Fall 12-9-2021

Barriers To Preoperative Warming: Best Practice Guideline

Tyler Comans
University of Southern Mississippi

Zachary Hays
University of Southern Mississippi

Caleb Leach
University of Southern Mississippi

BARRIERS TO PREOPERATIVE WARMING: BEST PRACTICE GUIDELINE

by

Tyler Comans, Zachary Hays, and Caleb Leach

A Doctoral Project
Submitted to the Graduate School,
the College of Nursing and Health Professions
and the School of Leadership and Advanced Nursing Practice
at The University of Southern Mississippi
in Partial Fulfillment of the Requirements
for the Degree of Doctor of Nursing Practice

Approved by:

Dr. Mary Jane Collins, Committee Chair
Dr. Stephanie Parks, Member

December 2021

Published by the Graduate School

ABSTRACT

The lack of preoperative warming has a direct relationship to perioperative hypothermia complications which include, but are not limited to: increased infection rate, coagulopathies, and increased myocardial oxygen consumption; all contributing to poor patient and facility outcomes. Implementation of an evidence-based educational module with visual aid can potentially increase the utilization of active warming techniques in the preoperative setting by perioperative staff. The DNP Project investigated barriers to preoperative warming by perioperative staff at a large teaching hospital in the southeastern United States. Barriers were assessed by a voluntary survey sent to 87 perioperative staff members. Twenty-two surveys were completed and analyzed. The survey results concluded that while the facility does provide access to preoperative warming capabilities, time constraint appears to be the most common barrier. An educational module based on evidence-based practice and peer-reviewed literature was provided to the perioperative staff along with a visual aid to potentially increase the utilization of preoperative warming techniques. The visual aid will not only provide a time-efficient option but will potentially serve as a reinforcement of the evidence-based educational module.

ACKNOWLEDGMENTS

We would like to thank our committee chair, Dr. Mary Jane Collins, for her guidance, knowledge base, and patience from the initiation of this project through the final stages. We would also like to thank Dr. Stephanie Parks, Dr. Nina McLain, and Dr. Michong Rayborn for their encouragement and any needed support throughout the entirety of completing the project. Finally, we would like to acknowledge all the participants of our survey.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF ILLUSTRATIONS

LIST OF ABBREVIATIONS

AACN	American Association of Colleges of Nursing
AANA	American Association of Nurse Anesthetists
AORN	American Association of Perioperative Registered Nurses
ASA	American Society of Anesthesiologists
C	Celsius
CRNA	Certified Registered Nurse Anesthetist
DNP	Doctor of Nurse Practice
F	Fahrenheit
HAI	Healthcare Associated Infection
IHI	Institute for Healthcare Improvement
IPH	Inadvertent Perioperative Hypothermia
IRB	Institutional Review Board
LOS	Length of Stay
MDA	Medical Doctor of Anesthesiology
MSDH	Mississippi Department of Health
NAP	Nurse Anesthesia Program
PACU	Post Anesthesia Care Unit
SSI	Surgical Site Infections
USM	The University of Southern Mississippi
WHO	World Health Organization

CHAPTER I - INTRODUCTION

Body temperature is a vital sign just the same as heart rate, blood pressure, and oxygen saturation. However, the temperature is often the most overlooked of all the vital signs. This is especially true in the fast-paced environment of surgery. Over the last decade, documentation of the presence of hypothermia in the Post Anesthesia Care Unit (PACU) is one of the first items on the list of clinical indicators provided by the Anesthesia Quality Institute (Butterworth et al., 2018). Also included on the clinical indicator list were postoperative nausea and vomiting, extended PACU stay, perioperative myocardial infarction, unrecognized difficult airway, hypotension in the PACU, dental trauma, and complications with vascular access (Murphy, 2012). Furthermore, according to the American Society of Anesthesiologists (ASA), temperature measurement is a basic standard of care and should be continually monitored during an anesthetic and monitored again during handoff in the PACU (ASA, 2020). Additionally, The American Association of Nurse Anesthetists (AANA) defines body temperature monitoring as a standard of care (AANA, 2020). The World Health Organization (WHO) released a systematic review demonstrating the benefits of maintaining normothermia preoperatively through postoperatively; namely, decreased infection rate and decreased opioid administration (World Health Organization [WHO], 2021).

Inadvertent perioperative hypothermia (IPH) is associated with numerous risks to patient outcomes following surgery. Adriani and Moriber (2013) define hypothermia as a core temperature of fewer than thirty-six degrees Celsius (C) (96.8 degrees Fahrenheit (F)). IPH impairs platelet function and coagulation, increasing blood loss during surgery and blood transfusion requirements. In addition, IPH increases patient heart rate, blood

pressure, and reported levels of pain postoperatively. Surgical site infections (SSI) and hospital length of stay (LOS) are also increased by IPH (Bindu et al., 2017).

Several factors contribute to high rates of IPH in patients under general anesthesia. For one, research generally acknowledges that core body temperature is not monitored as closely as other vital signs, making the temperature more likely to go out of the acceptable range (Bindu et al., 2017). Most anesthetic drugs greatly decrease the body's autonomic thermoregulation abilities. General anesthesia greatly blunts the body's response to heat and cold, while also promoting vasodilation leading to redistribution hypothermia (Hooven, 2011). Surgery and the cold operating room also contribute to IPH. The temperature of the operating suite contributes to a large percentage of core temperature loss through the effects of convection and radiation. Convection and radiation combine for up to eighty-five percent of heat loss for the exposed patient (Rosenkilde et al., 2017). Preoperative patient warming helps to prevent these problems. Preoperative warming has also been shown to reduce the effects of redistribution hypothermia, which leads to an overall decrease in IPH (Adriani & Moriber, 2013). The use of warming techniques in the pre-operative surgical area is not a standard of care in many facilities (Hooven, 2011). Implementation of prewarming practices can improve the outcomes of many surgical patients during and after surgery. According to Rosenkilde and colleagues (2017), preoperative warming decreased the incidence of perioperative hypothermia and the initial temperature drop associated with the induction of anesthesia.

Problem Description

Statement of the Problem

Research shows that an inconsistency between providers in the utilization of preoperative warming has a direct relationship to perioperative hypothermia complications which include, but are not limited to: increased infection rate, coagulopathies, and increased myocardial oxygen consumption; which contribute to poor patient and facility outcomes (Robinson et al., 2005). Perioperative warming practices vary between anesthesia providers and among The University of Southern Mississippi (USM) clinical affiliates (M. Collins, personal communication, November 23, 2020). Potential negative consequences of inadequate warming include poor patient and facility outcomes. An evidence-based best practice guideline for perioperative warming, along with an educational module and visual cognitive aid for providers, will be created and presented to anesthesia administration at a USM clinical affiliate.

Significance of the Problem

Inadvertent perioperative hypothermia (IPH) is a potential risk to all patients undergoing anesthesia because of the effect of anesthetic agents on the body's temperature regulation system (Munday et al., 2019). An educational module with a visual cognitive aid has the potential to decrease the occurrence of IPH by increasing the utilization of preoperative warming techniques. Identifying the current barriers across facilities that prevent widespread usage of prewarming techniques will aid in the development of an evidence-based educational module. An educational module and visual cognitive aid can be used by Certified Registered Nurse Anesthetists (CRNA),

Anesthesiologists, and preoperative nursing staff to increase their knowledge of preoperative warming, IPH, and the pathophysiology of IPH.

Available Knowledge

Pathophysiology of Hypothermia

In a patient with normal physiologic function, the hypothalamus maintains core body temperature. A small gap exists between the thresholds for vasodilation and vasoconstriction, more commonly known as sweating and shivering (Butterworth et al., 2018). Anesthesia blunts the hypothalamus response mechanism, therefore, blunting the vasoconstriction response to cold. This blunted response leads to a core body temperature decrease of approximately one to two degrees Celsius (C) in the first hour of general anesthesia followed by a more gradual decrease over the next three to four hours. The primary reason for the dramatic decrease of temperature is due to *redistribution of heat* which is explained by heat transferring from core compartments in the periphery. (Butterworth et al., 2018). IPH is associated with numerous risks to patient outcomes following surgery. Adriani and Moriber (2013) define hypothermia as a core temperature of fewer than 36 degrees C which correlates with 96.8 degrees F. IPH impairs platelet function and coagulation, increasing blood loss during surgery and blood transfusion requirements. In addition, IPH increases patient heart rate, blood pressure, and reported levels of pain postoperatively. SSIs and LOSs are also increased by IPH (Bindu et al., 2017). Establishing the negative consequences of perioperative hypothermia will serve as justification for creating an evidence-based guideline for prevention.

Increased Infection Rate

Surgical patients are vulnerable to perioperative surgical wound infections in the presence of hypothermia. Hypothermia leads to tissue vasoconstriction and impaired immunity. Resistance to infection is decreased due to the lowered partial pressure of oxygen caused by vasoconstriction. Chemotaxis, phagocytosis, macrophage mobility, and antibody production are all impaired in the presence of hypothermia. The engulfment of undesirable bacteria by neutrophils is impaired in the presence of hypothermia as well. (Barash et al., 2017).

According to the Mississippi Department of Health (MSDH) (2020), healthcare-associated infections (HAI) are one of the leading factors that contribute to death within the United States. Over the past decade, using every possible measure to prevent SSIs has become even more important for medical facilities. In 2008, the Centers for Medicare and Medicaid halted reimbursements for the treatment of certain HAIs, including SSIs (Kwong et al., 2017).

Coagulopathies

Hypothermia has a negative effect on the human body's ability to achieve hemostasis after injury. The normal clotting cascade is a complex process. Hypothermia's inhibitory effect on coagulation seems to mostly be centered on platelet function. Platelet shape and *sticking* ability seem to be drastically altered in the hypothermic patient (Smith et. al, 2015). Hypothermia is also suspected to contribute to alterations in the normal function of both thrombin generation and fibrin metabolism. Fibrinolysis, the process by which clots dissolve, is sped up in the hypothermic patient. Blood is slower to begin clotting, and the breakdown of clots begins to occur much sooner than would be expected

in the normothermic patient. According to Barash et al. (2017), coagulation factor function drops approximately ten percent for each one degree C below 36 degrees C.

Alteration of Drug Metabolism and Elimination

Up to 70% of surgical patients are affected by hypothermia, whereas hypothermia is defined as a "core body temperature less than 36 ° C" (Nagelhout & Elisha, 2018, p. 980). "When associated with hypothermia, the majority of drugs have delayed metabolism and clearance" (Nagelhout & Elisha, 2018, p. 69). A majority of drugs used in anesthesia are hepatically metabolized, more specifically, the drugs are metabolized by cytochrome enzymes found in a hepatocyte in the liver. The enzymes significantly rely on temperature (Barash et al., 2017). Drugs that are hepatically metabolized depend on hepatic blood flow. In the instance of hypothermia, hepatic blood flow is decreased (Zhou & Poloyac, 2011). To understand the effects of hypothermia on drug metabolism in anesthesia, one must understand the normal, general principles of drug metabolism. After understanding general principles of drug metabolism, factors affecting hepatic clearance of a drug which are dependent on hepatic blood flow, intrinsic clearance, and the fraction of the drug that is protein-bound can be comprehended more easily. (Zhou & Poloyac, 2011). As previously mentioned, enzyme production and function are decreased in hypothermia, therefore, drugs undergoing this pathway will also have a delayed metabolism and elimination. Another route pertinent to anesthesia is Hoffman elimination. Hoffman elimination is temperature and pH-dependent. The rise in pH and temperature, after injection, is what initiates Hoffman's elimination. A decrease in temperature and pH delays the elimination of drugs that undergo Hoffman elimination, therefore, prolonging the duration of the drug. (Nagelhout & Elisha, 2018, pp. 665-666).

Hypothermia increases tissue solubility of inhalation anesthetics. The increase in distribution leads to a longer recovery time from volatile anesthetics (Barash et al., 2017). Minimal alveolar concentration is also decreased in hypothermia and can be related to increased tissue solubility (Nagelhout & Elisha, 2018, p. 334).

Anesthetic Drugs, Acid-Base, and Hypothermia

Hypothermia leads to a build-up of lactic acid exceeding the capability of the liver to metabolize it. The build-up results in metabolic acidosis which contributes to an overall depressed respiratory, liver, and kidney function (Rosenfeld, 1963). Normal acid-base balance is empirical to the action of drugs. Drugs are buffered to have a certain pH and have a certain pKa. When introduced to the body, drug pH and pKa interact with physiological pH to comprise the desired form of the drug, whether ionized or non-ionized, so that the drug can carry out its target action (Nagelhout & Elisha, 2018, pp. 276-277). When pH is altered by hypothermia, resulting in a lower physiological pH, the desirable ionized or non-ionized portion of a drug can then also be altered.

Advantages of Preoperative Warming

Preoperative patient warming helps prevent the side effects associated with IPH. Preoperative warming has been shown to reduce the effects of redistribution hypothermia, which leads to an overall decrease in IPH (Adriani & Moriber, 2013). Implementation of prewarming practices can improve the outcomes of many surgical patients during and after surgery. According to Rosenkilde et al (2017), preoperative warming decreased the incidence of perioperative hypothermia and the initial temperature drop associated with the induction of anesthesia. Expected outcomes indicate cost efficiency and better patient outcomes. An earlier emergence from anesthesia can be

expected when patients are normothermic. Hypothermia is associated with longer drug metabolism. Also, expectations that postoperative patients will receive less infused clotting factors due to normothermia can be achieved (Matika et al., 2016). Along with early emergence from anesthesia, results are expected that surgical patients will have fewer postoperative infections and receive fewer doses of antibiotics when the patient is warmed preoperatively. (Melling et al., 2001). A decrease in opioid use for postoperative shivering can be expected since preoperative warming is associated with decreased postoperative shivering. (Sajid et al., 2009). Increased patient comfort is associated with preoperative warming as well which can also lead to higher patient satisfaction scores and decreased preoperative anxiety. Decreased patient anxiety can lead to a prediction in decreased medication use associated with preoperative anxiety. "Perioperative warming of surgical patients is effective in reducing postoperative wound pain, wound infection, and shivering" (Sajid et al., 2009, p. 231).

Facility Outcomes

In identifying efficient patient improvement plans, the cost is a significant contributing factor to consider. Preoperative patient warming allows for better patient outcomes with little increase in cost for a facility (Hooper et al., 2010). LOS is a high focus area when considering facility and patient healthcare costs. While surgical site infections are greatly increased in the presence of hypothermia, data demonstrated that even in the absence of infection, patients experiencing hypothermia had an increase in hospitalization by 20% (Hooper et al., 2010). "Maintenance of normothermia can result in a reduction of patient costs by an estimated $2,500 to $7,000 per patient" (Roberson et al., 2013, p. 354). According to Ruetzler and Kurz (2018), conservative estimations of

approximately 2,000 dollars can be expected for every patient that experiences IPH. Equipment used for intraoperative warming can be applied earlier in preoperative holding areas that will then travel with the patient to the surgical area, therefore, eliminating the need for all new equipment. Due to decreased needs, a decrease in medication costs can be expected. Postoperative infection also causes increased facility cost, with preoperative warming decreasing postoperative infection, which could lead to an overall reduction in facility cost (Roberson et al., 2013).

Barriers to Active Warming

"One reason why unintentional perioperative hypothermia prevention still fails may be to the lack of consensus in prewarming time, warming devices, and warming methods. Intraoperative warming prevents intraoperative heat loss from exceeding the heat production" (Erdling & Johannson, 2015, p. 102). Preventing hypothermia is often not a high priority to perioperative staff members due to forced-air warming systems potentially contaminating the sterile field and passive warming, such as increased room temperature, may decrease staff comfort during the case. In addition, inconsistent warming practices among practitioners and a lack of clinical guidelines may affect team members' efforts to prevent hypothermia (Levin et al., 2016). Even though the state of hypothermia is recommended to be avoided, hypothermia in the intraoperative setting is prevalent due to the lack of active warming techniques (Kurz et al., 1996). "Although safe and inexpensive methods of warming are available, perioperative hypothermia remains common" (Kurz et al., 1996, p. 1213). Implementation of an annual competency aided in the sustainability of hypothermia protocols. A lack of consistency in competency training for normothermic protocols leads to a decrease in the use of active warming

techniques (Levin et al., 2016). Another finding was a self-identified lack of knowledge and a need for education and best practice recommendations regarding perioperative hypothermia in terms of the etiology and prevention of the condition. Perioperative hypothermia was recognized as being detrimental by both nursing and medical participants; but the depth of understanding of the physiology and associated outcomes of the condition was variable (Munday et al., 2019).

Current Recommendations and Trends

Implementation of prewarming practices has the potential to improve the outcomes of many surgical patients during and after surgery. According to Rosenkilde and colleagues (2017), preoperative warming decreased the incidence of perioperative hypothermia and the initial temperature drop associated with the induction of anesthesia. Preoperative warming reduced the number of hypothermic events and improved patient comfort and satisfaction without increasing the cost to the hospital (Wasfie & Barber, 2015). The quality of health care is immensely improved through temperature maintenance. The utilization of prewarming for thirty to sixty minutes is effective to reduce the incidence of hypothermia in surgical patients (Brito-Povedo et al., 2013). Although prewarming for thirty to sixty minutes is recommended, shortened prewarming times also offer advantages (Erdling & Johannson, 2015). Convective forced-air warming preoperatively for approximately 30 minutes aids in the prevention of phase one hypothermia by eliminating the central-peripheral temperature gradient. (Butterworth et al., 2018). Phase two hypothermia is mitigated intraoperatively by forced-air warming blankets, warmed intravenous fluids, increased ambient operating room temperature, and heated humidification of inspired gases (Butterworth et al., 2018). Below is an example

of best practices regarding warming during each phase of the perioperative period. The table can help guide practitioner decision-making for each patient (Hooper et al., 2010).

Table 1

Preoperative, Intraoperative, and Postoperative Recommendations

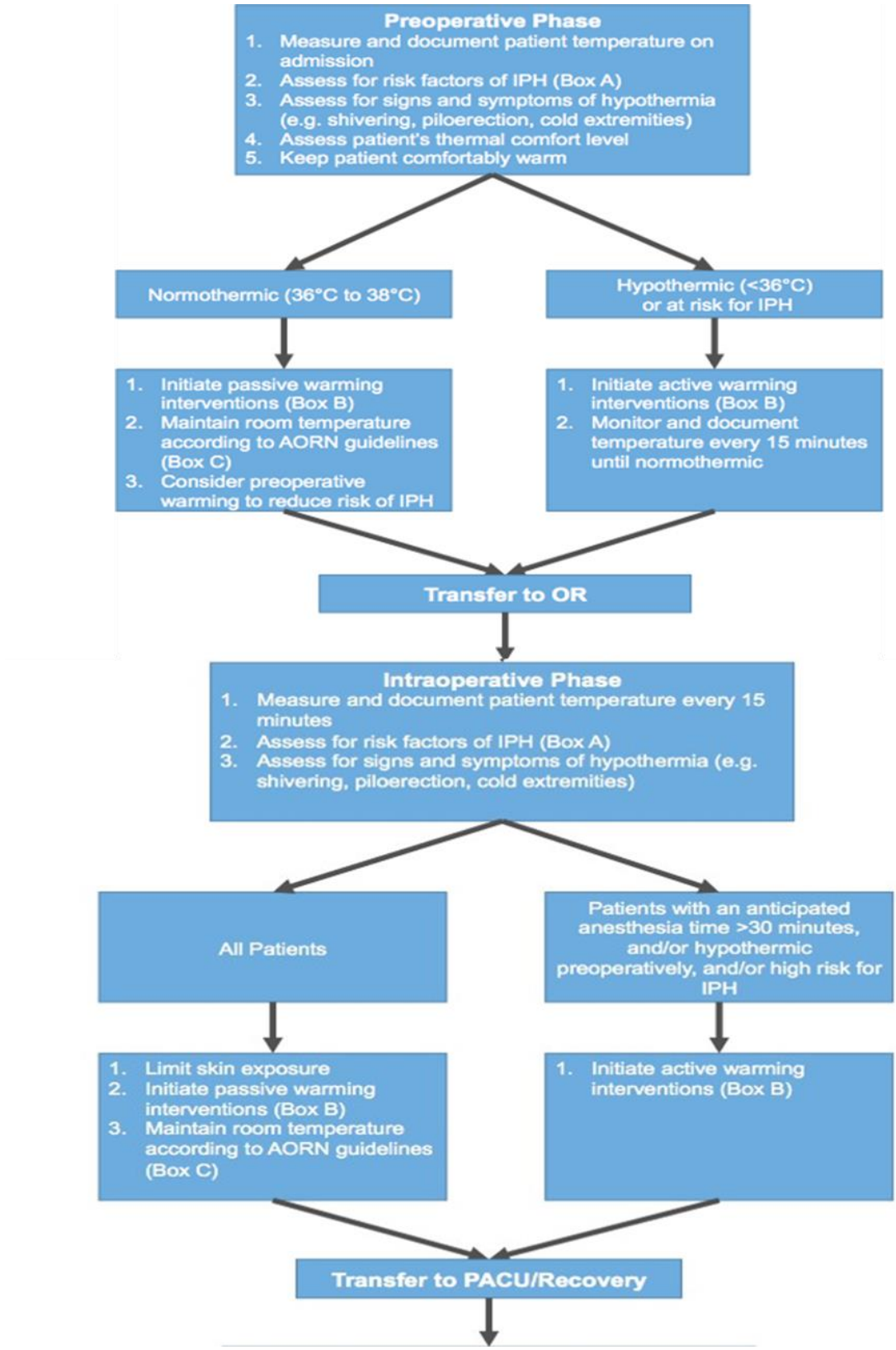
	Preoperative Recommendations	Intraoperative Recommendations	Postoperative Recommendations
Assessment	• Assess for risk factors for perioperative hypothermia • Measure patient temperature on admission • Determine patient's thermal comfort level • Assess for signs and symptoms of hypothermia (shivering, piloerection, and/or cold extremities) • Document and communicate all risk factor assessment findings to all members of the anesthesia/surgical team	• Identify patient's risk factors for unplanned perioperative hypothermia • Frequent intraoperative temperature monitoring should be considered in all cases • Assess for signs and symptoms of hypothermia • Determine patient's thermal comfort level • Document and communicate all risk factor assessment findings to all members of the anesthesia/surgical team	• Identify the patient's risk factors for perioperative hypothermia • Document and communicate all risk factor assessment finding to all members of the healthcare team • If normothermia, continue to measure temperature at least hourly, at discharge, and as indicated by patient condition • If hypothermic, measure temperature at a minimum of every 15 minutes until normothermia is achieved • Determine patient's thermal comfort level • Assess for signs and symptoms of hypothermia

Interventions	• Implement passive thermal care measures • Maintain ambient room temperature at or above 24 degrees Celsius • Institute active warming for hypothermic patients • Consider preoperative warming to reduce the risk of intra/postoperative hypothermia *Evidence suggests prewarming for a minimum of 30 minutes may reduce the risk of subsequent hypothermia	• All patients should receive the following: 1. Limit skin exposure to lower ambient environmental temperatures 2. Initiate passive warming measures 3. Maintain ambient room temperature greater than 20 degrees Celsius • Patients undergoing a procedure with an anticipated anesthesia time greater than 30 minutes and/or who are hypothermic preoperatively, and/or patients at risk for hypothermia or at increased risk for suffering its complications should have forced-air warming implemented • Alternative active warming measures may maintain normothermia when used alone or in combination with forced-air warming, these include: • Warmed IV fluids • Warmed irrigation fluids • Circulating water garments • Circulating water mattresses • Radiant heat • Gel pad surface warming • Resistive heating	If the patient is normothermic, provide thermal comfort measures: • Implement passive thermal care measures • Maintain ambient room temperature at or above 24 degrees Celsius • Assess patient thermal comfort level on admission, discharge, and more frequently as indicated • Observe for signs and symptoms of hypothermia • Reassess temperature if patient's thermal comfort level changes and/or signs or symptoms of hypothermia occur • Implement active warming measures as indicated • Measure patient temperature before discharge If the patient is hypothermic, in addition to normothermic interventions, initiate active warming measures: • Apply forced-air warming system • Consider warmed IV fluids and humidified warm oxygen • Assess temperature and thermal comfort

			level every 15 minutes until normothermia is achieved • Discharge teaching: instruct patient and responsible adult of methods to maintain normothermia after discharge
Expected Outcomes	• The patient will express thermal comfort level • Non-emergent patients should be normothermic before transfer to the operating room • Emergent patients should be warmed as soon as clinically appropriate	• The patient will be normothermic on discharge from the OR/ procedure area	• Patient achieves normothermia before discharge from the phase I and/or phase II PACU • The patient verbalizes thermal comfort

(Hooper et al., 2010).

The Process Workflow: Preoperative Warming Recommendations was provided through evidence-based, peer-reviewed literature that details steps to take in the preoperative setting for adequate implementation of best practice recommendations for preoperative warming. Nagelhout and Elisha (2018) define hypothermia as a core body temperature less than 36 degrees Hooper et al., (2010) agree that forced-air warming should be applied to prevent perioperative hypothermia. The American Association of Perioperative Registered Nurses (AORN) maintains up-to-date best practice recommendations for preventing perioperative hypothermia and has provided recommendations to sustain perioperative warming techniques (Levin et al., 2016). The authors agree that preoperative techniques provided in the process workflow below will aid in the prevention of perioperative hypothermia.


Preoperative Phase
1. Measure and document patient temperature on admission
2. Assess for risk factors of IPH (Box A)
3. Assess for signs and symptoms of hypothermia (e.g. shivering, piloerection, cold extremities)
4. Assess patient's thermal comfort level
5. Keep patient comfortably warm
Normothermic (36°C to 38°C)
Hypothermic (<36°C) or at risk for IPH
1. Initiate passive warming interventions (Box B)
2. Maintain room temperature according to AORN guidelines (Box C)
3. Consider preoperative warming to reduce risk of IPH
1. Initiate active warming interventions (Box B)
2. Monitor and document temperature every 15 minutes until normothermic
Transfer to OR
Intraoperative Phase
1. Measure and document patient temperature every 15 minutes
2. Assess for risk factors of IPH (Box A)
3. Assess for signs and symptoms of hypothermia (e.g. shivering, piloerection, cold extremities)
All Patients
Patients with an anticipated anesthesia time >30 minutes, and/or hypothermic preoperatively, and/or high risk for IPH
1. Limit skin exposure
2. Initiate passive warming interventions (Box B)
3. Maintain room temperature according to AORN guidelines (Box C)
1. Initiate active warming interventions (Box B)
Transfer to PACU/Recovery

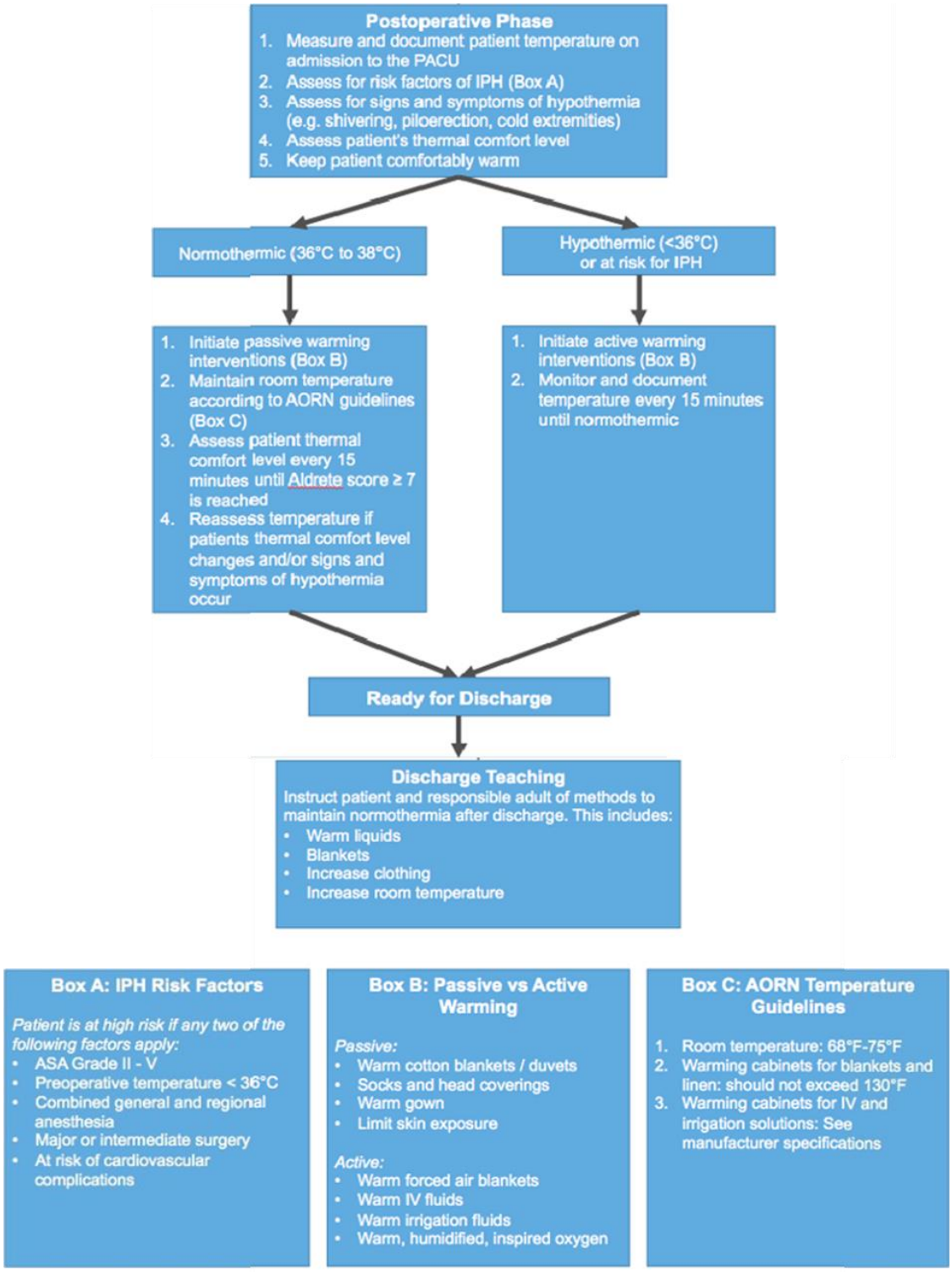


Figure 1. Process Workflow: Preoperative Warming Recommendations

(Slagle, 2015).

Rationale

Framework/Theory

By identifying the barriers to preoperative warming, a best practice guideline to address the barriers can be developed. Utilization of the best practice guideline has the potential to increase adherence to preoperative warming techniques and decrease the incidence of IPH. The educational module and visual cognitive aid follow the Donabedian Model of Quality by using a process workflow to increase the utilization of preoperative warming and improve patient outcomes. The Donabedian Model states that structure, process, and outcomes are closely related to determining the overall care of a facility. The model is commonly used to evaluate the quality of care given by a facility (Department of Health and Human Services [DHHS], 2015). In 2008, the Institute for Healthcare Improvement (IHI) introduced the Triple Aim, to aid in the improvement of health care. The three aims of focus for the Triple Aim are improving the individual experience of care, improving the health of populations, and reducing the per capita costs of care for populations (Institute for Health Care Improvement (IHI), 2020). Decreasing the incidence of IPH can potentially improve all three aims by improving the individual outcome of the patient which could lead to overall increases in the health of the population and decreased costs.

DNP Essentials

The Doctor of Nursing Practice (DNP) Essentials as outlined by The American Association of Colleges of Nursing (AACN) are eight educational competencies required for advanced nursing practice (AACN, 2006). The DNP Essentials serve as quality indicators and provide standards for advanced nursing practice. Each of the eight

Essentials was met in the completion of this DNP Project and outlined in Appendix A. Scientific Underpinnings for Practice is the first of the eight DNP Essentials included in this best practice guideline. Including current research on prewarming along with knowledge of the pathophysiology behind inadvertent perioperative hypothermia will allow for the creation of the best practice guideline. DNP Essential II, Organizational and Systems Leadership for Quality Improvement and Systems Thinking, correlates with quality improvement of preoperative warming regarding the implementation of best practice recommendations. DNP Essential VI, Interprofessional Collaboration for Improving Patient and Population Health Outcomes, also applies, as a collaboration between CRNAs, anesthesiologists, and preoperative nursing staff is required for success.

Specific Aims

Expected Outcomes of Best Practice Guidelines

The aims of identifying barriers to preoperative warming are to develop a best practice guideline and an educational module with visual cognitive aid for CRNAs, anesthesiologists, and preoperative nursing staff to increase the implementation of preoperative warming techniques and standardize practice. Once the common barriers are determined, the best practice guideline with educational module and visual aid will be created with a focus on the barriers, knowledge gaps, and variations of warming techniques in the preoperative environment. The education module and visual aid will be targeted to staff who have direct patient care both pre-and perioperatively. The results of the project along with the educational module will be presented to the clinical educator at a USM NAP clinical affiliate to distribute accordingly. The ultimate goal of the project is

to improve overall patient and facility outcomes by standardizing the use of preoperative warming.

Summary

Research shows that an inconsistency between providers in the utilization of preoperative warming has a direct relationship to perioperative hypothermia complications which include, but are not limited to: increased infection rate, coagulopathies, and increased myocardial oxygen consumption; all contributing to poor patient and facility outcomes (Robinson et al., 2005). Perioperative warming practices vary between anesthesia providers and among USM clinical affiliates (M. Collins, personal communication, November 23, 2020). Potential negative consequences of inadequate warming include poor patient and facility outcomes. An evidence-based best practice guideline for perioperative warming, along with an educational module and visual aid for providers, will be created and presented to anesthesia administration at a USM clinical affiliate.

CHAPTER II - METHODOLOGY

Introduction

The purpose of the study was to increase the use of warming techniques in the preoperative area and to potentially decrease the occurrence of intraoperative hypothermia and associated side effects. A survey was sent to CRNAs, MDAs, and preoperative nursing staff to access knowledge levels and barriers to the use of preoperative warming. Data from the survey has been analyzed and used, in addition to data collected from the literature review, to create an evidence-based practice guideline and educational module.

Context

Once the Institutional Review Board approval was received, stakeholders were surveyed to assess knowledge, current perioperative practices, and barriers to implementing warming practices. Approval was obtained to present to preoperative staff at a non-profit university-based hospital in the Southeast United States (Mississippi Secretary of State, 2020). The targeted facility consisted of a large spectrum of surgical procedures ranging from, but not limited to, general surgery, obstetrics, neurosurgical, transplant, and trauma. The facility hosts anesthesia residents, student registered nurse anesthetists, and nursing students that train in the preoperative ambulatory surgical unit alongside facility staff of nurses, CRNAs, and MDAs. Surgical Services at the facility include 15 main operating rooms that operated under the anesthetic model of medical direction with 87 certified registered nurse anesthetists and 39 anesthesiologists with a total of 722 beds at the facility (M. Collins, personal communication, October 26, 2020). The information was approved by the chief nurse anesthetist and clinical coordinator.

After approval was obtained from the lead nurse anesthetists, the best practice guideline, educational module, and visual cognitive aid were presented to preoperative nursing staff and nurse anesthetists. There were no external motivators for presenting an educational module on preoperative warming. The facility maintained a supportive culture for research as evidenced by a history of support of DNP Practice projects and a dedicated CRNA leader to focus on quality improvement.

Intervention

With the help of the doctoral project chair, an order of interventions was created. The steps below outline this process from beginning to end.

1. A survey was created consisting of questions that gather information from participants on the knowledge level of preoperative warming, current practices, and the barriers to using preoperative warming techniques. The survey was utilized to assess if the facility has an active preoperative warming protocol and resources to carry out preoperative warming measures. (Appendix F)
2. An email introduction and invitation to survey participants were created. (Appendix C)
3. Informed consent for participants was created. (Appendix D)
4. The project was submitted to The University of Southern Mississippi Institutional Review Board and approval was received.
5. Following Institutional Review Board approval, the email invitation, with informed consent and survey was sent to participants. (Appendix E)
6. Collected survey data was analyzed qualitatively and quantitatively for common themes. (Appendix B)

7. An evidence-based best practice recommendation for preoperative warming based on evidence-based peer-reviewed literature and survey feedback was created. An educational module and visual aid for preoperative warming based on survey responses incorporating peer-reviewed literature were created. Both the module and visual aid were approved by the DNP Project Chair and committee. (Appendix H, I, and J)
    - The educational module was provided to CRNAs and preoperative nursing staff. The educational module contained a PowerPoint with information that included evidence from the literature review. The PowerPoint included information from the literature review such as effects of general anesthesia-induced hypothermia, the definition of hypothermia, the statistical impact of preoperative warming, and best practice recommendations for implementing preoperative warming guidelines in the preoperative setting.
    - The visual aid was presented to preoperative nursing staff to use at their discretion. The visual aid was included in a condensed version of the best practice recommendations to follow to achieve adequate preoperative warming. The visual aid could be posted in preoperative rooms to serve as a reminder and resource to adhere to best practice recommendations as related to preoperative warming.
8. The project was submitted to the Doctor of Nursing Practice project committee for approval.

9. After approval was obtained, the best practice recommendation for preoperative warming and visual aid was presented to anesthesia staff at The University of Southern Mississippi clinical affiliate.
10. Disseminated project results at The University of Southern Mississippi School of Leadership and Advanced Practice Nursing Scholarship Day on October 1, 2021. Until data was presented, physical data was kept in a locked drawer and electronic data was stored on a password-protected computer.
11. Physical data were destroyed by shredding, electronic data by sending to trash file then deleting trash file.

Stakeholders and Participants

Stakeholders and participants for this project included the nurse anesthesia program faculty, members of the DNP committee, the chief nurse anesthetist, and preoperative nurse staff at a large teaching hospital in the southeastern United States. Each aspect of the targeted staff provides a unique perspective and feedback. The researchers surveyed CRNAs, anesthesiologists, and preoperative nursing staff to determine current warming practices at their facility. The stakeholders included were involved in the decision-making process throughout the perioperative period; therefore, benefited from best practice recommendations related to preoperative warming. The participants of the project's survey were chosen regarding direct patient involvement and care during the preoperative period.

Measures and Instruments Used to Develop the Intervention

A survey was developed to determine current practices of anesthesiologists, CRNAs, and preoperative nurses and barriers regarding preoperative warming. From the

data collected by the survey, a best practice guideline, educational module, and visual aid were developed with assistance from the DNP Chair and committee. The panel consisted of five experts from anesthesiology and nursing involved in the perioperative period, along with DNP faculty and staff. Preference for inclusion was for anesthesiology and nursing staff who were up to date with current evidence-based practices for preoperative warming. Providers were excluded who work in quick turnover areas such as GI lab which do not utilize warming techniques.

The survey consisted of five questions to help better understand current practices at the targeted facility. The following are the five questions used in the survey. Question one: Do you currently utilize active warming techniques in the preoperative setting? The rationale for question one was to assess the current utilization of preoperative warming techniques. Question two: From your experience and practice, do you believe prewarming decreases intraoperative hypothermia and associated adverse effects? The rationale to question two was to assess the preexisting beliefs on prewarming among clinicians. Question three: Does the facility in which you work have a preoperative recommendation and/or guideline in place? The rationale for question three was to assess if the facility has a prewarming policy in place and to assess the staff's knowledge of that policy if it does exist. Question four: What are the barriers to using active warming techniques in the preoperative setting? The rationale for question four was to identify barriers to prewarming from a clinician's perspective. Question five: Would you be interested in an educational module related to the use of preoperative warming? The rationale for question five was to assess the staff’s motivation to receive best practice recommendations. The survey can be found in Appendix F.

Measures and Instruments Used to Study the Intervention

The survey results and evidenced-based practice guidelines were submitted to the project's Doctor of Nurse Practice chair and committee for evaluation and recommendations. Feedback from the chair and committee was used to make appropriate changes to the guideline. Questions included:

- Is this guideline based on current evidence?
- Is this guideline doctoral-level work?
- Will this guideline improve current practices?
- What information should be added or removed from this best practice guideline?

By analyzing the answers to the previous questions, the determination was made if the project matches up with current evidence-based data and what changes could be made to strengthen the project. Feedback was also obtained regarding whether the goals of the project were achievable and laid out appropriately for a high compliance rate. The DNP Chair and committee concluded that the guideline was based on current evidence, appropriate for doctoral work, has the potential to decrease the knowledge deficit of providers regarding the significance of perioperative warming practices, and has the potential to increase adherence to evidence-based guidelines. Feedback indicated that no alteration to the evidence-based guidelines, educational module, or visual aid was necessary.

Analysis

Survey data was evaluated both quantitatively and qualitatively. A majority of the survey allowed for *yes, no, or unsure* answers which data results being interpreted in

percentages. The last portion of the survey had a question with common answer choices based on the literature review along with an open-ended option for input. The data was organized into table form so that common themes can be readily identified. Common themes were established to provide a focal point in developing the best practice guideline, educational module, and visual aid.

Ethical Considerations

Due to lack of consistency in protocols and prewarming techniques, ethical considerations included multiple standards of care being delivered by different providers and acknowledgment that there could be special exceptions where practice guideline does not apply. To address knowledge deficits, visual aids with best practice guidelines were made readily accessible to staff. Through the collection of data from evidenced-based practice, a best practice recommendation and an educational module were provided to anesthesia providers and preoperative staff at the teaching hospital. The project was submitted to the IRB committee for oversight of ethical considerations.

Summary

This project aimed to identify the barriers to and increase the usage of preoperative warming. The survey was created to access barriers and stakeholder's perceptions regarding preoperative warming. Using the data gathered from surveying stakeholders, a visual cognitive aid, educational module, and best practice guideline were created. In Chapter III, the findings and interpretations of the survey are discussed extensively.

CHAPTER III – RESULTS

Introduction

Research shows that an inconsistency between providers in the utilization of preoperative warming has a direct relationship to perioperative hypothermia complications which include, but are not limited to: increased infection rate, coagulopathies, and increased myocardial oxygen consumption; all contributing to poor patient and facility outcomes (Robinson et al., 2005). Perioperative warming practices vary between anesthesia providers and among USM clinical affiliates (M. Collins, personal communication, November 23, 2020). Potential negative consequences of inadequate warming include poor patient and facility outcomes. An evidence-based best practice guideline for perioperative warming, along with an educational module for providers, was created and presented to anesthesia administration at a USM clinical affiliate to decrease barriers that prevent the utilization of preoperative warming.

Steps of Intervention

A survey was created consisting of questions utilized to gather information from participants on the knowledge level of preoperative warming, current practices, and the barriers to using preoperative warming techniques. The survey was utilized to assess if the facility had an active preoperative warming protocol and the needed resources to carry out preoperative warming measures. An email introduction, invitation to participate in the survey, and informed consent were created. The project was then submitted to The University of Southern Mississippi Institutional Review Board (IRB) protocol number IRB-21-20 and approval was obtained (Appendix E). Personal email addresses of participants were gathered voluntarily through personal contact and the introduction,

invitation, and informed consent were sent to each participant. Once the survey was closed, data were analyzed both qualitatively and quantitatively. The data, along with evidenced-based peer-reviewed literature, was utilized to create a best practice recommendation, an education module, and a visual aid. The project was then submitted and approved to the Doctoral of Nursing Practice project committee at The University of Southern Mississippi (USM). The best practice recommendation, education module, and visual aid were presented by email to the lead educator of the anesthesia department of a USM clinical affiliate. The project results were then disseminated at The University of Southern Mississippi School of Leadership and Advanced Practice Nursing Scholarship Day on October 1st, 2021. Physical data were stored on a password-protected computer and destroyed once the project was disseminated. The steps of the project were completed without deviation from the proposed plan.

The survey was titled *Increasing Utilization of Preoperative Warming Techniques*. The survey consisted of five questions to gather data to answer the problem statement plus one question used to obtain consent from the participant (Appendix F). The survey was sent anonymously to 87 participants consisting of Anesthesiologists, CRNAs, and preoperative nursing staff. The survey was sent electronically using Qualtrics® and was open for 30 days. The results obtained from each participant by the survey can be seen in Appendix B. Twenty-two responses were obtained. Of the 22 participants, 73% answered definitely or probably yes on the use of preoperative warming in practice, while 5% answered probably or definitely not. The remaining 22% were unsure if the information would be utilized. From participant experience, 68% of the participants believe preoperative warming decreases perioperative adverse effects, 9%

do not believe adverse effects are decreased, and 23% are unsure. Concerning current preoperative warming recommendations and guidelines being in place, 68% of the participants responded that a guideline was in place, 13% responded no guideline was in place, and 18% were unsure. Question 5 of the survey, which allowed for an open-ended answer, was included to determine if any common barriers prevented the use of preoperative warming. Time (50%), cost (18%), lack of education (14%) were responses obtained from the participants. The last question of the survey obtained data to determine the interest of participants in receiving an education module related to preoperative warming. Forty percent of the participants were currently interested in receiving an education module, 18% were interested but at a later time, and 41% were not interested in an educational module. Appendix B contains a complete analysis of the survey results.

Details of Process Measures and Outcome

The results obtained from the survey were consistent with the literature collected informing the problem statement for the project. The survey results mirrored the lack of consistency involving the utilization of preoperative warming between anesthesia providers (M. Collins, personal communication, November 23, 2020). The data obtained from the survey allowed the best practice recommendation, education module, and visual aid to focus on key points and common barriers and inconsistencies on the use of preoperative warming in everyday practice. In seeking to increase the utilization of preoperative warming, an improved practitioner knowledge level and a best practice recommendation are the key interventions of the project.

Summary

The preoperative warming survey allowed data to be collected on the views and current practices of providers at a large clinical affiliate of The University of Southern Mississippi Nurse Anesthesia Program. The data obtained from the survey mirrored the knowledge obtained from a literature review. The collected data, along with input from the panel of experts, allowed for an education module and visual aid to be designed with a focus on common trends and discrepancies.

CHAPTER IV – DISCUSSION

Summary

A best practice recommendation has been presented to the anesthesia and preoperative nursing staff in a Mississippi hospital to improve outcomes in surgical patients. Research shows that an inconsistency between providers in the utilization of preoperative warming has a direct relationship to perioperative hypothermia complications which include, but are not limited to: increased infection rate, coagulopathies, and increased myocardial oxygen consumption; all contributing to poor patient and facility outcomes (Robinson et al., 2005). Barriers to preoperative warming were identified through a survey of preoperative nurses and nurse anesthetists. Common barriers that were identified were time constraints and lack of initiative. The best practice recommendation, educational module, and visual cognitive aid aimed to increase the utilization of preoperative warming techniques by offering relevant data on the importance of preoperative warming, as well as offering a visual aid to serve as a step-by-step reminder to increase the utilization of preoperative warming. The strength of this project is the implementation process. The project goals did not require "reinventing the wheel" yet built on knowledge of the staff and served as reminders to increase the utilization of preoperative warming.

Interpretation

The survey results noted that the primary barriers included lack of time, initiative, lack of knowledge, and current policy to initiate preoperative warming techniques. The findings mirror the current literature on implementing preoperative warming techniques and were addressed with the specific aims and rationale for the best practice

recommendation proposal. With the implementation of the visual aid in preoperative holding areas, preoperative warming techniques have the potential to be integrated into the standard preoperative workflow. The potential increases in the utilization of preoperative warming techniques may be obtained with minimal additional time added to the preoperative workflow. Integrating preoperative warming into the standard preoperative workflow negates the barrier of time constraints identified in the survey. While offering integration into the workflow, the visual aid also serves as a potential reminder to combat the lack of initiative barrier identified in the survey.

Limitations

The project did have some limitations. Although the results from the survey mirrored the research completed in the literature review, the number of participants was small with only 22 completing the survey out of the 87 invited to participate. The survey was only sent to participants at one facility. A potential bias on the topic of preoperative warming and the targeted facility's current practices and routines may have skewed the results obtained from the survey. The addition of a broader range of facilities and participants may provide valuable feedback for future researchers.

Conclusion

Poor patient and facility outcomes can be associated with intraoperative hypothermia due to increased infection rates, coagulopathies, and increased myocardial oxygen consumption (Robinson et al., 2005). As identified by the survey results of the project, along with a literature review, preoperative warming technique practices and knowledge levels vary widely between providers. Consistent implementation of preoperative warming techniques has the potential to decrease the incidence of

intraoperative hypothermia. Implementing preoperative warming techniques into the preoperative workflow increases the utilization of preoperative warming techniques. As preoperative warming techniques are adopted as a standard step in the preoperative workup, the perception from the staff may acclimate and preoperative warming techniques could be viewed as less of a time burden. The distribution of the educational module would be directed at decreasing the knowledge deficit, along with educating of the potential benefits, regarding preoperative warming techniques to current, new, and future staff. The visual aid potentially serves as a quick reminder for staff to view during the application of preoperative warming techniques. With appropriate application of the education module and visual aid, an increase in standardized utilization of preoperative warming techniques and improved outcomes of surgical patients could potentially be seen at this facility and other facilities in the area.

Expansion of the current project could be a future consideration for research. A post-intervention survey could be completed to determine if the education module and visual aid had any effect on the practices and perceptions of preoperative warming utilization. A post-intervention survey could also be used to target recommendations for improvements in the education module and visual aid. Also, the research could be expanded to include a larger number of participants and a wider range of facilities which include multiple-size facilities and financial capabilities. Future research would allow for individualized educational modules and implementation plans for different types of facilities.

APPENDIX A – Doctor of Nursing Practice Essentials

DNP Essential	Clinical Implications
I: Scientific Underpinnings for Practice	This project identified nursing actions and processes by which positive changes in health status are affected. Additionally, the project identified negative physiological outcomes related to IPH.
II: Organizational and Systems Leadership for Quality Improvement and Systems Thinking	Quality improvement is achieved by the utilization of best practice recommendations related to preoperative warming techniques.
III: Clinical Scholarship and Analytical Methods for Evidence-Based Practice	Literature was reviewed and analyzed. Critical appraisal was utilized, and evidence-based practice was implemented.
IV: Information Systems/Technology and Patient Care Technology for the Improvement and Transformation of Health Care	An educational module was formed to aid the implementation of preoperative warming techniques. Research technology was used to gather evidence.
V: Healthcare Policy for Advocacy in Health Care	Current practice policies were analyzed, and education was offered regarding health care policy and patient care outcomes.
VI: Interprofessional Collaboration for Improving Patient and Population Health Outcomes	This project will potentially improve outcomes through collaboration between nurses, anesthesia staff, and department leadership.
VII: Clinical Prevention and Population Health for Improving the Nation's Health	This project uses an evidence-based approach to synthesize analytical scientific data for clinical prevention of intraoperative hypothermia and utilization of preoperative warming techniques.
VIII: Advanced Nursing Practice	Comprehensive data were considered, therapeutic interventions were designed and developed with an evidence-based approach then used to guide education in the clinical setting.

APPENDIX B – Survey Results

Participant	Question 2[b]	Question 3[c]	Question 4[d]	Question 5[e]	Question 6[f]
1	Might/might not	Yes	No	Time constraint Lack of routine	Yes
2	Definitely yes	Yes	Yes	Cost Time commitment	Yes
3	Probably Yes	Yes	Yes	Patients unaware	Yes, not at this time
4	Might/Might not	Yes	Yes	Time Constraints	Yes, not at this time
5	Probably Yes	Unsure	Yes	---	No
6	Definitely yes	No	Yes	---	No
7	Definitely Yes	Yes	Yes	Time New practice	Yes
8	Probably Yes	Unsure	Yes	---	No
9	Definitely Yes	Unsure	No	Time constraint Education	Yes
10	Probably Not	Yes	Unsure	Time constraint	Yes
11	Probably Yes	Unsure	Yes	Time Constraint Patient Preference	Yes, not at this time
12	Definitely Yes	No	Yes	Surgical exposure	No
13	Definitely Yes	Yes	Yes	Time constraint Ownership	No
14	Might/might not	Yes	Yes	Time constraint	No
15	Definitely Yes	Yes	Yes	---	Yes
16	Definitely Yes	Yes	Yes	Time constraint	Yes
17	Definitely Yes	Yes	No	Cost Time constraint	Yes
18	Might/might not	Yes	Unsure	Short-staffed Supplies inconsistent Lack of education	No
19	Definitely Yes	Yes	Unsure	Cost	Yes
20	Might/might not	Unsure	Yes	Cost Time Constraint	Yes, not at this time
21	Definitely Yes	Yes	Unsure	---	No
22	Definitely Yes	Yes	Yes	Time Constraints	No

[a] Question one was omitted from the table due to question only obtaining consent for participation

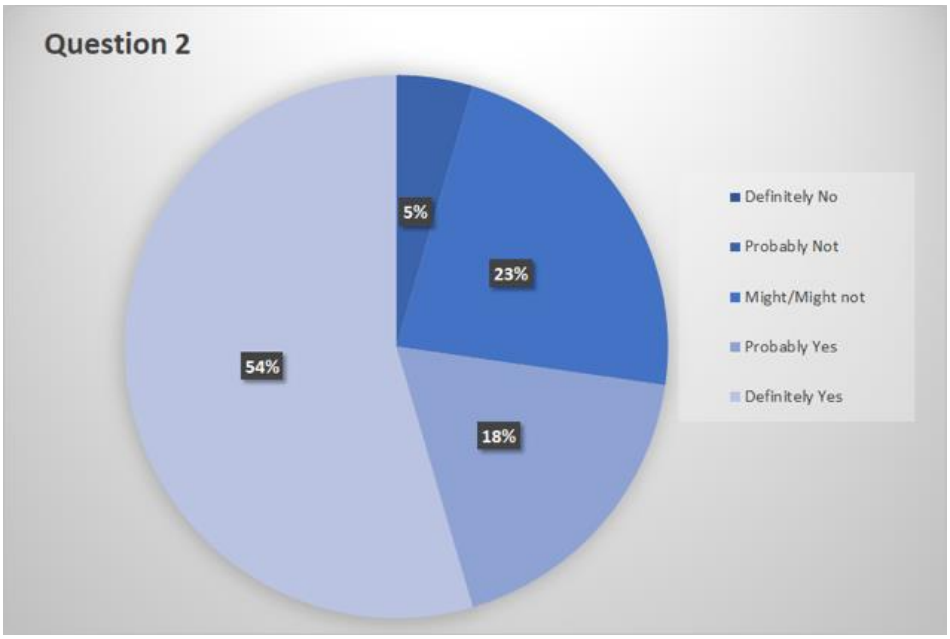
[b] Do you currently utilize active warming techniques in the preoperative setting?

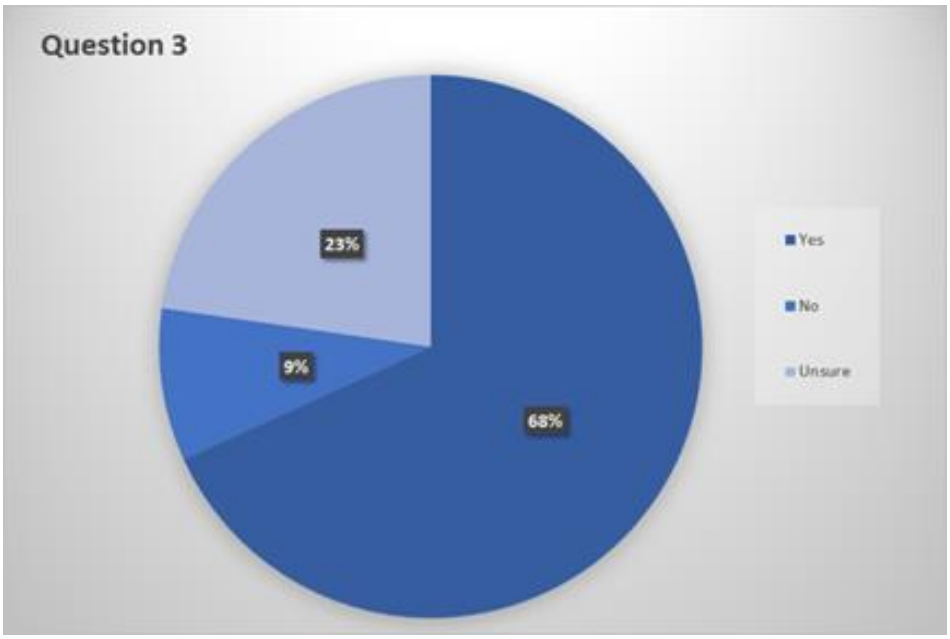
[c] From your experience and practice, do you believe prewarming decreases intraoperative hypothermia and associated adverse effects?

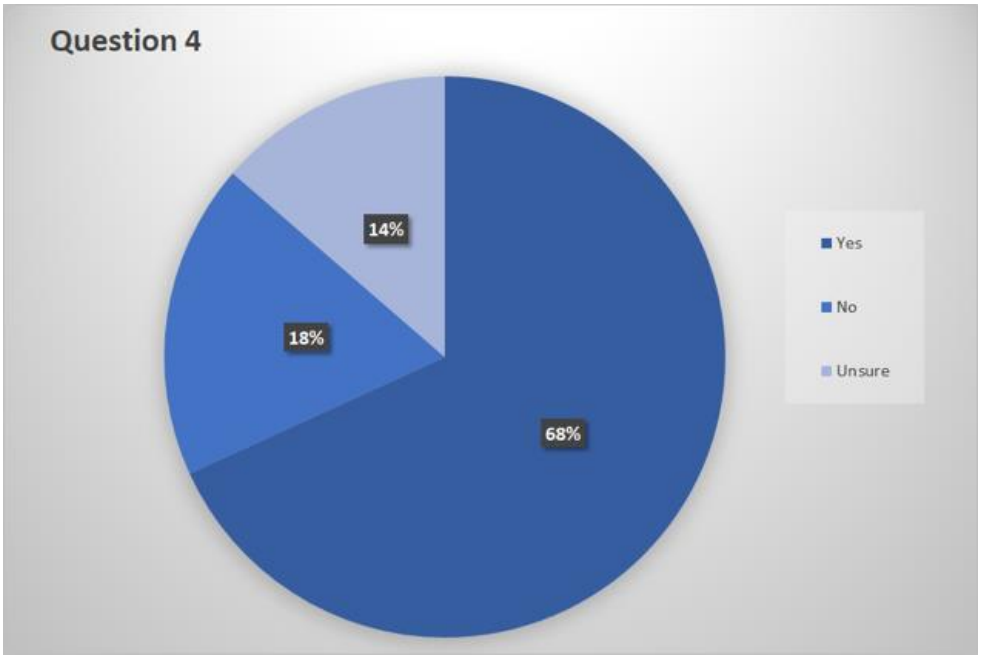
[d] Does the facility in which you work have a preoperative recommendation and/or guideline in place?

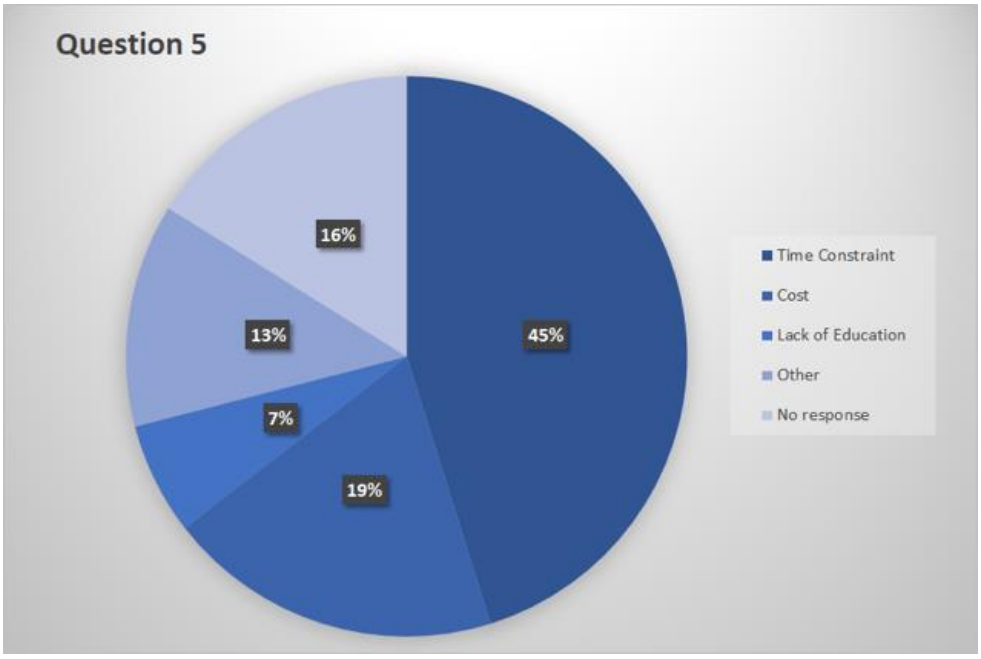
[e] What are the barriers to using active warming techniques in the preoperative setting?

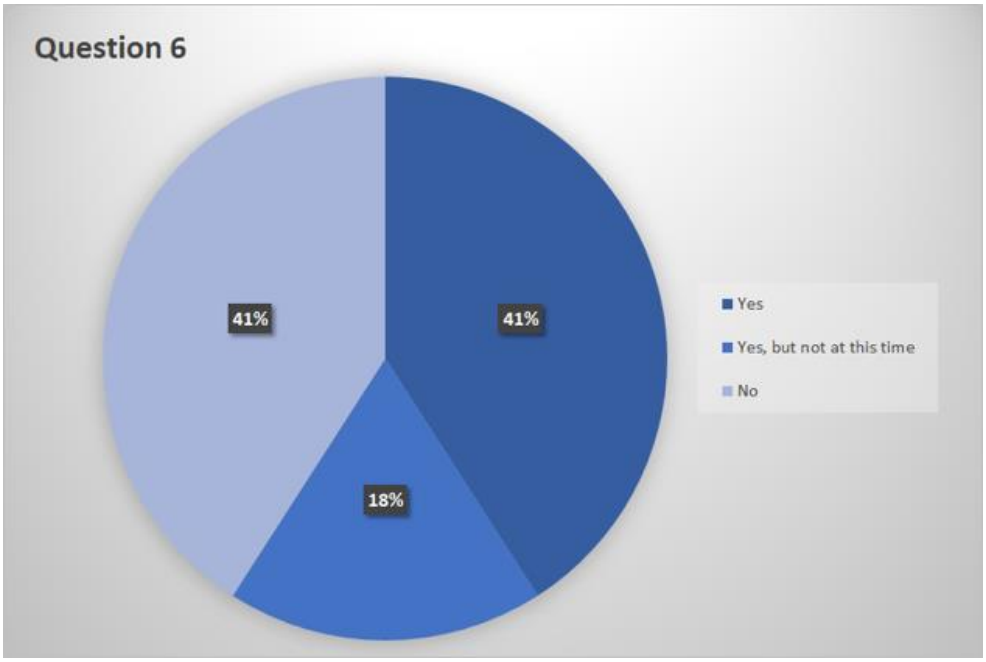
[f] Would you be interested in an educational module related to the use of preoperative warming?






Question 4
14%
18%
68%
Yes
No
Unsure


Question 5
16%
13%
45%
7%
19%
Time Constraint
Cost
Lack of Education
Other
No response


Question 6
41%
41%
18%
Yes
Yes, but not at this time
No

APPENDIX C - Survey Invitation

Dear Sir/Madam:

As Doctor of Nursing Practice students at The University of Southern Mississippi, we are writing to you to request your participation in a survey. The survey is very brief and will take less than 30 minutes to complete.

We would like to get feedback about your experiences with preoperative warming practices and barriers to preoperative warming practices. Your responses to this survey will help to develop a best practice guideline for preoperative warming practices.

Your participation in the survey is completely voluntary and all of your responses will be kept confidential with the use of Qualtrics. No personally identifiable information will be associated with your responses to any reports of these data. The USM Institutional Review Board has approved this survey, IRB-21-20. Please review the informed consent attached to this email for project details. If you should have any comments or questions, please feel free to contact us using the information provided below.

Please click the link below to go to the survey.

https://usmuw.co1.qualtrics.com/jfe/form/SV_9MpPRbrSdBj1dVY

Thank you for your time and cooperation.

Sincerely,

Caleb Leach
[redacted]

Tyler Comans
[redacted]

Zach Hays
[redacted]

APPENDIX D – Informed Consent

ORI | Office of Research Integrity

Institutional Review Board

STANDARD (ONLINE) INFORMED CONSENT

Today's date: 1/25		
Project Information		
Project Title: Barriers to Preoperative Warming		
Principal Investigator: Zachary Hays	Phone: 662-552-1071	Email: zachary.hays@usm.edu
College: Nursing and Health Professions	School and Program: School of Leadership and Advanced Nursing Practice	
RESEARCH DESCRIPTION		

Purpose:

The purpose of the survey is to ascertain current preoperative warming measures and barriers to preoperative warming measures from RNs and CRNAs.

Description of Study:

An anonymous electronic survey will be utilized to ascertain current preoperative warming measures and barriers to preoperative warming measures from RNs and CRNAs. The survey can be completed in less than thirty minutes with minimal inconvenience to participants. The data will be collected and analyzed for common themes. This data will be used to develop a best practice guideline for preoperative warming. Results will be disseminated at USM DNP SLANP Scholarship Day in September, 2021.

Benefits:

No benefits have been identified to the participant or others as a result of participation in the study,

Risks:

The time required to complete this survey is the only expected inconvenience. The survey is brief and consists of 5 questions to minimize the inconvenience to the participants.

Confidentiality:

The electronic survey is anonymous with no participant identifiers. Deidentified survey results will be kept confidential by storing on a password-protected computer and in a locked drawer. Following the dissemination of research results, electronic data will be destroyed by deleting from the password-protected computer and the trash bin will be deleted. Physical data will be destroyed by shredding.

Alternative Procedures:

The survey is voluntary with no repercussions for non-participation. Alternatives to participation will be the choice to not participate.

Participant's Assurance:

Purpose:

The purpose of the survey is to ascertain current preoperative warming measures and barriers to preoperative warming measures from RNs and CRNAs.

Description of Study:

An anonymous electronic survey will be utilized to ascertain current preoperative warming measures and barriers to preoperative warming measures from RNs and CRNAs. The survey can be completed in less than thirty minutes with minimal inconvenience to participants. The data will be collected and analyzed for common themes. This data will be used to develop a best practice guideline for preoperative warming. Results will be disseminated at USM DNP SLANP Scholarship Day in September, 2021.

Benefits:

No benefits have been identified to the participant or others as a result of participation in the study,

Risks:

The time required to complete this survey is the only expected inconvenience. The survey is brief and consists of 5 questions to minimize the inconvenience to the participants.

Confidentiality:

The electronic survey is anonymous with no participant identifiers. Deidentified survey results will be kept confidential by storing on a password-protected computer and in a locked drawer. Following the dissemination of research results, electronic data will be destroyed by deleting from the password-protected computer and the trash bin will be deleted. Physical data will be destroyed by shredding.

Alternative Procedures:

The survey is voluntary with no repercussions for non-participation. Alternatives to participation will be the choice to not participate.

Participant's Assurance:

This project and this consent form have been reviewed by the Institutional Review Board, which ensures that research projects involving human subjects follow federal regulations. Any questions or concerns about rights as a research participant should be directed to the Chair of the Institutional Review Board, The University of Southern Mississippi, 118 College Drive #5125, Hattiesburg, MS 39406-0001, 601-266-5997.

Any questions about this research project should be directed to the Principal Investigator using the contact information provided above.

CONSENT TO PARTICIPATE IN RESEARCH

CONSENT TO PARTICIPATE IN RESEARCH

I understand that participation in this project is completely voluntary, and I may withdraw at any time without penalty, prejudice, or loss of benefits. Unless described above, all personal information will be kept strictly confidential, including my name and other identifying information. All procedures to be followed and their purposes were explained to me. Information was given about all benefits, risks, inconveniences, or discomforts that might be expected. Any new information that develops during the project will be provided to me if that information may affect my willingness to continue participation in the project.

Include the following information only if applicable. Otherwise, delete this entire paragraph before submitting for IRB approval: The University of Southern Mississippi has no mechanism to provide compensation for participants who may incur injuries as a result of participation in research projects. However, efforts will be made to make available the facilities and professional skills at the University. Participants may incur charges as a result of treatment-related research injuries. Information regarding treatment or the absence of treatment has been given above.

CONSENT TO PARTICIPATE IN RESEARCH

By clicking the box below, I give my consent to participate in this research project.

Check this box if you consent to this study, and then click "Continue." (Clicking "Continue" will not allow you to advance to the study unless you have checked the box indicating your consent.)

If you do not wish to consent to this study, please close your browser window at this time.

APPENDIX E – IRB Approval Letter

Office of Research Integrity

THE UNIVERSITY OF SOUTHERN MISSISSIPPI

118 COLLEGE DRIVE #5125 • HATTIESBURG, MS | 601.266.6576 | USM.EDU/ORI

NOTICE OF INSTITUTIONAL REVIEW BOARD ACTION

The project below has been reviewed by The University of Southern Mississippi Institutional Review Board in accordance with Federal Drug Administration regulations (21 CFR 26, 111), Department of Health and Human Services regulations (45 CFR Part 46), and University Policy to ensure:

The risks to subjects are minimized and reasonable in relation to the anticipated benefits.

- The selection of subjects is equitable.
- Informed consent is adequate and appropriately documented.
- Where appropriate, the research plan makes adequate provisions for monitoring the data collected to ensure the safety of the subjects.
- Where appropriate, there are adequate provisions to protect the privacy of subjects and to maintain the confidentiality of all data.
- Appropriate additional safeguards have been included to protect vulnerable subjects.
- Any unanticipated, serious, or continuing problems encountered involving risks to subjects must be reported immediately. Problems should be reported to ORI via the Incident template on Cayuse IRB.
- The period of approval is twelve months. An application for renewal must be submitted for projects exceeding twelve months.
- Face-to-Face data collection may not commence without prior approval from the Vice President for Research's Office.

PROTOCOL NUMBER: IRB-21-20
PROJECT TITLE: Increasing the Utilization of Preoperative Warming Techniques
SCHOOL/PROGRAM: School of LANP, Leadership & Advanced Nursing
RESEARCHER(S): Zachary Hays, Mary Jane Collins, Caleb Leach, Tyler Comans
IRB COMMITTEE ACTION: Approved
CATEGORY: Expedited
7. Research on individual or group characteristics or behavior (including, but not limited to, research on perception, cognition, motivation, identity, language, communication, cultural beliefs or practices, and social behavior) or research employing survey, interview, oral history, focus group, program evaluation, human factors evaluation, or quality assurance methodologies.

PERIOD OF APPROVAL: March 10, 2021

Donald Sacco Jr.

Donald Sacco, Ph.D.
Institutional Review Board Chairperson

APPENDIX F – Survey

1. I agree to participate in the research study. I understand the purpose and nature of this study and I am participating voluntarily. I understand that I can withdraw from the study at any time, without any penalty or consequences.
    a. Yes
    b. No

2. Do you currently utilize active warming techniques in the preoperative setting?
    a. Definitely No
    b. Probably No
    c. Might/ Might not
    d. Probably Yes
    e. Definitely Yes

3. From your experience and practice, do you believe prewarming decreases intraoperative hypothermia and associated adverse effects?
    a. Yes
    b. No
    c. Unsure

4. Does the facility in which you work have a preoperative recommendation and/or guideline in place?
    a. Yes
    b. No
    c. Unsure

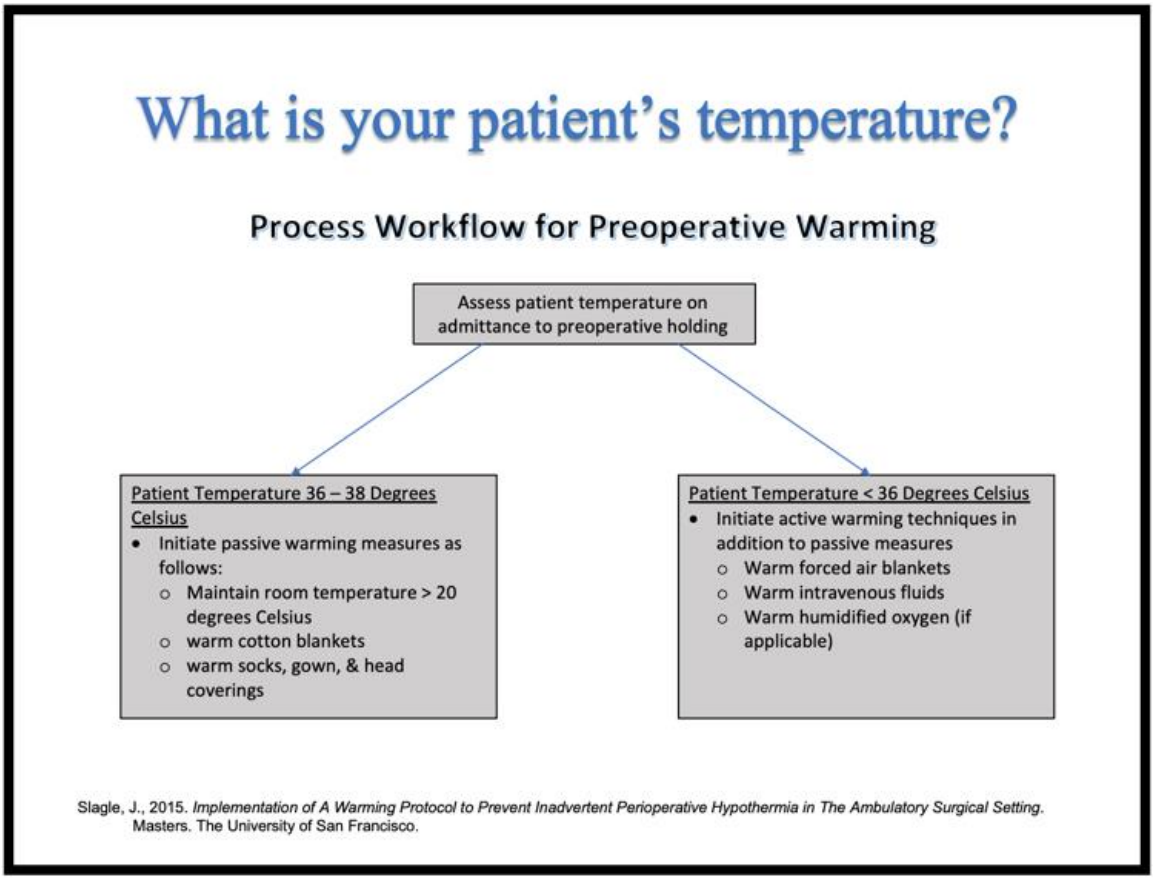
5. What are the barriers to using active warming techniques in the preoperative setting?
    a. Cost
    b. Lack of equipment
    c. Time
    d. Other _____

6. Would you be interested in an educational module related to the use of preoperative warming?
    a. Yes
    b. Yes, but not at this time
    c. No

APPENDIX G – Literature Matrix

Authors	Date	Purpose	Subjects	Data	Comments
Madrid, Urrutia, Figuls, Hernandez, Campos, Paniagua, Maestre, & Alonso-Coello Active body surface warming systems for preventing complications caused by inadvertent perioperative hypothermia in adults	2016	To assess the effectiveness of pre-or intraoperative active body surface warming systems (ABSW), or both, to prevent perioperative complications from unintended hypothermia during surgery in adults.	67 trials with 5,438 subjects	Data was collected by literature review in 2016	Active warming reduced the rate of infection and complications of surgical wounds. Patients receiving active warming systems had about one-third the risk of postsurgical chills or shivering compared to those receiving the control treatment
Brito Poveda, Clark, & Galvao A systematic review on the effectiveness of prewarming to prevent perioperative hypothermia	2013	To analyze available research on the effectiveness of prewarming to prevent perioperative hypothermia and identify knowledge gaps for future research.	14 Randomized controlled trials that included 416 adults	Data was collected in 2013 by literature review	The findings of the included studies indicate that 30–60 minutes of prewarming is an effective measure to reduce hypothermia in surgical patients. Perioperative hypothermia prevention is directly proportional to the reduction in surgery-associated complications and hospital costs
Bindu, Bindra, & Rath Temperature management under general anesthesia: Compulsion or option	2017	Principles behind the physiology of thermoregulation, and the effects of anesthesia upon thermoregulation	Adults undergoing general or other types of anesthesia.	Data was gathered by literature review in 2017	Skin surface warming for 30 minutes before induction decreases redistribution hypothermia Intraoperative core temperature should be maintained at 36 C unless contraindicated
Munday, Delaforce, Forbes, & Keogh Barriers and enablers to the implementation of perioperative hypothermia prevention practices from the perspectives of the multidisciplinary team: a qualitative study using the Theoretical Domains Framework	2019	What forces act as barriers and enablers to perioperative hypothermia prevention in the opinions of staff members.	Qualitative study using semi-structured interviews of 12 members of a surgical staff	Data were gathered by an interview in 2019	Intervention strategies need to take a team-based, multi-modal approach, as this is most likely to facilitate improvements in perioperative hypothermia prevention The diffusion of responsibility around who was responsible seemed to be present.

APPENDIX H - Visual Aid



(Saigle, 2015).

APPENDIX I – Educational Module Presentation

Barriers to Preoperative Warming: Best practice guideline

Tyler Comans BSN, RN, DNP Student
Zachary Hays BSN, RN, DNP Student
Caleb Leach BSN, RN, DNP Student

Introduction

- Inadvertent preoperative hypothermia (IPH) is a common problem in the surgical setting that leads to many adverse outcomes.
- A few factors that place patients at higher risk for IPH include general anesthesia, extremes of age, abdominal or thoracic surgery, and long duration of surgery (Barash et. al, 2017).
- Preoperative warming reduces the risk associated with these factors.

Pathophysiology of Hypothermia

- Anesthesia disrupts the bodies normal response to maintain core temperature.
  - This leads to more drastic fluctuations in temperature.
  - Heat is redistributed from core to peripheral body compartments.
- Hypothermia is associated with many adverse outcomes following surgery.
  - Impaired coagulation
  - Increased myocardial oxygen consumption
  - Increased pain scores
  - Increased surgical site infection and length of stay (Smith et. al, 2015)

Advantages of Preoperative warming

- Preoperative warming lessens the risk of IPH.
  - Core to periphery heat redistribution is lessened in patients who have received active warming.
    - Warming helps create a heat reservoir which slows the rate of heat lost following induction of anesthesia.
- Normothermic patients show better outcomes post operatively.
  - Lower pain scores
  - Increase patient satisfaction
  - Lower infection rates (Adriani & Moriber, 2013)

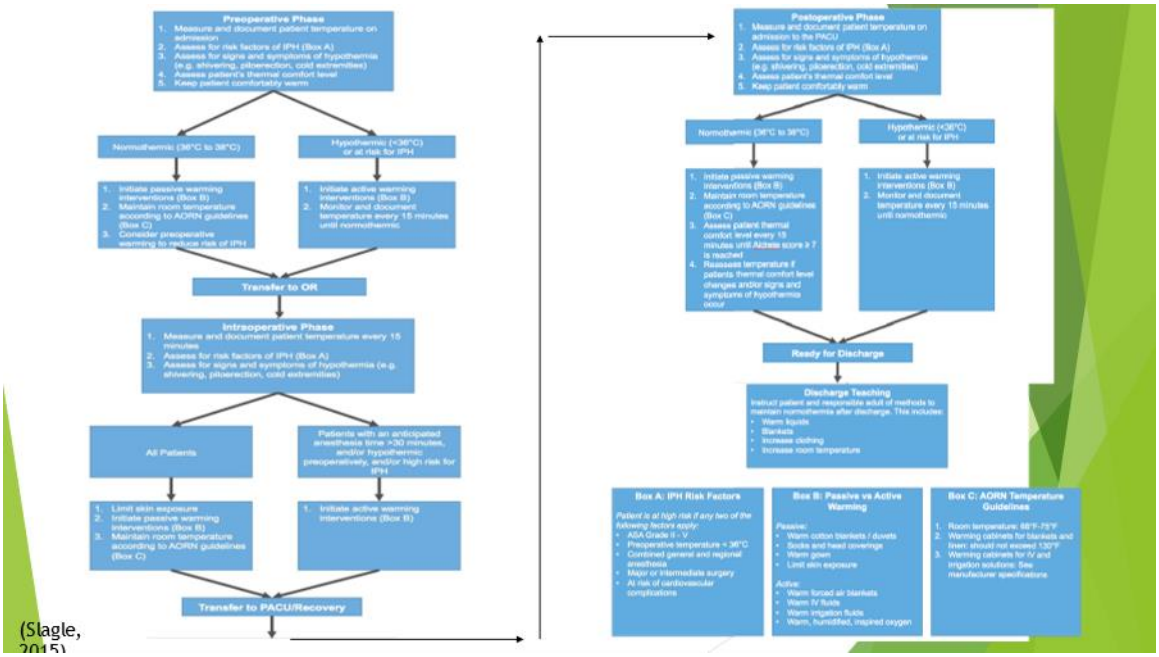
Methods of preoperative warming

- Warm forced air blankets
- Warm blankets and gowns
- Maintain room temperatures 66F-75F
- Socks and head coverings
- Warmed IV fluids

- (Slagle, 2015)

Barriers to preoperative warming

- IPH remains a problem partially because of the lack of consensus on preoperative warming protocols.
- Other barriers include
  - Lack of education amongst preoperative staff
  - Time constraints
  - Lack of equipment (Levin, Wright, Pecoraro & Kopec, 2016)

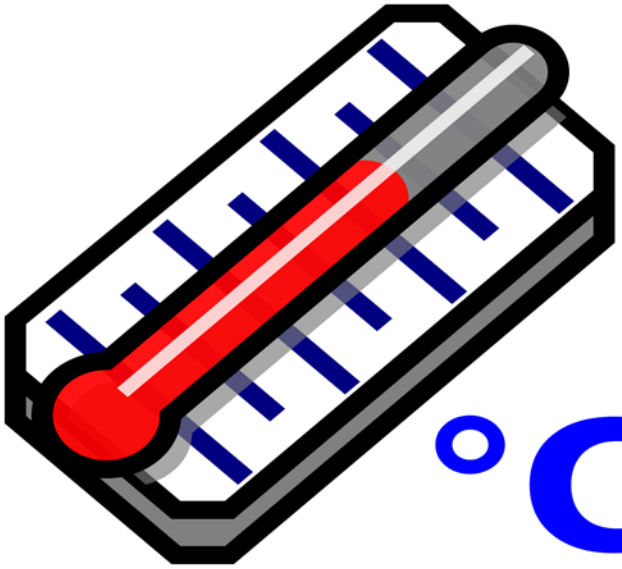


(Slagle, 2015)

References

- Adriani, M. B., & Moriber, N. (2013). Preoperative Forced-Air Warming Combined With Intraoperative Warming Versus Intraoperative Warming Alone in the Prevention of Hypothermia During Gynecologic Surgery. AANA Journal, 81(6), 445-51. Retrieved from http://search.ebscohost.com.lynx.lib.usm.edu/login.aspx?direct=true&db=c8h&AN=107923843&site=ehost-live
- Barash, P., Cullen, B., Stoelting, R., Cahalan, M., Stock, C., Ortega, R., Sharar, S., & Holt, F. (2017). *Clinical anesthesia; eighth edition*. Wolters Kluwer
- Levin, R., 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. doi: 10.1016/j.aorn.2015.12.020
- Slagle, J., 2015. Implementation Of A Warming Protocol To Prevent Inadvertent Perioperative Hypothermia In The Ambulatory Surgical Setting. Masters. The University of San Francisco.
- Smith, S. A., Travers, R. J., & Morrissey, J. H. (2015). How it all starts: Initiation of the clotting cascade. *Critical reviews in biochemistry and molecular biology*, *50*(4), 326-336. doi:10.3109/10409238.2015.1050550

APPENDIX J – Best Practice Recommendation



Barriers to Preoperative Warming: A Best Practice Recommendation

Background

- Perioperative hypothermia can lead to negative patient outcomes such as increased pain scores, rate of infection, blood transfusion requirements, and length of stay (Bindu, Bindra, & Rath, 2017).
- Hypothermia in the intraoperative setting is prevalent due to the lack of active warming techniques and implementation.
    - Lack of consistency in competency training for normothermic protocols leads to a decrease in active warming usage (Levin, Wright, Pecoraro, & Kopec, 2016).

Recommendation

- Implementation of educational module and visual aid in the preoperative area can increase consistency of use of preoperative warming techniques.
- Preoperative recommendations are as follows:

Normothermic Patient (36C to 38C)	**Hypothermic Patient (<36C)**
Passive warming interventions • Warm cotton blankets, limit skin exposure, socks and head coverings.	Active warming interventions • Warm forced air blankets, warmed IV fluids.

(Slagle, 2015)

REFERENCES

Adriani, M. B., & Moriber, N. (2013). Preoperative Forced-Air Warming Combined With Intraoperative Warming Versus Intraoperative Warming Alone in the Prevention of Hypothermia During Gynecologic Surgery. *AANA Journal, 81*(6), 446–451. https://pubmed.ncbi.nlm.nih.gov/24597006/

Alam, A., Olarte, R., Callum, J., Fatahi, A., Nascimento, B., Laflamme, C., … Tien, H. (2018). Hypothermia indices among severely injured trauma patients undergoing urgent surgery: A single-centered retrospective quality review and analysis. *Injury, 49*(1), 117–123. 10.1016/j.injury.2017.11.028

American Association of Colleges of Nursing (AACN). (2006). *The essentials of doctoral education for advanced nursing practice.* AACN.

American Association of Nurse Anesthetists (AANA). (2020). *Documenting Anesthesia Care: Practice and Policy Considerations* [Ebook] (pp. 1-10). https://www.aana.com/docs/default-source/practice-aana-com-web-documents-(all)/documenting-anesthesia-care.pdf?sfvrsn=ac0049b1_4.

American Society of Anesthesiologists (ASA). (2020). Standards for Postanesthesia Care. https://www.asahq.org/standards-and-guidelines/standards-for-postanesthesia-care

Barash, P., Cullen, B., Stoelting, R., Cahalan, M., Stock, C., Ortega, R., Sharar, S., & Holt, F. (2017). *Clinical Anesthesia;* 8th edition. Wolters Kluwer

Bindu, B., Bindra, A., & Rath, G. (2017). Temperature management under general anesthesia: Compulsion or option. J*ournal of anaesthesiology, Clinical Pharmacology, 33*(3), 306–316. 10.4103/joacp.JOACP_334_16

Brito Poveda, V., Clark, A. M., & Galvão, C. M. (2013). A systematic review on the effectiveness of prewarming to prevent perioperative hypothermia. *Journal of Clinical Nursing*, *22*(7-8), 906–918. https://doi.org/10.1111/j.1365-2702.2012.04287.x

Butterworth, J. F., Mackey, D. C., & Wasnick, J. D. (2018). *Clinical anesthesiology* (6 ed.). McGraw Hill Education.

Department of Health and Human Services (DHHS). (2015, July). *Types of health care quality measures*. Agency of Healthcare Research and Quality. https://www.ahrq.gov/talkingquality/measures/types.html

Erdling, A., & Johansson, A. (2015). Core temperature--the intraoperative difference between esophageal versus nasopharyngeal temperatures and the impact of prewarming, age, and weight: a randomized clinical trial. *AANA Journal, 83*(2), 99–105.

Hooper, V., Chard, R., Clifford, T., Fetzer, S., Fossum, S., & Godden, B. et al. (2010). ASPAN's evidence-based clinical practice guideline for the promotion of perioperative normothermia: 2nd Edition. *Journal of Perianesthesia Nursing*, *25*(6), 346-365. 10.1016/j.jopan.2010.10.006

Hooven, K. (2011). Preprocedure Warming maintains normothermia throughout the perioperative period: A quality improvement project. *Journal of Perianesthesia Nursing*, *26*(1), 9-14. 10.1016/j.jopan.2010.07.013

Institute for Health Care Improvement (IHI). (2020). *IHI triple aim initiative.* http://www.ihi.org/Engage/Initiatives/TripleAim/Pages/default.aspx

Kurz, A., Sessler, D., & Lenhardt, R. (1996). Perioperative Normothermia to reduce the incidence of surgical wound infection and shorten hospitalization. *New England Journal of Medicine*, *334*(19), 1209-1216. 10.1056/nejm199605093341901

Kwong, J. Z., Weng, Y., Finnegan, M., Schaffer, R., Remington, A., Curtin, C., McDonald, K. M., Bhattacharya, J., & Hernandez-Boussard, T. (2017). Effect of medicare's nonpayment policy on surgical site infections following orthopedic procedures. *Infection Control and Hospital Epidemiology*, *38*(7), 817–822. https://doi.org/10.1017/ice.2017.86

Levin, R., 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. 10.1016/j.aorn.2015.12.020

Madrid, E., Urrutia, G., Roque I Figuls, M., Pardo-Hernandez, H., Campos, J. M., Paniagua, P., Maestre, L., & Alonso-Coello, P. (2016). Active body surface warming systems for preventing complications caused by inadvertent perioperative hypothermia in adults. *The Cochrane Database of Systemic Reviews*, *4*, CD009016. https://doi.org/10.1002/14651858.CD009016.pub2

Matika, R., Ibrahim, M., & Patwardhan, A. (2016). The importance of body temperature: An anesthesiologist's perspective. *Temperature*, *4*(1), 9-12. https://doi.org/10.1080/23328940.2016.1243509

Melling, A. C., Ali, B., Scott, E. M., & Leaper, D.J. (2001). Effects of preoperative warming on the incidence of wound infection after clean surgery: A randomized controlled trial. *Lancet, 358*(9285), 876-880. https://doi.org/10.1016/S0140-6736(01)06071-8

Mississippi Department of Health (MDH). (2020). *Healthcare-associated infection control.* https://msdh.ms.gov/msdhsite/index.cfm/14,16655,73,691.html

Mississippi Secretary of State. (2020). https://corp.sos.ms.gov/corp/portal/c/page/corpBusinessIdSearch/portal.aspx?#

Munday, J., Delaforce, A., Forbes, G., & Keogh, S. (2019). Barriers and enablers to the implementation of perioperative hypothermia prevention practices from the perspectives of the multidisciplinary team: a qualitative study using the Theoretical Domains Framework. *Journal of Multidisciplinary Healthcare, 12*, 395–417. https://doi.org/10.2147/JMDH.S209687

Murphy, P. (2012). Measuring and recording outcomes. *British Journal of Anaesthesia*, *109*(1), 92-98. 10.1093/bja/aes180

Nagelhout, J. J., & Elisha, S. (2018). *Nurse Anesthesia* (6 ed.). Elsevier.

Perlman, R., Callum, J., Laflamme, C., Tien, N., Nascimento, B., Beckett, A., & Alam, A. (2016). A recommended early goal-directed management guideline for the prevention of hypothermia-related transfusion, morbidity, and mortality in severely injured trauma patients. *Critical Care 20*, 107. 10.1186/s13054-016-1271-z

Roberson, M., Dieckmann, L., Rodriguez, R., Austin, P. (2013). A review of the evidence for active preoperative warming of adults undergoing general anesthesia. *AANA Journal,* (5), 351-356.

Robinson, S., Katariya, K., Sessler, D., Kurz, A., Hodges, W., & Odom-Forren, J. (2005). Perioperative temperature management: roundtable discussion identifies need to avoid hypothermia. *Anesthesia Patient Safety Foundation Newsletter, 20*(4).

https://www.apsf.org/article/perioperative-temperature-management-roundtable-discussion-identifies-need-to-avoid-hypothermia/

Rosenfeld, J. B. (1963). Acid-base and electrolyte disturbances in hypothermia. *The American Journal of Cardiology*, *12*, 678-682. http://dx.doi.org/10.1016/0002-9149(63)90259-5

Rosenkilde, C., Vamosi, M., Lauridsen, J., & Hasfeldt, D. (2017, October). Efficacy of prewarming with a self-warming blanket for the prevention of unintended perioperative hypothermia in patients undergoing hip or knee arthroplasty. *Journal of PeriAnesthesia Nursing*, 32(5), 419-428. https://pubmed.ncbi.nlm.nih.gov/289389771/

Ruetzler, K., & Kurz, A. (2018). *Consequences of perioperative hypothermia. Handbook of Clinical Neurology, 687–697.* 10.1016/b978-0-444-64074-1.00041-0

Sajid, M. S., Shakir, A. J., Khatri, K., & Baig, M. K. (2009). The role of perioperative warming in surgery: A systematic review. *Saw Paulo Medical Journal, Revista Paulista de Medicina, 127*(4), 231-237. https://doi.org.10.1590/s1516-3180200900040009

Sessler, D. I. (2001). Complications and treatment of mild hypothermia. *Anesthesiology, 95(2),* 531-543. https://anesthesiology.pubs.asahq.org/article.aspx?articleid=1945095#81337994

Slagle, J. (2015). *Implementation of a warming protocol to prevent inadvertent perioperative hypothermia in the ambulatory surgical setting*. [Master's thesis, The University of San Francisco].

Smith, S. A., Travers, R. J., & Morrissey, J. H. (2015). How it all starts: Initiation of the clotting cascade. *Critical Reviews in Biochemistry and Molecular Biology, 50*(4), 326–336. 10.3109/10409238.2015.1050550

Stoelting, R. K., Hines, R. L., & Marschall, K. E. (2012). *Stoelting's anesthesia and co-existing disease* (6 ed.). Saunders/Elsevier.

Wasfie, T. J., & Barber, K. R. (2015). Value of extended warming in patients undergoing elective surgery. *International Surgery, 100*(1), 105–108.https://doi.org/10.9738/INTSURG-D-13-00155.1

Weirich, T. L. (2008). Hypothermia/warming protocols: why are they not widely used in the OR? *AORN Journal*, *87*(2), 333–340. https://pubmed.ncbi.nlm.nih.gov/18262000/

World Health Organization (WHO). (2021). Summary of a systematic review on maintaining normal body temperature (normothermia) [Guideline]. https://www.who.int/gpsc/appendix14.pdf

Yenari, M., & Han, H. (2012). Neuroprotective mechanisms of hypothermia in brain ischemia. *Nature Reviews Neuroscience, 13*, 267–278. 10.1038/nrn3174

Zhou, J., & Poloyac, S. M. (2011). The effect of therapeutic hypothermia on drug metabolism and drug response: Cellular mechanisms to organ function. *Expert Opinion on Drug Metabolism & Toxicology, 7:7*, 803-816. http://dx.doi.org/10.1517/17425255.2011.574127