Anesthesia Providers' Perceptions of Perioperative Temperature Monitoring: A DNP Project

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Abstract

Perioperative temperature monitoring is a standard of care and is important to prevent inadvertent perioperative hypothermia (IPH) and the associated increased risks. IPH is defined as a temperature of less than 36° Celsius and contributes to many negative outcomes. The purpose of this quality improvement project was to assess anesthesia providers' perceptions of the effectiveness of their current practice for intraoperative temperature monitoring and of a newly developed intraoperative temperature monitoring and management tool. The project was structured in a PDSA format with Qualtrics surveys utilized to collect participant responses prior to and two weeks after implementation of an educational tool. Survey data from seven anesthesia providers showed positive results, but participants indicated they were unlikely to use the tool in their daily practice. Anesthesia providers using the educational tool decreased the amount of time it took to access reference material when in the perioperative setting. Overwhelmingly, anesthesia providers knew important information regarding perioperative temperature monitoring and management, including identifying core modality sites and identifying there is a standard in place governed by each institution. The project was helpful in determining anesthesia providers' perceptions of not wanting additional resources to utilize during their daily practice, despite reporting that it proved to be useful and saved them time during their busy workday. Future suggestions include repeating this project on a larger scale to obtain more conclusive results.

Keywords: inadvertent perioperative hypothermia, temperature monitoring, anesthesia

Table of Contents

Section I. Introduction

Background

Perioperative temperature monitoring has been and remains an understudied phenomenon, with the most common concern being an increased risk of unintentional hypothermia. Inadvertent perioperative hypothermia (IPH) is defined as a temperature less than 36° Celsius and contributes to increased operative blood loss, increased postoperative wound infections, greater hospital length of stay, and hospital costs (John et al., 2016). This issue has gained the attention of healthcare workers and researchers through the years due to the increased awareness of adverse events. In a 2016 article published in The Lancet, Sessler (2016) noted that volatile anesthetics, inhaled anesthetics, intravenous anesthetics, and opioids given during anesthesia can significantly alter thermoregulatory control and reduce blood vessel constriction. These alterations have a compounding effect on patients' ability to maintain thermoregulation, which suggests accurate temperature monitoring is paramount to good patient outcomes during anesthesia. There are two primary methods of monitoring body temperature, peripheral and core monitoring. Core body temperature is the gold standard in monitoring because it is most accurate, with measurements obtained via pulmonary artery catheter, distal esophagus, nasopharynx, and tympanic membrane methods (Sessler, 2016).

Most importantly, monitoring the patient's temperature perioperatively is considered current standard of care and if not performed consistently and accurately may result in detrimental outcomes for the patient. Mitigation of negative patient outcomes is an important component of professional associations in anesthesia, and they have developed multiple standards of care that often include required tasks for specific cases to monitor patient's temperature. The American Association of Nurse Anesthesiology (AANA) Standard 9 requires

CRNAs to "When clinically significant changes in body temperature are intended, anticipated, or suspected, monitor body temperature. Use active measures to facilitate normothermia. When malignant hyperthermia (MH) triggering agents are used, monitor temperature, and recognize signs and symptoms to immediately initiate appropriate treatment and management of MH" (2021, Standard 9: Monitoring, Alarms section). In addition to the previously mentioned risks of IPH, anecdotal experience suggests that, unlike pain and nausea, memories of postoperative thermal discomfort remain intense for years after surgery (Sessler, 2016).

Measurement of central core temperature, maintenance of normothermia, and successful warming of patients in the perioperative period are vital. Many interventions have been implemented during the preoperative, perioperative, and postoperative period to counteract IPH. These interventions consist of preoperative warming, active and passive intraoperative patient warming, and ambient temperature control within the operating room (Sessler, 2016). Although studies have demonstrated the efficacy of prewarming patients in reducing redistribution hypothermia, it requires a significant amount of heat transfer and approximately an hour of moderate warming prior to surgery, which is not always feasible and often poorly tolerated by patients (Esnaola & Cole, 2011). Multiple commercial warming devices are available, including several that provide active skin warming, considered the most efficient, inexpensive, easy-to-use, and cost-effective warming method for most patients and surgeries (Ruetzler & Kerz, 2018).

It is paramount that anesthesia providers accurately monitor and manage body temperature during surgical cases to decrease the likelihood of adverse events related to hypothermia. Additionally, maintenance of perioperative temperatures may also impact an organization's financial standing. According to the Center for Medicare and Medicaid's (CMS, 2021) Merit-Based Incentive Payment System (MIPS) which covers care of Medicare recipients,

IPH occurs in 20% of surgical cases and up to 50% of pediatric cases. For maximum CMS reimbursement, patients must register a body temperature above 35.5° Celsius within 30 minutes before or 15 minutes after anesthesia stop time.

Organizational Needs Statement

The partnering facility, a large medical center in eastern North Carolina, operates in accordance with AANA Standard 9-Part d, which states the anesthesia provider will monitor, evaluate, and document the patient's physiologic condition as appropriate for the procedure and anesthetic technique (AANA, 2021). When a physiological monitoring device is used, variable pitch and threshold alarms are turned on and audible. It is necessary to document blood pressure, heart rate, and respiration at least every 5 minutes for all anesthetics. The facility also operates in accordance with guidance from the American Society of Anesthesiologists (ASA) Standard 2.4 that states temperature monitoring will be performed on every patient receiving anesthesia when "clinically significant changes in body temperature are intended, anticipated or suspected" (2021; Standard 2.4: Body temperature). Considering these standards, assessment of anesthesia providers' perceptions of potential barriers or challenges to accurately meeting them is important to consider when evaluating areas of strength and potential improvement.

Problem Statement

IPH is defined as a temperature of less than 36° Celsius and contributes to increased operative blood loss, increased postoperative wound infections, greater hospital length of stay and hospital costs (John et al., 2016). If IPH continues to occur, patients may suffer from preventable negative outcomes leading to patient dissatisfaction and ultimately a potential lack of reimbursement for services provided. Therefore, it is imperative to evaluate anesthesia providers'

perceptions pertaining to current practice to inform improvement efforts and increase adherence to national standards regarding temperature monitoring.

Purpose Statement

The purpose of this quality improvement project was to assess anesthesia providers' perceptions of the effectiveness of their current practice for intraoperative temperature monitoring and of a newly developed intraoperative temperature monitoring and management resource.

Section II. Evidence

Description of Search Strategies

The purpose of this literature review was to examine current evidence and recommendations addressing perioperative temperature monitoring. The PICOT question used to guide the search strategy was: How do anesthesia providers perceive the newly developed temperature monitoring resource designed to help mitigate inadvertent perioperative hypothermia with anesthesia. Although there was not a comparison for the PICOT question, the specific setting was identified, which would be included in the PICOTS version.

A search of current literature was conducted using the databases PubMed and Cumulative Index to Nursing and Allied Health Literature (CINAHL) as well as the search engine Google Scholar. Boolean operators were used to combine keywords and concepts. The search strategy used to query PubMed was (temperature monitoring OR hypothermia) AND (nurse anesthesia OR nurse OR anesthesia OR nurse anesthetist OR anesthesiologist OR operating room OR perioperative OR intraoperative OR preoperative OR PACU). This search strategy pulled in the MeSH terms temperature, physiologic monitoring, hypothermia, nurses, anesthesia, nurse anesthetists, anesthesiologists, and operating rooms. Limits applied included publication in the most recent 5 years (2016-2021) and English language. CINAHL was searched using a combination of keywords such as core body temperature, ineffective thermoregulation, education, nurse anesthesia, and operating room personnel; and subject headings were identified using the keywords. Google Scholar was searched using the same search strategy as PubMed. See Appendix A for a complete list of keywords, MeSH terms, and subject terms utilized in searches. See Appendix B for search strategy and number of articles found and kept using structured searching. Additional evidence and information were identified by reviewing related

and referenced articles as well as the websites and resources of professional anesthesia organizations. No additional search strategies were used.

Items identified through searches of the databases and websites were reviewed for inclusion criteria such as quality improvement projects, specifically focusing on temperature monitoring during the perioperative period, interventions/tools utilized to change future practice, and anything related to perioperative temperature monitoring standards. Over 250 articles were reviewed, and 25 examined in full-text, with five kept after full-text review, as they met criteria for use. Upon full-text review, using the level of evidence categories of Melnyk and Fineout-Overholt (2019), a single Level I systematic review, a single Level III retrospective observational study, and three Level VI quality improvement projects were identified as applicable to this project. See Appendix C for literature matrix.

Selected Literature Synthesis

Literature selected for inclusion in this review addressed perioperative temperature monitoring and the importance of IPH prevention to anesthesia providers. A single systematic review identified as meeting criteria for inclusion (Moola et al., 2011). Other results were from observational intervention studies (Lakha et al., 2020) or quality improvement projects (Duff et al., 2018; Kim, 2013; Lakha, 2020; Levin, 2016). Thus, there is limited high level evidence available and ongoing need to continue investigations in this area.

A systematic review published in the *International Journal of Evidence-Based Healthcare* by Moola et al. (2011), identified and analyzed 19 of 130 potentially eligible studies with a combined 1,451 perioperative patients aged 18 years and older undergoing randomized clinical trials to compare the relationships of various warming methods to changes in core body temperature. The studies demonstrated that prevention of IPH could reduce hospital costs by as

much as $7000, as well as the risk of morbidity and mortality for each surgical patient though it is important to note that the definition of hypothermia was not consistent across all studies. The authors found that forced-air warming devices helped to prevent pregnant women and their fetuses from developing hypothermia during cesarean section, and that intravenous fluid warmers provided significant benefit to patients in terms of hemodynamic stability and higher core body temperatures post-operatively. Reviewed studies also found that water garment warmers were significantly more effective than forced-air warming in preventing hypothermia in liver transplant patients, and that passive warming techniques such as reflective heating blankets or elastic bandages wrapped around the legs were ineffective in reducing the magnitude of hypothermia. Additionally, low-flow anesthesia in conjunction with forced-air warming was demonstrated to be effective in stabilizing core body temperature in various surgical procedures. Therefore, research suggests that anesthesia providers warm patients preoperatively, utilize forced-air warmers, warmed intravenous fluids, and low-flow anesthesia to effectively mitigate IPH in specific cases and subsequently improve patient outcomes.

A quality improvement project by Duff et al. (2018) reported findings regarding the use of a thermal care bundle consisting of risk assessment, temperature recording, and active warming methods with the intent to prevent, detect, and treat IPH via pre- and post-implementation studies. The perioperative temperature monitoring of 729 patients from four different hospitals was studied and it was determined that, despite the implementation of the thermal care bundle, IPH incidence increased rather than decreased as expected. In their discussion of these findings, the authors suggested that rather than demonstrating failure of the bundle to improve care, the results revealed a greater incidence of IPH than was being detected without the accuracy of monitoring performed during the study. So, this reflected suboptimal

temperature assessment prior to implementing the bundle. In contrast, Kim et al. (2013) noted that implementation of an IPH bundle consisting of eight items about strict temperature management techniques demonstrated a 53% reduction in IPH in their pediatric population. This study, which consisted of 7,532 patients over 66 weeks, was performed using six plan-do-study-act cycles to determine the most effective interventions to utilize in the temperature management bundle. One main result of this study was that anesthesia providers benefited from this bundle by the presence of an Electronic Medical Record (EMR) alert to ensure that IPH prevention compliance measures were met.

A large study by Lakha et al. (2020) found that when temperature monitoring EMR alerts are connected to CMS' MIPS measures the alert may produce a Hawthorne effect and double as a reason for anesthesia providers to comply. In this retrospective observational study, 50,029 cases at one hospital over a period of two years were reviewed, with data analyzed in relation to differences occurring between times when EMR alerts were being and not being utilized. The results demonstrated that the presence of EMR alerts significantly increased perioperative temperature monitoring by anesthesia providers. Historically, studies constructed as such tend to not have a lasting impact on clinical practice, but this study demonstrated a statistically significant increase over pre-implementation baseline, indicating a learning effect from the electronic alerts. Improvement in clinical practice was still occurring even after the EMR alerts were stopped, demonstrating a learning effect.

Sustainability was the focus of Levin et al. (2016) who used an evidence-based project improvement model to carry out multiple plan-do-study-act cycles to evaluate postoperative temperature outcomes. The initial snapshot evaluation consisted of only 26 patients but led to a sustainability evaluation of 263 patients over a period of two months. Despite previous

perceptions of operating room temperature norms, when ambient temperature was set between 68-75° F, patients had a 96% chance of being normothermic when reaching PACU. Advocating for patients can be difficult at times, but anesthesia providers are responsible for maintaining normothermia and adherence to national practice guidelines to help facilitate good patient outcomes.

Project Framework

The model used in this quality improvement project was described by the Institute for Healthcare Improvement (IHI). This model has been used in similar projects in the past and was implemented as a single plan-do-study-act (PDSA) cycle to test for change (Langley et al., 2009). Review of literature in the *plan* phase identified that inconsistencies in collection of data and maintenance of normothermia in perioperative patients supported the need for further work on this issue. A quality improvement project involving pre- and post-assessment surveys and an educational intervention was developed. During the *do* phase, emails were sent out to participants with links to pre- and post-assessment surveys and educational resources which were to be reviewed between completion of surveys. During the *study* phase, the author analyzed data collected from participating CRNAs via the pre- and post-assessment surveys to determine the perceptions of the educational resources. The *act* phase involved the author presenting results obtained from the project to members from the organization and suggesting potential changes to be incorporated in additional PDSA cycles. Langley provided an excellent example of how the PDSA model could be used for projects similar to this one.

Ethical Considerations and Protection of Human Subjects

There were no specific ethical considerations or protection of human subject concerns identified with this project. The intervention could benefit the participants and potentially future

patients. There was no potential harm greater than that encountered in the normal work environment identified for the participants. The project lead completed ethical training through the Collaborative Institutional Training Initiative (CITI) modules (https://www.about.citiprogram.org) prior to project start and the covered concepts were used to guide the ethical considerations throughout the project.

This project was determined to be quality improvement through a collaborative approval process set up between the East Carolina University (ECU) College of Nursing (CON) and the University and Medical Center Institutional Review Board (UMCIRB) and as such determined to be exempt from full IRB review. The project was also reviewed and approved through a process set up between the partnering facility and the ECU UMCIRB with the same determination made. A representative of the partnering facility provided a signature of support for collection of data from CRNAs under their supervision (see Appendix D).

Section III. Project Design

Project Setting

Data was collected from a surgery center in eastern North Carolina that is a part of a larger hospital system. The surgery center has been serving the community for almost 40 years and generates over $1.3 million in revenue annually. The SurgiCenter provides outpatient procedures for various specialties such as ophthalmology, orthopedics, and plastic surgery, to name a few. These procedures are performed on a range of patients from infants to elderly. There was potential for the fast pace of the environment to act as a barrier to obtaining data, but data collection was streamlined to best meet the needs of practicing CRNAs. One potential facilitator to participation was that this location has been utilized by previous colleagues in the anesthesia program and, being affiliated with a teaching hospital, CRNAs have supported student projects in the past.

Project Participants

The participants in this quality improvement project were CRNAs delivering anesthesia care at a critical access surgery center in eastern North Carolina. Each CRNA was sent a pre-intervention survey before receiving an educational resource on perioperative temperature monitoring. After receiving the education and implementing the interventions for two weeks, CRNAs were sent a post-intervention survey to assess their perceptions. Surveying CRNAs with various experience levels assisted in obtaining a diverse perception of temperature monitoring practice.

Project Team

The project team was led by a Student Registered Nurse Anesthetist (SRNA) who worked with several other students to develop this quality improvement project. The project was

then implemented by each student in a different setting, with implementation and data analysis performed separately. The CRNA faculty project chair served as a resource and mentor, assisting in topic discussions, project development, project implementation, and data analysis. The site contact person signed the letter of acknowledgement that data would be collected in the surgery center. The clinical contact person, a CRNA faculty member in the program, oversaw multiple quality improvement projects simultaneously. The program director helped to maintain good working relationships amongst the team and guide the project when needed. Finally, the course director helped facilitate each step from start to completion of the project process.

Methods and Measurement

Initially, approval was obtained through the ECU CON and UMCIRB with the project determined to be exempt from full IRB review. Approval was also sought through a process set up between the participating organization and the ECU UMCIRB with the same determination made. A representative of the participating organization provided a signature of support for collection of data from participating CRNAs under their supervision (see Appendix D).

The purpose of the quality improvement project was to assess anesthesia providers' perceptions of the effectiveness of their current practice for intraoperative temperature monitoring and of a newly developed intraoperative temperature educational resource (See Appendix E). Pre- and post-intervention surveys, as included in Appendix F, were used to assess anesthesia provider's perceptions about their effectiveness of monitoring temperature during the perioperative period. The temperature monitoring resource served to refresh CRNA participants' knowledge of temperature monitoring standards and be a ready resource, if necessary. The resource was delivered via email to all CRNA participants as shown in Appendix G.

The project methods were structured in a PDSA format and performed using a survey tool via Qualtrics, as previously mentioned. The survey was developed to collect a range of data categorized in various responses such as ordinal, interval, and open-ended responses. The *plan* stage also included current temperature monitoring practices performed by CRNAs and were examined to provide baseline data. During the *do* stage, CRNAs were provided with an educational resource to refresh their knowledge and stress the importance of why we monitor temperature in the perioperative period. Pre- and post-intervention surveys were sent out before and after the educational resource was provided to assess results after two weeks in the *study* phase. In the act phase recommendations were made for future quality improvement studies. These recommendations ideally would be used in future PDSA cycles.

All methods and measurement steps went according to plan and were arranged in accordance with COVID-19 guidelines, policies, and procedures. It was known that staffing was short at the SurgiCenter, but surveys were still completed in their entirety and in a timely manner. It was also known in advance that paper charting was utilized at the SurgiCenter, and arrangements were made to facilitate an integrative method between paper charting and electronic surveys to achieve desirable results.

Section IV. Results and Findings

Results

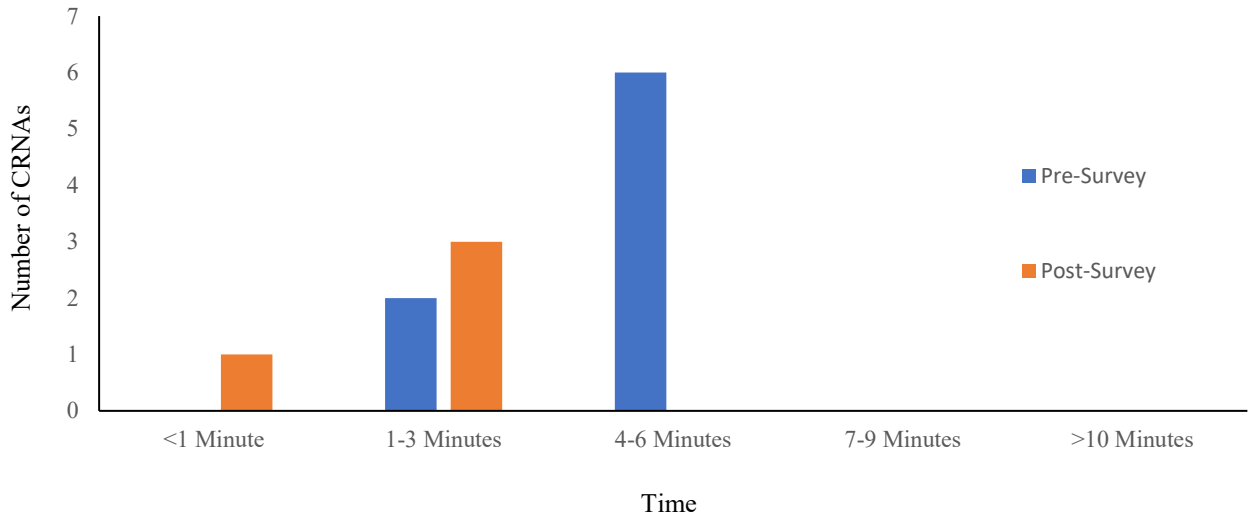
The purpose of the quality improvement project was to assess anesthesia providers' perceptions of the effectiveness of their current practice for intraoperative temperature monitoring and of a newly developed intraoperative temperature monitoring educational resource (See Appendix E). Pre- and post-intervention surveys were utilized to gather perceptions from project participants. The pre- and post-surveys were sent to seven anesthesia providers currently working at the SurgiCenter facility. There was a two-week collection period between surveys and during that time anesthesia providers used the educational resource to aid in their practice. Survey results were obtained using Qualtrics survey software via a link sent to the participants' email that could be accessed via a computer, phone, or other electronic device. The pre-survey resulted in eight responses and the post-survey resulted in five responses. The results were analyzed using Excel and figures were derived from the data collected.

Data Presentation

During the pre-intervention survey, participants were asked nine questions about their perceptions involving perioperative temperature monitoring. At least half of participants answered *yes* when asked if they had received education on temperature monitoring policies or standards for their surgical setting. When surveyed if they were aware of the AANA national standard for temperature monitoring, all participants responded *yes*. Survey participants were then asked how long it would take them to access a reference of evidence-based guidelines to address a question regarding perioperative temperature monitoring and the majority responded *four to six minutes*, but several responded *one to three minutes,* as shown in Figure 1.

Figure 1

Time Required to Access Temperature Monitoring Reference Material

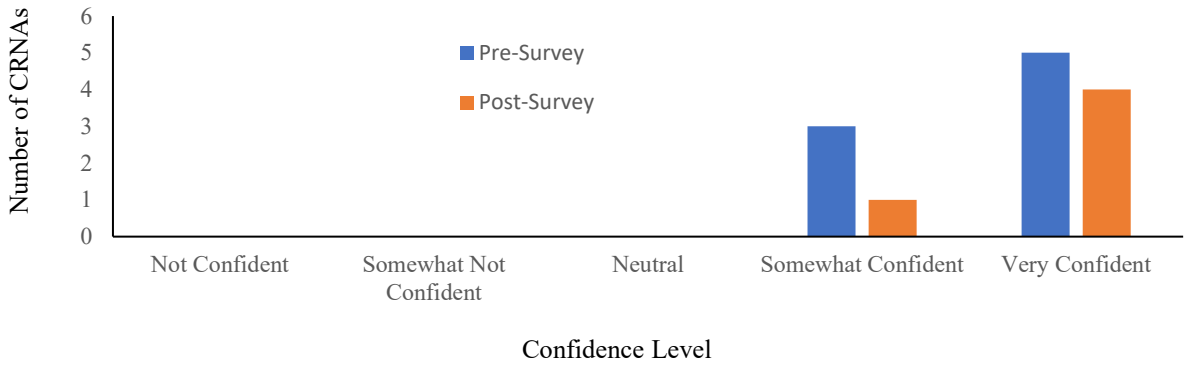


Note. Comparison of time it takes to access reference material before educational tool and time it takes to access the educational tool if saved to a smartphone or personal electronic device. Pre-survey responses n=8. Post=survey responses n=5.

Next, participants' confidence levels were assessed with the following four questions. The first question surveyed their confidence level regarding overall perioperative temperature monitoring, and most were *somewhat confident*. Participants were then questioned about their confidence in ability to identify core temperature sites and all responses were at least *somewhat confident,* with over half *very confident*, as shown in Figure 2. Participants were asked how confident they were in the available monitors to accurately record core temperature. Half of the participants responded as *neutral* or *not confident*.

Figure 2

Identification of core temperature sites

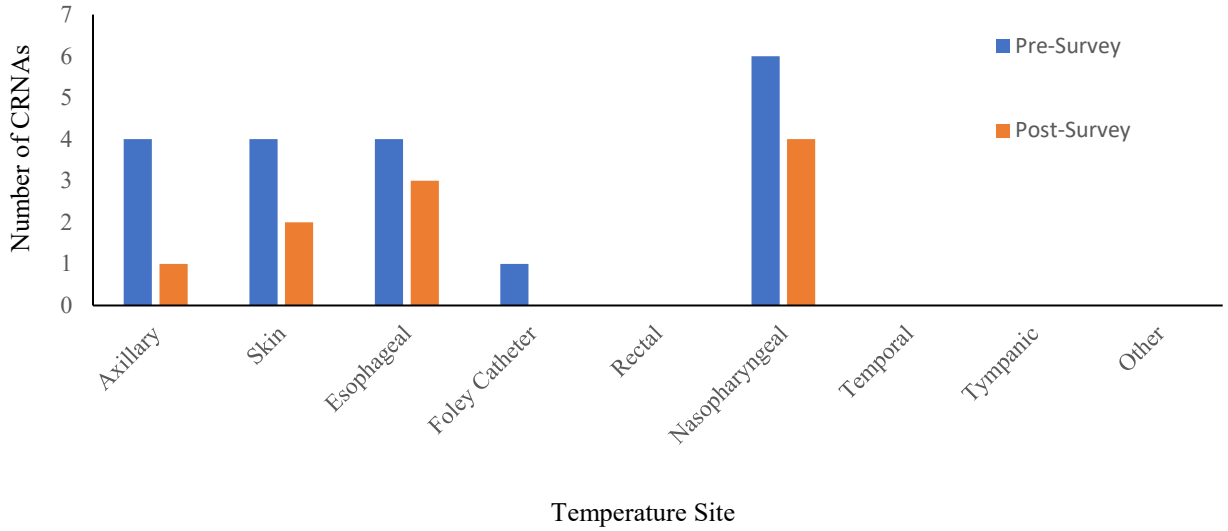


Note. Pre-survey responses n=8. Post=survey responses n=5.

Participants were also surveyed regarding how often they utilized temperature monitoring during the perioperative period during a typical work week and most participants responded *75-100% of cases*. Finally, participants were asked their preferred modality or site for monitoring temperature perioperatively. With multiple responses allowed, the most frequent were *axillary, skin, esophageal, and nasopharyngeal*, as shown in Figure 3.

Figure 3

Comparison of Preferred Modality or Site for Temperature Monitoring



Note. Multiple responses were allowed. Pre-survey responses n=8. Post=survey responses n=5.

The post-survey was sent out at the conclusion of the two-week implementation period of the educational resource and results were analyzed. Participants were asked 12 questions regarding their perceptions and the knowledge they gained via the educational resource during the two weeks of use. First, participants were asked if they could readily access the AANA national standard on temperature monitoring and all five participants responded *yes*. They were then asked how likely they were to use the reference material they were provided during this project, and they all stated *neutral* to *very unlikely*. Participants were then asked how long they

thought it would take to access the educational reference if saved to their smartphone or device and all responses were *three minutes or less*, as referenced in Figure 1.

Next, confidence levels were assessed in three questions, including participants' knowledge of perioperative temperature monitoring, ability to identify patients or procedures at higher risk of heat loss, and ability to identify core temperature sites after reviewing the resource as shown in Figure 2. Most participants responded they were *very confident*. The preferred modality and site for temperature monitoring remained the same in the post-survey, with the exception of foley catheter monitoring, as shown in Figure 3. Utilization of temperature monitoring perioperatively was then assessed and the majority responded they use it *75-100% of the time*. Participants were then asked how often they find the last operating room temperature to correlate with the first PACU temperature and over half responded only *50-75% of the time*. The last four questions were either open ended or gave the option of selecting multiple responses, including what participants would do to improve the lack of correlation between operating room and PACU temperatures. Several participants responded with the suggestion of using better thermometers when asked what barriers they believed existed to preventing intraoperative hypothermia. Participants responded that surgeons wanting the operating rooms colder and the lack of waterproof surgical gowns that would not be too hot for surgical staff were also offered as potential barriers.

Analysis

Although the results of the pre- and post-surveys did not equal the number of respondents, analysis was conducted with the data available. Not all respondents reported having previously received education on their clinical site temperature monitoring policies or standards. This is worth noting because, while there are national standards for monitoring intraoperative

temperature, many hospitals and surgery centers do not have local policies in place. All participants in this study reported that they were aware of the AANA national standard for temperature monitoring. The AANA temperature monitoring Standard 9-Part d "When clinically significant changes in body temperature are intended, anticipated, or suspected, monitor body temperature"(2021; Standard 9: Monitoring, Alarms section) is important to ensuring quality of care. All participants reportedly could access evidence-based guidelines in less than six minutes. Though this is acceptable, as referencing temperature monitoring guidelines is not time essential, monitoring the patient's temperature in and of itself is essential. Therefore, the anesthesia provider has time to fine tune the details within the guidelines set forth by the governing body or institution policy.

Results of the comparison between reported confidence levels before and after viewing the educational resource suggested it was informational and of value to the participants. This could be used in support of future projects or studies involving dispersal of the educational resources to even more anesthesia providers within the facility and measuring the change in confidence and knowledge on a larger scale. As expected, most anesthesia providers were confident in their abilities to identify patients at higher risk for intraoperative heat loss, which supports the validity of other responses within the survey because they are aware of the physiology involved in intraoperative temperature monitoring. The educational resource may have reinforced anesthesia providers' knowledge, but responses remained the same for the post-survey.

Assessing the ability to identify those at high risk for heat loss, and then knowing what temperature monitoring sites constitute core temperature is important to maintaining normothermia. The ability to measure core temperature is imperative with high-risk procedures

and most participants were reportedly *confident* in their abilities to identify these sites before and after utilization of the educational resource, as demonstrated in Figure 2.

Results indicate that participants perceived that the monitoring devices in use at the institution were not always reliable. Temperature modality preferences were compared before and after the educational resource was presented. The preferences changed slightly, and one could infer that this change was based on exposure to the educational resource. Interestingly, anesthesia providers did not prefer rectal, temporal, or tympanic monitoring before or after the tool was presented. Results are depicted in Figure 3.

All participants were able to readily access AANA standards on temperature monitoring after reviewing the educational resource. This supports the effectiveness of the resource and enhances safety by effectively resourcing national standards and employing those standards. Interestingly, most participants reported they were *unlikely* to utilize the educational resource in the future. This is worth investigating further with a larger group of participants, as this resource was perceived as effective in enhancing access to information and confidence regarding temperature monitoring standards. Also, if barriers exist to utilizing this resource it would be beneficial to identify them. Utilization of the educational resource when saved to a smartphone cuts time to access the material and makes this tool easier to keep and use.

Fewer than half of the participants indicated that their last operating room temperature correlates with their first PACU temperature. This raises the question: Why do the temperatures not correlate all the time? As suggested by participants, tympanic monitors may not accurately reflect the patient's temperature, therefore, a different temperature monitor modality could be used to obtain a more accurate temperature. It was also suggested that patients could be transported with warm blankets to PACU to help reduce further temperature loss in transport.

Participants suggested a barrier to preventing perioperative hypothermia is the need for surgeons to have the room colder. It was identified that the institution does not have surgical gowns that are waterproof, but also breathable to keep the surgeon cool during the operation. There were no recommendations for strengthening the educational resource. This could indicate the educational resource was clear, succinct, and informative and did not warrant any critique. Overall, it would be helpful to determine what could be done to promote the use of this resource in the future, such as being saved to smartphones for quick and easy access when needed at a moment's notice.

Section V. Implications

Financial and Nonfinancial Analysis

There is the potential for many benefits to anesthesia providers, healthcare institutions, and patients by improving perioperative temperature monitoring. Cost to implement this project was virtually nothing because all resources and processes were conducted electronically. Improving patient outcomes and keeping the patient's temperature above 36 degrees Celsius helps to cut healthcare costs. It is important to also not forget about the cost of each employee's time when caring for patients. If a patient is brought out of surgery and they are hypothermic, this will increase their length of stay in the hospital and cost more by increasing the amount of healthcare provider time with the patient. Temperature monitoring modalities utilized by PACU nurses could be improved beyond tympanic monitoring to accurately reflect the last operating room temperature.

Implementation of accurate temperature monitoring within the perioperative period and during transition to PACU would be advantageous to the institution and would provide long term patient benefit. Improved clotting and wound healing are just a couple of benefits of maintaining normothermia in post operative patients. All help to reduce hospital length of stay and decrease the cost to the patient. According to Donigian et al., 2021, the cost of an overnight stay, compared to discharge to home from PACU, adds an additional $7000 to the patient's surgical costs.

Although a decrease in cost is always preferred, sometimes it is necessary to spend more to achieve better outcomes. The suggestion of using surgical gowns that are breathable but still waterproof would result in additional costs as these gowns would be more expensive than what is currently being utilized, but it could be the answer to increasing ambient perioperative room

temperature. Improving the temperature monitoring modalities and accuracy in PACU or providing better training and oversight on the thermometers used could be warranted to improve patient outcomes. Sometimes there may be a hypothermic reading when the patient is really normothermic as the measure is incorrect. When this occurs and treatment is delivered based on the metric for that reading, extra costs would be incurred even if there was not true hypothermia.

Overall, improvement of temperature monitoring modalities in PACU, use of a thermal care bundle, and preoperative pre-warming could be utilized to improve patient outcomes. Implementation of these actions could prove beneficial to the institution and cut costs simultaneously in all areas, including employee, patient, and facility costs.

Implications of Project

Changes suggested after surveying participants illustrated the need for better surgical gowns to increase operating room temperatures. The educational resource was helpful to anesthesia providers, but it was not helpful enough for them to keep using it according to the survey data. Although anesthesia providers indicated they would not continue to use the educational resource, it still refreshed their knowledge of temperature monitoring standards and of core temperature sites. Further, the educational resource may have increased anesthesia providers' awareness of the importance of preventing IPH.

As previously stated, the purpose of this project was to adhere to facility, state, and national standards to facilitate perioperative temperature monitoring. AANA Standard Nine (2021) states that the anesthesia provider will monitor, evaluate, and document the patient's physiologic condition as appropriate for the procedure and anesthetic technique. When a physiological monitoring device is used, variable pitch and threshold alarms are turned on and audible. It is necessary to document blood pressure, heart rate, and respiration at least every five

minutes for all anesthetics. The facility also operates in accordance with guidance from the ASA, whose standard states that temperature monitoring will be performed on every patient receiving anesthesia when clinically significant changes in body temperature are intended, anticipated, or suspected (2021).

According to Kim et al., (2013), increasing perioperative room temperature in pediatric operating rooms resulted in a 53% reduction in perioperative hypothermia. This would be beneficial if implemented in adult operating rooms, along with the suggestion of implementing breathable and waterproof surgical gowns so surgeons could withstand the heat of the room. This implies the need for further investigation into the cost effectiveness of the breathable and waterproof surgical gowns and the benefit of their use.

All patients would benefit by elimination of perioperative hypothermia and patients at higher risk of bleeding and infection would benefit most. Anesthesia providers would receive better reimbursement rates if all patients were normothermic before leaving the operating room. Facilities would see a reduction in cost and improvement in national rankings if outcomes were improved by elimination of perioperative hypothermia.

Sustainability

This pilot study conducted by surveying anesthesia providers' perceptions of adequacy of perioperative temperature monitoring could be conducted on a larger scale to develop further quality improvement projects. The educational resource could provide a low-cost improvement to the institution by keeping temperature monitoring and management at the forefront of anesthesia providers' clinical practice, although it is uncertain whether providers will use the educational resource, as evidenced by the lack of interest in further utilization of it based on post-survey responses. Providing an incentive could possibly increase anesthesia providers'

interest. If the educational resource is used, organizations could potentially save money by improving perioperative temperature monitoring. Elimination of just one bad outcome from a patient being unable to clot, or suffering from infection, might offset the cost of newer and improved surgical gowns for surgeons and staff to wear. The cost of improving temperature monitoring modalities or improved training on such devices for PACU nurses would still be cost effective as the expense of unplanned ICU admissions resulting in complications associated with intraoperative hypothermia would be greater than these costs.

Future department discussions about perioperative temperature monitoring could result in improved PACU temperatures if higher operating room temperatures were implemented. Other efforts could be focused on getting revised surgical gowns in stock and surveying the surgeons' satisfaction after use to determine if the change is acceptable. All efforts are sustainable if they provide benefit, whether it be improved morbidity/mortality, decreased length of hospital stay, or decreased overall hospital and patient costs.

Dissemination Plan

The results obtained by this project were represented in a virtual poster and presented to ECU SRNA students and faculty in person, as well as to additional SRNA students and project participants online. All project participants were invited to attend the presentation. The final versions of this project paper and poster were uploaded into The Scholarship, the East Carolina University digital repository.

Section VI. Conclusion

Limitations

Some limitations of this project included not having full participation with both the pre- and post-survey. There is speculation that the pre-survey could have been taken twice by one of the participants or multiple participants took the survey twice and some may not have participated. The sample size was limited to only seven anesthesia providers, and it could be more beneficial to survey the entire anesthesia department. Although the Qualtrics survey made for easy data collection, it was difficult to pull data from and organize into a chart format. Further, implementation time of only two weeks may not have given anesthesia providers enough time to utilize or see the benefits of the educational resource. Limiting focus to anesthesia providers' perceptions made the ability of gaining further information regarding temperature monitoring practices a challenge.

Recommendations for Future Implementation and/or Additional Study

Further implementation of interventions would warrant the need for additional quality improvement projects. It would be worth investigating a change in setting from a surgery center to a larger medical facility and how the operative tempo affects the desire to improve temperature monitoring. Ultimately, with the right amount of time, resources, and participation, advances in perioperative temperature monitoring care can be accomplished.

Recommendations for further studies include utilization of EMR alerts that are efficacious in clinical practice and prove to be beneficial in high tempo environments that anesthesia providers often experience. Trialing the benefit of breathable and waterproof surgical gowns on improving the temperature in the operating room would also be worth studying. Furthermore, providing adequate pre-warming for patients during the preoperative period and

how that improves outcomes is worth considering. Finally, it would be worth further surveying to determine what would make anesthesia providers want to keep this as a resource in the future.

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Appendix A

Literature Concepts Table

	Concept 1: Temperature Monitoring Hypothermia	Concept 2: Nurse Anesthesia	Concept 3: Operating Room
Keywords (these are the "normal" words you would use anywhere)	**temperature:** temperature OR temperatures **monitoring:** monitored OR monitoring OR monitoring physiologic OR physiologic monitoring OR monitor OR monitors **hypothermia:** hypothermia OR hypothermias	**nurse anesthesia:** nurse anesthesia **nurse:** nurses OR nurse **anesthesia:** anaesthesia OR anaesthesia **nurse anesthetist:** nurse anaesthetist OR nurse anesthetist **anesthesiologist:** anaesthesiologist OR anesthesiologist	**operating room:** operating room **perioperative:** perioperative OR perioperatively **intraoperative:** intraoperative OR intraoperatively **preoperative:** preoperative OR preoperatively
PubMed MeSH (subject heading specific to PubMed)	Temperature Monitoring, physiologic Hypothermia	Nurses Anesthesia Nurse anesthetists Anesthesiologists	Operating Rooms
CINAHL Subject Terms (Subject headings specific to CINAHL)	(MH "Core Body Temperature") OR (MH "Body Temperature Changes") OR (MH "Monitoring, Physiologic") OR (MH "Temperature")	(MH "American Association of Nurse Anesthetists") OR (MH "Anesthetists") OR (MH "Anesthesia") (MH "Education, Nurse Anesthesia") OR (MH "Anesthesia, General")	(MH "Operating Rooms") OR (MH "Surgical Equipment and Supplies") OR (MH "Perioperative Nursing") OR (MH "Operating Room Personnel")

	(MH "Hypothermia") OR "hypothermia" OR (MH "Hypothermia, Induced") OR (MH "Ineffective Thermoregulation (NANDA)")		

Appendix B

Literature Search Log

Search date	Database or search engine	Search strategy	Limits applied	Number of citations found/kept	Rationale for inclusion/exclusion of items
9/21/2021	PubMed	(temperature monitoring OR hypothermia) AND (anesthesia OR surgery OR operating room OR nurse anesthetist OR perioperative) AND (quality improvement)	2011-2021	118 Found/10 kept	Intervention - Intraoperative alerts improve compliance/ many articles not used because not applicable, clinical practice guideline for tonsillectomy, infants undergoing MRI, ERAS
9/21/2021	CINAHL	((MH "Core Body Temperature") OR (MH "Body Temperature Changes") OR (MH "Body Temperature") OR (MH "Temperature") OR "temperature monitoring") AND ((MH "Anesthesia") OR (MH "Anesthesia, General"))	2016-2021 English Peer-reviewed	61 found/ 5 kept	Few interventions and expert opinion articles met criteria/ many articles not used because not applicable, comparison of warming methods, prewarming, targeted temperature management, therapeutic hypothermia, temperature management
9/21/2021	Google Scholar	(temperature monitoring OR hypothermia) AND (anesthesia OR surgery OR operating room OR nurse anesthetist OR perioperative) AND (quality improvement)	2016-2021	5 pages reviewed/ 5 kept	Few interventions and expert opinion articles met criteria/ many articles not used because not applicable, malignant hyperthermia, pre-procedure warming, neuromuscular monitoring, thermal suit, ketamine infusions for depression

Appendix C

Literature Matrix

Author, Title, Journal	Purpose & Conceptual Framework or Model	Design and Level of Evidence	Setting	Sample	Tool/s and/or Intervention/s	Results
Duff, J., Walker, K., Edward, K. L., Ralph, N., Giandinoto, J. A., Alexander, K., Gow, J., & Stephenson, J. (2018). Effect of a thermal care bundle on the prevention, detection and treatment of perioperative inadvertent hypothermia. *Journal of Clinical Nursing, 27*(5-6), 1239-1249. https://doi.org/10.1111/jocn.14171	Improve the prevention, detection, and treatment of IPH in adult surgical patients Institute of Healthcare Improvement's Breakthrough Series Collaborative Model	QI/Level 6	4 Hospitals	729 Patients	Pre & post implementation study Perioperative thermal care bundle EMR review Workshop training	Improvements in the percentage of patients with a risk assessment At least one documented temperature recording per perioperative stage and appropriate active warming No impact on the incidence of IPH
Kim, P., Taghon, T., Fetzer, M., & Tobias, J. D. (2013). Perioperative Hypothermia in the Pediatric Population: A Quality Improvement Project. *American Journal of Medical Quality*, *28*(5), 400–406.	Decrease the incidence of perioperative hypothermia by 50% Institute for Healthcare	QI/Level 6	Hospital	1,758 Stage 1 pre-intervention 2,118 Stage 2 intervention	8 item Temperature management bundle (paper checklist & EMR reminder)	53% Sustained reduction of hypothermia in the pediatric population

https://doi.org/10.1177/10628606612473350	Improvement Model			3,656 Stage 3 post-intervention	Education on proper use of bundle	
Lakha, S., Levin, M. A., Leibowitz, A. B., Lin, H. M., & Gal, J. S. (2020). Intraoperative Electronic Alerts Improve Compliance with National Quality Program Measure for Perioperative Temperature Management. *Anesthesia & Analgesia*, *130*(5), 1167-1175. https://doi.org/10.1213/ANE.0000000000004546	Measure effectiveness on intraoperative temperature monitor compliance based on value-based reimbursement model outlines in CMS Measure #424 with or without the presence of electronic clinical-decision alerts. No framework or model mentioned	Retrospective Observational Study/Level 3	Medical Center	50,029 Reviewed cases 28,202 Pre alerts 14,323 Alerts began 3360 Alerts non-functional 4144 Alerts resumed	EMR Data extraction: service date, day of the week, age, gender, ASA physical status, BMI, procedure length, patient position, primary anesthetic technique, site of body temperature monitoring, primary surgeon specialty, anesthesia providers, number of transitions of care between anesthesia team members. Primary Analysis: calculation of daily percentage of MIPS compliance	Presence of decision-support alerts significantly increased intraoperative temperature monitoring in compliance with the MIPS #424 quality measure.

Levin, R. F., Wright, F., Pecoraro, K., & Kopec, W. (2016). Maintaining perioperative normothermia: Sustaining an evidence-based practice improvement project. *AORN Journal, 103*(2), 213.e1-213.e13. https://doi.org/10.1213/ANE.0000000000004546	Improve compliance of staff in increasing the rate of postoperative normothermia by raising OR temperatures until patient warming strategies are in place. EBPI Model	QI/ Level 6	Hospital	236 surgical patients	Subsequent PDSA or "small test of change" cycles to include snapshot compliance evaluation to assess, educate, and intervene to foster sustainability. After success, implementation on all surgical procedures	Improved rate of normothermia.
Moola, S., & Lockwood, C. (2011). The effectiveness of strategies for the management and/or prevention of hypothermia within the adult perioperative environment: Systematic review. *JBI Library of Systematic Reviews, 8*(19), 752-792. https://doi.org/10.1111/j.1744-1609.2011.00227.x	Identify the most effective methods for the treatment and preventions of hypothermia in operating room and PACU No Model or Framework	Systematic Review/ Level 1	Operating Room	19 Studies including 1,451 patients	Linen or cover, aluminum foil wrap, forced-air warmer, radiant warmer, and fluid warming device Change in core temp was measured Rectal temp excluded	Forced air warming leads to better outcomes and higher core temperatures Active warming preoperatively is helpful Use warmed fluids

Note. IPH = Inadvertent Perioperative Hypothermia; QI = Quality Improvement; EMR = Electronic Medical Record; CMS = Centers for Medicare and Medicaid Services; ASA = American Society of Anesthesiologists; BMI = Body Mass Index; MIPS = Merit-based Incentive Payment System; EBPI = Evidence Based Practice Improvement; PDSA = Plan Do Study Act; PACU = Post-anesthesia Care Unit; Levels of evidence from *Evidence-based practice in nursing and healthcare: A guide to best practice (4th ed.)*, by B. M. Melnyk and E. Fineout-Overholt, 2019, p. 131.

Appendix D

Research Department Letter

Center for Research & Grants

Quality Assurance/Quality Improvement Project vs. Human Research Study (Requiring IRB approval) Determination Form

This worksheet is a guide to help the submitter to determine if a project or study is a quality assurance/quality improvement (QA/QI) project or research study and is involving human subjects or their individually identifiable information and requires IRB approval as defined by the Health and Human Services (HHS) or Food and Drug Administration (FDA). Once completed, please email the form to the CRG.Quality@ A CRG team member will contact you with the results of their review and may request additional information to assist with their determination. The determination will be made in conjunction with the UMCIRB office.

Please contact the CRG with any questions at 252-847-1177 or CRG.Quality@

For more guidance about whether the activity meets the definition of Human Subjects Research see https://rede.ecu.edu/umcirb/irb-faqs/definitions/ or https://www.hhs.gov/ohrp/regulations-and-policy/decision-charts-2018/index.html#c1

Project Title: Anesthesia Providers' Perceptions of Perioperative Temperature Monitoring: A DNP Project		
Funding Source: None		
Project Leader Name: Zachary Soderblom	☐ Ed.D. ☐ J.D. ☐ M.D. ☐ Ph.D. ☐ Pharm.D. ☒ R.N. ☐ Other(specify):	
Job Title: ECU/SRNA/ECU CRNA Faculty	**Phone:**	**Email:**
	Primary Contact (If different from Project Leader): Student	
	Phone: 704-743-6183	**Email:** soderblomz20@students.ecu.edu

Key Personnel/ Project Team members:

Name and Degree:	**Department:** (Affiliation if other than Vidant)	**Email:**
Zachary Soderblom, SRNA	ECU Nurse Anesthesia Program	soderblomz20@students.ecu.edu
DNAP, CRNA	ECU Nurse Anesthesia Program	
PhD, CRNA	ECU Nurse Anesthesia Program	

rev. 03.21

Page 1 of 4

QI/QA Assessment Checklist:

Consideration	Question	Yes	No
PURPOSE	Is the PRIMARY purpose of the project/study to: • IMPROVE care right now for the next patient? OR • IMPROVE operations outcomes, efficiency, cost, patient/staff satisfaction, etc.?	☑	☐
RATIONALE 1	The project/study falls under well-accepted care practices/guidelines or is there sufficient evidence for this mode or approach to support implementing this activity or to create practice change, based on: • literature • consensus statements, or consensus among clinician team	☑	☐
RATIONALE 2	The project/study would be carried out even if there was no possibility of publication in a journal or presentation at an academic meeting. (**Please note that answering "Yes" to this statement does not preclude publication of a quality activity.)	☑	☐
METHODS 1	Are the proposed methods flexible and customizable, and do they incorporate rapid evaluation, feedback and incremental changes?	☑	☐
METHODS 2	Are patients/subjects randomized into different intervention groups in order to enhance confidence in differences that might be obscured by nonrandom selection? (Control group, Randomization, Fixed protocol Methods)	☐	☑
METHODS 3	Will there be delayed or ineffective feedback of data from monitoring the implementation of changes? (For example to avoid biasing the interpretation of data)	☐	☑
METHODS 4	Is the Protocol fixed with fixed goal, methodology, population, and time period?	☐	☑
RISK	The project/study involves no more than minimal risk procedures meaning the probability and magnitude of harm or discomfort anticipated are not greater in and of themselves than those ordinarily encountered in daily life or during the performance of routine physical or psychological examinations or tests.	☑	☐
PARTICIPANTS	Will the project/study only involve patients/subjects who are ordinarily seen, cared for, or work in the setting where the activity will take place?	☑	☐
FUNDING	Is the project/study funded by any of the following? • An outside organization with an interest in the results • A manufacturer with an interest in the outcome of the project relevant to its products • A non-profit foundation that typically funds research, or by internal research accounts	☐	☑

If all of the check marks are inside the shaded gray boxes, then the project/study is very likely QI and not human subject research. Projects that are not human subject research do not need review by the IRB.

In order to assess whether your project meets the definition of human subject research requiring IRB review or may qualify as a quality improvement/assurance activity, please provide the following information:

1. **Project Summary: In the space provided below, please provide a summary of the purpose and procedures.**

   Purpose: The purpose of this quality improvement project is to assess anesthesia providers' perceptions of the effectiveness of their current practice for intraoperative temperature monitoring and of a newly developed temperature monitoring/management guide.
   Procedures: A quick reference Perioperative Temperature Monitoring and Management Guide, based upon accepted national guidelines, will be developed. Anesthesia providers at SurgiCenter will be asked several questions (through Qualtrics) about their perceptions of the adequacy of their currently used perioperative temperature monitoring and management practices and preparedness for prevention of inadvertent perioperative hypothermia. An educational presentation about the use of the newly developed evidence-based guide will be made available to them, and they will be asked to use the guide for two weeks. Upon completion of the two-week utilization period, they will be asked to complete a Qualtrics post-intervention questionnaire addressing their practices and preparedness for prevention of inadvertent perioperative hypothermia as well as the acceptability and adequacy of the guide in supporting best practice. No patient information will be recorded or maintained during this project.

2. **If the Primary purpose of your project/study is for QA/QI, have you obtained approval from the operational leader within your department or health system** [Please specify here whom and obtain their signature in the signature section below]: MSN, CRNA

   ☐ **Yes**
   ☐ **No** [Contact the appropriate operational leader for approval.]

Please note:

- By submitting your proposed project/study for QA/QI determination you are certifying that if the project/ study is established to qualify as QA/QI project, you and your Department would be comfortable with the following statement in any publications regarding this project: "This project was reviewed and determined to qualify as quality improvement by the Center for Research and Grants."
- If you are submitting a Poster to Media Services for printing, you will need to also submit this Quality Improvement Worksheet or proof of your IRB Application and IRB Approval.
- If the CRG determines the activity is not human subject research, then any presentation, publication, etc. should not refer to the activity as "human subject research," "exempt research," or "expedited research."
- If you would like the CRG to verify that a project/study is not human subject research, please provide this form completed with the summary of your activity and any additional information to the CRG at CRG.Quality@ and the following will be completed and returned to you for your records.

NHSR vs. HSR Determination:

☒ **Not Human Subject Research:** The CRG has determined that based on the description of the project/study, approval by the IRB is not necessary. Any changes or modifications to this project may be discussed with the CRG at that time to ensure those changes do not elevate the project to human research that would need IRB approval.

☐ **Human Subject Research:** This project/study requires review by the IRB prior to initiation. An application in the electronic IRB submission system should be submitted.

Approval Signatures:

Operational Mgr/Leader: _____ **Date:** 3/3/22

CRG Reviewer: _____ **Date:** 3/14/22

UMCIRB Office Staff Reviewer: _____ **Date:** 3/15/22

Attestation of Understanding

My signature below indicates that I fully understand that HIPAA Privacy standards as they apply to Quality Projects involving Protected Health Information and patient medical records as outlined below.

Under HIPAA's minimum necessary provisions, Health must make reasonable efforts to limit PHI to the minimum necessary to accomplish the purpose of the use, disclosure or request.

Under HIPAA, a Covered Entity can disclose PHI to another CE (i.e. BSOM) for the following subset of health care operations activities of the recipient CE without needing patient consent:

- Conducting quality assessment and improvement activities
- Developing clinical guidelines
- Conducting patient safety activities as defined in applicable regulations
- Conducting population-based activities relating to improving health or reducing health care cost

Vidant healthcare data utilized in this project should not be shared outside of the CE without a fully executed data use/sharing agreement. Health leadership reserves the opportunity to review all articles for dissemination/ publication for which healthcare data has been utilized.

_____ 2/21/2022

Project Leader Signature **Date**

Click "download PDF" to save a copy of this page for your records.
Note: The IRB Office does not maintain copies of your responses.

Below is a summary of your responses

Download PDF

Quality Improvement/Program Evaluation Self-Certification Tool

Purpose:
Projects that do not meet the federal definition of human research pursuant to 45 CFR 46 do not require IRB review. This tool was developed to assist in the determination of when a project falls outside of the IRB's purview.

Instructions:
Please complete the requested project information, as this document may be used for documentation that IRB review is not required. Select the appropriate answers to each question in the order they appear below. Additional questions may appear based on your answers. If you do not receive a STOP HERE message, the form may be printed as certification that the project is "not research", and does not require IRB review. The IRB will not review your responses as part of the self-certification process. For projects being done at Vidant Health, site support will be required. Please email crg.quality@ to obtain site support from Vidant Health.

Name of Project Leader:

Zachary Soderblom

Project Title:

Anesthesia Providers' Perceptions of Perioperative Temperature Monitoring: A DNP Project

Brief description of Project/Goals:

Purpose: The purpose of this quality improvement project is to assess anesthesia providers' perceptions of perioperative temperature monitoring and to provide continuing education regarding evidence-based temperature monitoring and management practices. Process: A perioperative temperature monitoring resource based on current literature and national standards and guidelines will be developed. Anesthesia providers at the individually assigned clinical site will be asked several questions via a qualtrics survey to assess their perceptions regarding currently used perioperative temperature monitoring practices. An educational presentation about the newly developed resource, "Raising the Brrrr on Perioperative Temperature Monitoring," will be recorded and made available to them to review, along with a downloadable and printable copy of the resource. After reviewing these materials, they will be asked to complete a post-educational questionnaire to assess their perceptions of the project's educational tool and to reassess their perception of temperature monitoring in practice. Qualtrics survey software will be employed to deliver the intervention link and gather CRNA participant survey responses. No patient information will be recorded or maintained during this project.

Will the project involve testing an experimental drug, device (including medical software or assays), or biologic?

- ○ Yes
- ● No

Has the project received funding (e.g. federal, industry) to be conducted as a human subject research study?

- ○ Yes
- ● No

Is this a multi-site project (e.g. there is a coordinating or lead center, more than one site participating, and/or a study-wide protocol)?

- ○ Yes
- ● No

Is this a systematic investigation designed with the intent to contribute to generalizable knowledge (e.g. testing a hypothesis; randomization of subjects; comparison of case vs. control; observational research; comparative effectiveness research; or comparable criteria in alternative research paradigms)?

- ○ Yes
- ● No

Will the results of the project be published, presented or disseminated outside of the institution or program conducting it?

- ● Yes
- ○ No

Would the project occur regardless of whether individuals conducting it may benefit professionally from it?

- (●) Yes
- ( ) No

Does the project involve "no more than minimal risk" procedures (meaning the probability and magnitude of harm or discomfort anticipated are not greater in and of themselves than those ordinarily encountered in daily life or during the performance of routine physical or psychological examinations or tests)?

- (●) Yes
- ( ) No

Is the project intended to improve or evaluate the practice or process within a particular institution or a specific program, and falls under well-accepted care practices/guidelines?

- (●) Yes
- ( ) No

Based on your responses, the project appears to constitute QI and/or Program Evaluation and IRB review is not required because, in accordance with federal regulations, your project does not constitute research as defined under 45 CFR 46.102(d). If the project results are disseminated, they should be characterized as QI and/or Program Evaluation findings. Finally, if the project changes in any way that might affect the intent or design, please complete this self-certification again to ensure that IRB review is still not required. Click the button below to view a printable version of this form to save with your files, as it serves as documentation that IRB review is not required for this project. 11/29/2021

Appendix E

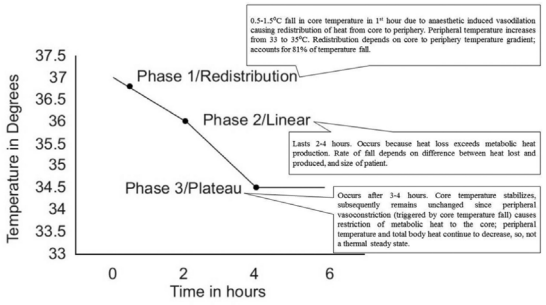
Educational Tool

Causes of Hypothermia Under Anesthesia

1) Exposure to a cold environment
2) Behavioral regulation is impaired or nonexistent
2) Anesthetic-induced impaired thermoregulation
   - Vasodilation promoting heat loss
   - Vasoconstriction, shivering, and non-shivering thermogenesis are less effective and have a reduced threshold for activation
   - Autonomic defense mechanisms
   - 20-30% reduction in metabolic rate
   - Inter-threshold range increases up to ten-fold → poikilothermia

Mechanisms of Heat Loss Under Anesthesia

Conduction, convection, radiation, evaporation, and redistribution



Current Standard of Care

The current minimally accepted temperature is 36 °C.

AANA Standard IX: Monitoring

"When clinically significant changes in body temperature are intended, anticipated, or suspected, monitor body temperature. Use active measures to facilitate normothermia."

ASA Standards for Basic Anesthetic Monitoring

"During all anesthetics, the patient's oxygenation, ventilation, circulation, and temperature shall be continually evaluated. To aid in the maintenance of appropriate body temperature during all anesthetics, every patient receiving anesthesia shall have temperature monitoring when clinically significant changes in body temperature are intended, anticipated, or suspected."

Potential Negative Outcomes

- Alterations in pharmacokinetics of anesthetic drugs
- Enzymatic reduction
- Increased blood loss and transfusion requirements
- Surgical site infection and complications
- Delayed post-operative discharge

Raising the Bar On Temperature Management

High risk Populations & Procedures

Advanced Age >65	Recent burn
ASA Grade 2-5	Large fluid shifts
Pre-op temp <36 °C	Combined GA and RA
Pediatrics/Neonates	Prolonged duration of GA
Female > Male	Open abdomen
Low BMI	Orthopedics
Autonomic dysfunction	Trauma/Blood loss

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Prevention of hypothermia

- #1 Pre-operative warming (most effective)
- Passive warming – covering the patient with blankets and a headcover to minimize heat loss
- Active Warming – forced air cover (Bair Hugger), circulating water mattress/pads (Arctic Sun), heated fluids, maintaining ambient room temperature of 23 °C

Accepted core body sites	Other monitoring sites
Esophageal	Axillary
Bladder	Skin
Rectal	Nasopharyngeal
Right Atrium	Temporal
	Tympanic

Tools available for temperature monitoring

Transesophageal probe
Foley catheter
Rectal temperature probe
Pulmonary artery catheter
Oral probe thermometer
Temporal scanner
Nasopharyngeal probe
Tympanic thermometer

ECU
Nurse Anesthesia Program

Appendix F

Pre- and Post-Intervention Surveys

Pre-Survey Questions

1) Have you ever received education on temperature monitoring policies or standards for your surgical setting?

   a) Yes / No / Unsure

2) Are you aware of the AANA national standard for temperature monitoring?

   a) Yes / No

3) If you had a question about perioperative temperature monitoring, approximately how long would it take you to access a reference of evidence-based guidelines to address your question?

   a) <1 minute / 1-3 minutes / 4-6 minutes / 7-9 minutes / 10 or more minutes

4) How confident are you in your knowledge about perioperative temperature monitoring?

   a) Not at all confident 1 2 3 4 5 Very confident

5) How confident are you in your ability to identify a patient or procedure at higher risk of intraoperative heat loss?

   a) Not at all confident 1 2 3 4 5 Very confident

6) How confident are you in your ability to identify core temperature sites?

   a) Not at all confident 1 2 3 4 5 Very confident

7) How confident are you that the temperature monitoring devices currently available to you accurately detect the patient's core body temperature?

   a) Not at all confident 1 2 3 4 5 Very confident

8) During a normal work week (approximately 40-hour week) how often do you utilize temperature monitoring intraoperatively?

   a) 0-25% of cases / 25-50% of cases / 50-75% of cases / 75-100% of cases

9) What is your preferred modality/site for temperature monitoring in the intraoperative setting? (select all that apply)

   a) Axillary

   b) Skin

   c) Esophageal

   d) Foley catheter

e) Rectal

f) Nasopharyngeal

g) Temporal

h) Tympanic

i) Other _____

Post-Survey Questions

1) After this educational initiative, can you readily access the AANA national standard on temperature monitoring?

a. Yes / No

2) How likely are you to reference this material in your future practice?

a. Very unlikely / unlikely / neutral / likely / very likely

3) If you saved this educational tool to your smartphone/device, how long do you think it would take you to access this reference to address your questions about perioperative temperature monitoring?

a. < 1 minute / 1-3 minutes / 4-6 minutes / 7-9 minutes / 10 or more minutes

4) After reviewing this resource, how confident are you in your knowledge about perioperative temperature monitoring?

a. Not at all confident 1 2 3 4 5 Very confident

5) After reviewing this resource, how confident are you in your ability to identify a patient or procedure at higher risk of intraoperative heat loss?

a. Not at all confident 1 2 3 4 5 Very confident

6) After reviewing this resource, how confident are you in your ability to identify core temperature sites?

a. Not at all confident 1 2 3 4 5 Very confident

7) After reviewing this resource, how often will you utilize temperature monitoring intraoperatively?

a. 0-25% of cases / 25-50% of cases / 50-75% of cases / 75-100% of cases

8) In your practice, how often do you find that your last operating room temperature correlates well with the first PACU temperature?

a. 0% of the time / 25% of the time / 50% of the time / 75% of the time / 100% of the time

9) If you find the correlation between the operating room temperature and PACU temperature lacking, what recommendations do you have for how to improve this issue?

_____

10) After reviewing this material, which modality/site for temperature monitoring in the intraoperative setting are you most likely to use in practice? (select all that apply)

a. Axillary

b. Skin

c. Esophageal

d. Foley catheter

e. Rectal

f. Nasopharyngeal

g. Temporal

h. Tympanic

i. Other _____

11) In your opinion, what do you perceive as being barriers to preventing intraoperative hypothermia?

_____

12) Is there anything you feel could be added to strengthen this educational tool?

_____

Appendix G

Emails to Participants

Initial Pre-Survey and Video Email to Participants

Dear SurgiCenter CRNAs,

Thank you for considering participating in a quality improvement project titled "Anesthesia Providers' Perceptions of Perioperative Temperature Monitoring: A DNP Project." The purpose of this project is to assess Anesthesia Providers' perceptions of perioperative temperature monitoring at the SurgiCenter.

Participation is voluntary and will involve completing a short pre-intervention questionnaire, viewing a brief video, utilizing an educational tool "Raising the Brr on Temperature Management" in your CRNA practice for two weeks at your discretion, and completing a short post-intervention questionnaire when the two-week implementation period is over.

Each questionnaire and the video should take less than 2-4 minutes to complete. The questionnaires were created and are completed using Qualtrics® survey software. The use of the educational tool "Raising the Brr on Temperature Management" falls within currently accepted practice in your work area. Your participation is voluntary and confidential. We will share the results of this QI study with you upon completion.

First, complete the pre-intervention questionnaire
https://ecu.az1.qualtrics.com/jfe/form/SV_8tUAjsbdfexdRpc.
Followed by viewing the educational tool "Raising the Brr on Temperature Management" and watching our video available as an attachment in this email. Again, thank you for your participation in our quality improvement project. I will be at the SurgiCenter from (3/28/2022-4/7/2022) if you have any questions but you may also reach out to me or Angela Ciuca by email.

Sincerely,

Zachary Soderblom, BSN, SRNA
Soderblomz20@students.ecu.edu

Pre-Survey and Video Reminder Email to Participants

Hello, SurgiCenter CRNAs,

I just wanted to send a quick reminder about the ongoing DNP Project on assessing Anesthesia Providers' Perceptions of Perioperative Temperature Monitoring. If you've already filled out the pre-survey and viewed the video, thank you! If you haven't had a chance to yet, it's not too late and would be very helpful and much appreciated. After the end of next week, I will begin sending out the post-surveys.

Links:
https://ecu.az1.qualtrics.com/jfe/form/SV_8tUAjsbdfexdRpc

Please let me know if you have any questions and thank you again for your participation.

Sincerely,
Zachary Soderblom BSN, SRNA
ECU Nurse Anesthesia Program
Class of 2023

Post-Survey Email to Participants

Dear SurgiCenter CRNAs,

Thank you to everyone who has already completed my pre-survey and viewed the video! It's now time to complete the brief post-survey (link below). If you have not filled out a pre-survey, I would really and truly appreciate your participation (it's just surveys and a video!). The pre-survey link is https://ecu.az1.qualtrics.com/jfe/form/SV_8tUAjsbdfexdRpc.

If you've already completed the first survey, here is the post-survey link https://ecu.az1.qualtrics.com/jfe/form/SV_39Hheeb6sw7pa18. It should take less than 2 minutes.

If anyone has questions or issues with the links, please let me know. Again, thank you to everyone for your help and for being excellent preceptors. I look forward to coming back to the SurgiCenter soon.

Sincerely,
Zachary Soderblom BSN, SRNA
ECU Nurse Anesthesia Program
Class of 2023

Final Thank You Email to Participants

Dear SurgiCenter CRNAs,

I just wanted to say thank you so much to everyone for helping me out with my DNP Project! I have collected all the data that I need to proceed with data analysis and will then be finishing my paper. Once it's complete you all will be able to read it if you'd like. And if you liked the education tool “Raising the Brr on Temperature Management” and found it useful, you can continue to use it in your practice and feel free to share with your co-workers.

Thank you again! I hope to work with you more in the future.

Take care,
Zachary Soderblom BSN, SRNA
ECU Nurse Anesthesia Program
Class of 2023