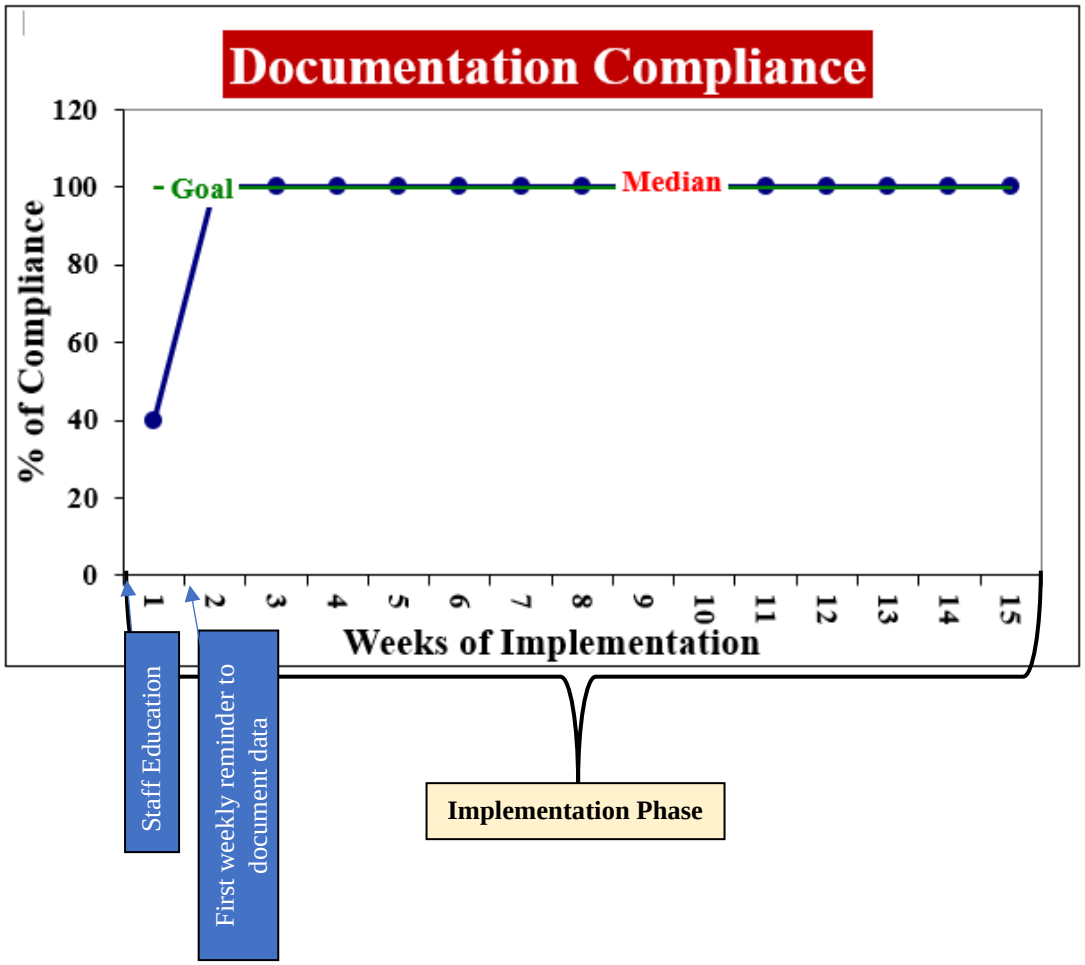
*Knowledge to Action Framework*




*Note.* A figure illustrating the KTA model with attention to the action cycle components (Field et al., 2014).

**Figure 4**

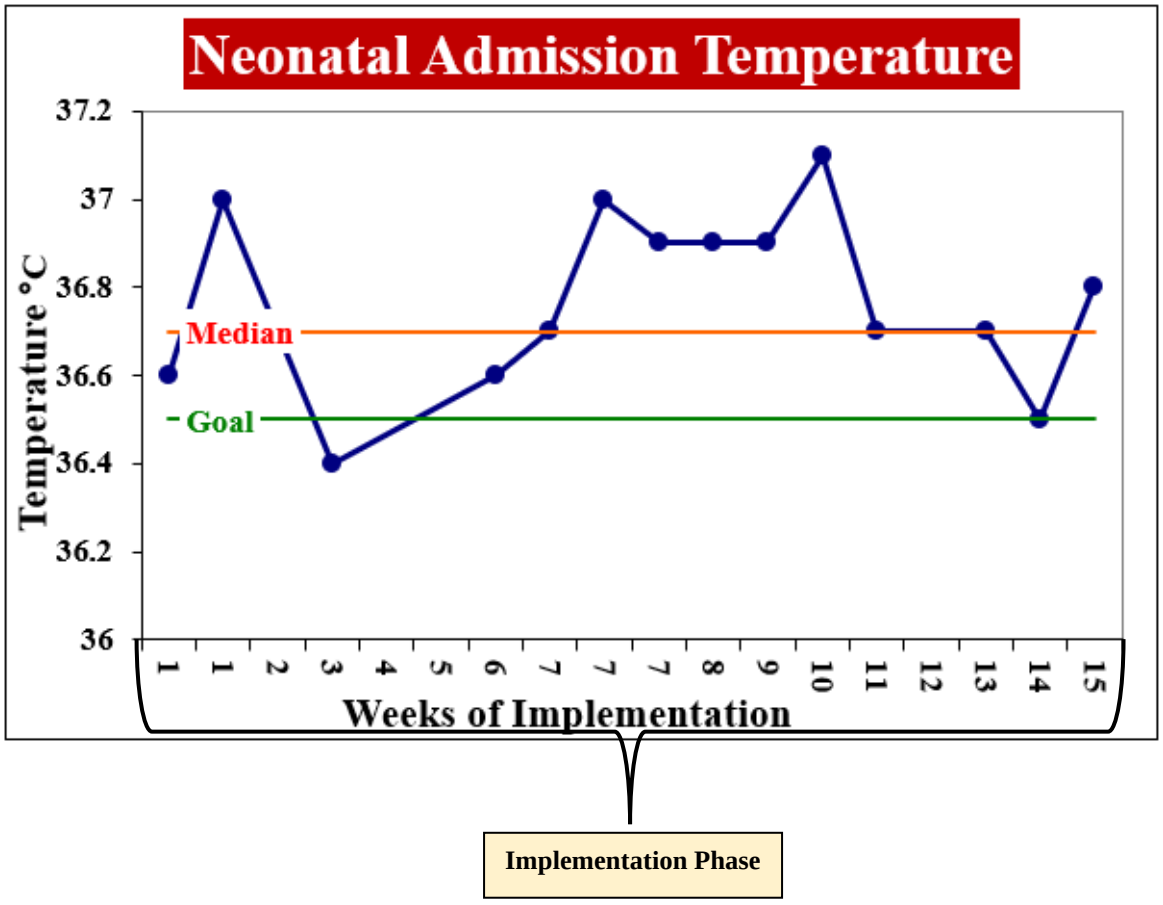
*Run Chart: Documentation Compliance*




*Note.* A Run Chart illustrating the temperature of each neonate that was born who met criteria. 13 out of the 14 neonates were euthermic at 36.5°C–37.5°C.

**Figure 5**

*Run Chart of the Neonatal Admission Temperatures*



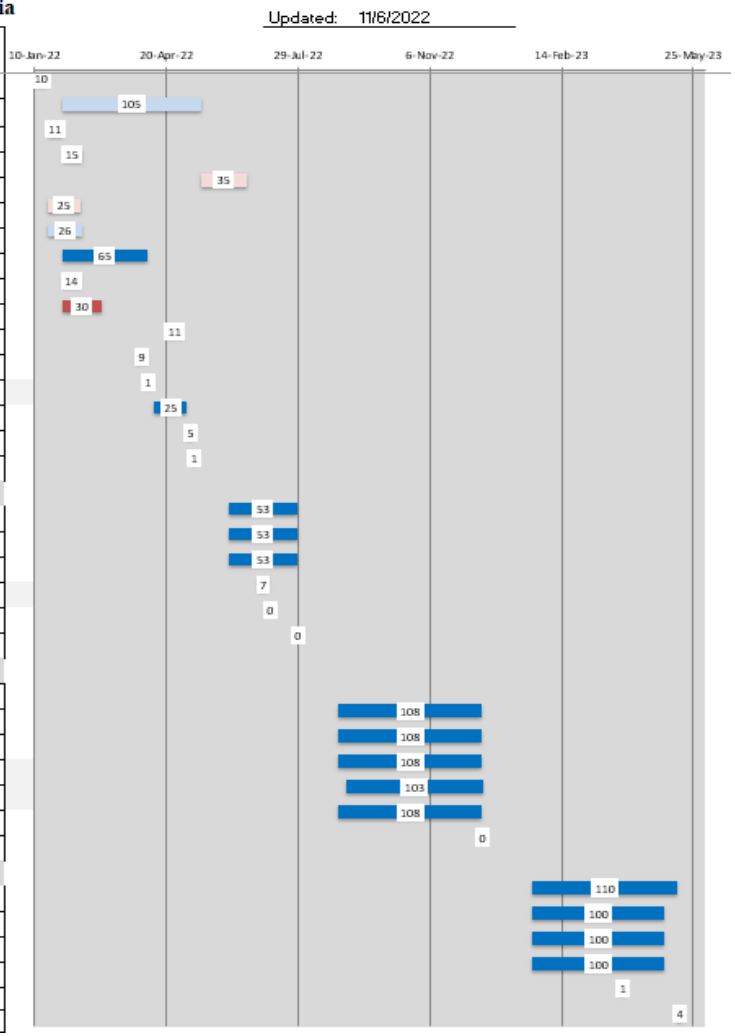

*Note*. A Run Chart illustrating the temperature of each neonate that was born who met criteria. 13 out of the 14 neonates were euthermic at 36.5°C–37.5°C.

**Figure 6**

*Gantt Chart*

**Increasing Operating Room Temperatures to Reduce Neonatal Hypothermia**

| Status | Task | Start | Duration (days) | End | Responsible Resource |
|---|---|---|---|---|---|
| ☑ | Submit draft of fishbone diagram | 1/10/2022 | 10 | 1/20/2022 | DJ |
| ☑ | Start of Spring Term | 1/31/2022 | 105 | 5/16/2022 | DJ |
| ☑ | Post site team table on Groups Discussion Board | 1/20/2022 | 11 | 1/31/2022 | DJ |
| ☑ | Confirm practice problem, CSR & Sponsor | 1/31/2022 | 15 | 2/15/2022 | AD |
| ☑ | Develop DNP Project Management Tool | 5/16/2022 | 35 | 6/20/2022 | DJ |
| ☑ | Post maps of the current and desired practice processes | 1/20/2022 | 25 | 2/14/2022 | DJ |
| ☑ | Complete Fishbone Diagram Draft | 1/20/2022 | 26 | 2/15/2022 | DJ |
| ☑ | Set Smart goals | 1/31/2022 | 65 | 4/6/2022 | DJ/CW |
| ☑ | Develop data measuring plan | 1/31/2022 | 14 | 2/14/2022 | DJ |
| ☑ | Finalize Fshbone Diagram | 1/31/2022 | 30 | 3/2/2022 | DJ |
| ☑ | Start Data Mangement Plan | 4/21/2022 | 11 | 5/2/2022 | DJ |
| ☑ | Register for REDCap Account | 3/28/2022 | 9 | 4/6/2022 | DJ |
| ☑ | Submit DNP Proposal | 4/6/2022 | 1 | 4/7/2022 | DJ |
| ☑ | Second Reader Feedback | 4/11/2022 | 25 | 5/6/2022 | DJ |
| ☑ | Submit Proposal after Second Read Feedback | 5/6/2022 | 5 | 5/11/2022 | DJ |
| ☑ | End of Spring Term | 5/11/2022 | 1 | 5/12/2022 | AD |
| ☑ | ***NDNP811*** | | | | |
| ☑ | Start of Summer Term | 6/6/2022 | 53 | 7/29/2022 | AD |
| ☑ | Develop REDCap data entry tool | 6/6/2022 | 53 | 7/29/2022 | DJ |
| ☑ | IRB Approval | 6/6/2022 | 53 | 7/29/2022 | DJ |
| ☑ | Develop a Presentation | 6/29/2022 | 7 | 7/6/2022 | DJ |
| ☑ | Give Presentation | 7/8/2022 | 0 | 7/8/2022 | DJ |
| ☑ | End of Summer Term | 7/29/2022 | 0 | 7/29/2022 | AD |
| ☑ | ***NDNP812*** | | | | |
| ☑ | Project go-live (implement) | 8/29/2022 | 0 | 8/29/2022 | DJ/CW/SC |
| ☑ | Start of Fall Term | 8/29/2022 | 108 | 12/15/2022 | AD |
| ☑ | Monitor tasks and progress | 8/29/2022 | 108 | 12/15/2022 | DJ/CW/SC |
| ☑ | Communicate with stakeholders | 8/29/2022 | 108 | 12/15/2022 | DJ |
| ☑ | Chart Audit for Track Intervention Compliance | 9/4/2022 | 103 | 12/15/2022 | DJ |
| ☑ | Collect data | 8/29/2022 | 108 | 12/15/2022 | DJ |
| | End of Fall Term | 12/16/2022 | 0 | 12/16/2022 | AD |
| ◯ | ***NDNP813*** | | | | |
| | Start of Spring Term | 1/23/2023 | 110 | 5/13/2023 | AD |
| | Analyze, synthesize & evaluate results | 1/23/2023 | 100 | 5/3/2023 | DJ |
| | Document lessons learned | 1/23/2023 | 100 | 5/3/2023 | DJ |
| | Plan corrective actions | 1/23/2023 | 100 | 5/3/2023 | DJ |
| | Submit manuscript | 4/1/2023 | 1 | 4/2/2023 | DJ |
| | End of Spring Term | 5/13/2023 | 4 | 5/17/2023 | AD |




*Note.* A Gantt Chart illustrating the timeline of pre and post-implementation.

## Appendix A

Presentation Survey



# Post Presentation Survey

Please complete the survey below.

Thank you!

1) Staff Name _____

2) Staff Role
- ◯ NICU Nurse
- ◯ Labor and Delivery Nurse
- ◯ Mother Baby Nurse
- ◯ Physician
- ◯ Nurse Practitioner
- ◯ Nurse Manager
- ◯ Clinical Educator/Specialist

3) Education Completed?
- ◯ YES
- ◯ NO

4) Date of Completion _____

5) Questions, Comments, Concerns, Ideas? _____

**Appendix B**

Pre-Op Checklist



# Pre Op Checklist

Please complete the survey below.

Thank you!

1) Date _____

2) Average OR 1 Temperature _____

3) Average OR 2 Temperature _____

4) RN Name _____

**Appendix C**

Temperature Collection Survey



# Temperature Collection

Please complete the survey below.

Thank you!

1) Date of Birth _____

2) Week Number _____

3) OR Temperature at Delivery _____

4) Neonatal Admission Temperature _____