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The Use of an Intraoperative Forced Air Warming Device Alone Versus Warmed Intravenous Fluid Infusion and Forced Air Warming Versus Warmed Intravenous Fluid Alone in Patients Undergoing Open Intra-Abdominal Surgery

Charlie Adderley
University of Southern Mississippi

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THE USE OF AN INTRAOPERATIVE FORCED AIR WARMING DEVICE ALONE
VERSUS WARMED INTRAVENOUS FLUID INFUSION AND FORCED AIR
WARMING VERSUS WARMED INTRAVENOUS FLUID ALONE IN PATIENTS
UNDERGOING OPEN INTRA-ABDOMINAL SURGERY

by

Charlie Stark Adderley

Abstract of a Capstone Project
Submitted to the Graduate School
of The University of Southern Mississippi
in Partial Fulfillment of the Requirements
for the Degree of Doctor of Nursing Practice

December 2015
ABSTRACT

THE USE OF AN INTRAOPERATIVE FORCED AIR WARMING DEVICE ALONE VERSUS WARMED INTRAVENOUS FLUID INFUSION AND FORCED AIR WARMING VERSUS WARMED INTRAVENOUS FLUID ALONE IN PATIENTS UNDERGOING OPEN INTRA-ABDOMINAL SURGERY

by Charlie Stark Adderley

December 2015

Patients undergoing open abdominal surgery with general anesthesia are at increased risk for adverse outcomes associated with disturbances in thermoregulation during the intraoperative phase of the surgical experience. The purpose of this quantitative capstone project was to examine and compare the differences between the use of an intraoperative forced air-warming device and a forced air warming device plus warmed intravenous fluid (IVF) in the management of postoperative hypothermia, as measured by the postoperative temperatures of patients undergoing open abdominal surgery. A comparative retrospective chart review was performed using two groups to assess the effectiveness of preventing postoperative hypothermia in this patient population. Data were analyzed descriptively and inferentially using the T-test and Chi square methods. The results showed no significant differences between the pre, intra, and postoperative temperatures of the subjects from both groups. Since nurse anesthesia providers are likely to be assessing patients for perioperative hypothermia, implementing specific types of warming methods, and addressing potential postoperative hypothermia, it is essential for anesthesia providers as well as the entire surgical team to become knowledgeable regarding management of postoperative hypothermia.
THE USE OF AN INTRAOPERATIVE FORCED AIR WARMING DEVICE ALONE VERSUS WARME D INTRAVENOUS FLUID INFUSION AND FORCE AIR WARMING VERSUS WARME D INTRAVENOUS FLUIDS ALONE IN PATIENTS UNDERGOING OPEN INTRA-ABDOMINAL SURGERY

by

Charlie Stark Adderley

A Capstone Project Submitted to the Graduate School and the Department of Advanced Practice at The University of Southern Mississippi in Partial Fulfillment of the Requirements for the Degree of Doctor of Nursing Practice

Approved:

________________________________  __________________
Dr. Vickie L. Stuart, Committee Chair
Assistant Professor, Advanced Practice

________________________________  __________________
Dr. Michong K. Rayborn, Committee Member
Assistant Professor, Advanced Practice

________________________________  __________________
Dr. Bonnie L. Harbaugh, Committee Member
Professor, Systems Leadership and Health Outcomes

________________________________  __________________
Dr. Karen S. Coats
Dean of the Graduate School

December 2015
DEDICATION

I would like to sincerely thank my family for their unwavering support in all my endeavors.
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I would like to express my sincerest gratitude to my committee chair Dr. Vickie Stuart for all her guidance through this tough capstone process from beginning to completion. I would also like to thank my committee members, Dr. Michong Rayborn and Dr. Bonnie Harbaugh, for their time and attention to help me complete my capstone project. I would like to thank Dr. Everson for all her help and assistance through the capstone process. Additionally, I would like to thank Dr. Alma Yow for her attention to detail while completing the capstone project process.
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LIST OF ABBREVIATIONS

ANP – Advance nurse practitioner
ASA – American Society of Anesthesiology
ASPA – American Society of Perioperative Nursing
BMI – Body mass index
CDC – Centers for Disease
CMMS – Centers for Medicare and Medicaid Services
DNP – Doctorate of Nursing Practice
EBL – Estimated blood loss
EMR – Electronic medical record
ETT – Endotracheal tube
IPH – Inadvertent perioperative hypothermia
IRB – Institutional Review Board
IVF – Intravenous fluid
LOS – Length of stay
MP – Mallampati
MI – Myocardial infarction
PACU – Postoperative care unit
PH – Perioperative hypothermia
SCIP – Surgical Care Improvement Project
USM – University of Southern Mississippi
WMD – weighted mean difference
X² – Chi Square test
CHAPTER I

INTRODUCTION

The impact of inadvertent perioperative hypothermia (IPH) can lead to increased morbidity and mortality in surgical patients undergoing open abdominal procedures. Despite current intraoperative warming measures with forced air warmers or warm water garments, hypothermia during large open abdominal surgeries is often inevitable (Janicki et al., 2002). Research efforts over the past decade have been aimed at cost-effective measures that minimize associated complications related to hypothermia after general anesthesia. According to Cobbe, Grad Dip, Duff, Walker, and Draper (2012), inadvertent hypothermia leads to deleterious complications postoperatively such as myocardial infarction (MI), surgical site infection, and increased length of stay in postoperative care unit (PACU) as well increased incidences of readmission-associated infections.

Clinical Question

This study addressed the clinical question: What is the difference between the use of an intraoperative forced air-warming device alone compared with forced air warming device and warmed intravenous fluids (IVFs) in the management of postoperative hypothermia, as measured by the postoperative temperatures of patients undergoing open abdominal surgery?

Hypothermia in the surgical patient continues to be of great concern for the surgical team especially in patients undergoing open abdominal procedures. The inability of the anesthetized patient to maintain normothermia through thermogenesis is compounded by the length of the procedure along with general anesthesia, ambient room temperature and other variables common to the operative setting. The use of an
intraoperative forced air warmer is routine in most surgical cases; however, in open abdominal surgery, patients are at an increased risk of cutaneous heat loss due to size of the exposed surgical site (Chicharu et al., 2003). The open surgical site and multiple postoperative adverse outcomes also attribute to (IPH).

Problem Statement

Patients having open abdominal surgery often experience periods of IPH throughout the perioperative period. Undergoing general anesthe sia often leads to thermal imbalances because “autonomic defenses against cold stress are not under conscious control” (John & Harper, 2014, p. 207). The effects of hypothermia in the perioperative period can lead to devastating outcomes for the surgical patient. According to Scott and Buckland (2006), “if hypothermia is not prevented during surgery, 70% of patients may be hypothermic on admission to the post anesthesia care unit (PACU)” (p. 1090). Additionally, Forbes et al. (2009) reported that “as many as 46% of general surgery patients undergoing abdominal operations have temperatures < 36°C at the start of the operation and more than one-third were hypothermic on arrival in the PACU” (p. 492). The consequences of IPH are associated with various physiological outcomes, including bleeding due to platelet dysfunction, delayed surgical wound healing, postoperative shivering with increased oxygen consumption which often leads to increased length of stays in the PACU, cardiac dysfunctions, longer inpatient hospital stays and finally death (Moola & Lockwood, 2011).

Purpose of Capstone

The purpose of this capstone project was to examine and compare the differences between the use of an intraoperative forced air-warming device alone and a forced air
warming device plus IVFs in the management of postoperative hypothermia, as measured by the postoperative temperatures of patients undergoing open abdominal surgery. Unplanned hypothermia in the perioperative period is not a benign matter. Due to the increased understanding of the effects of hypothermia as a safety concern for patients, there has been a sharp growth in the number of published clinical studies over the last decade, which focus on “defining its consequences in surgical patients and identifying the most effective strategies for its prevention” (Young & Watson, 2006, p. 552). The variables to be measured included core body temperatures at different points throughout the perioperative period, length of surgery, ambient operating room temperature, age, gender, body mass index (BMI), and the type of surgery. A white paper change proposal will disseminate the results to key stakeholders in an effort to reduce future incidences ofIPH in patients undergoing open abdominal surgery.

Background and Significance

Maintaining normal body temperature is vitally important to the overall well-being of a patient. Increased or decreased temperature leads to feelings of discomfort or generalized malaise. Unplanned hypothermia in the perioperative period not only affects the overall surgical outcome such as infection but also has other potential effects on cost to hospital and patient, increased risk for myocardial infarction and decreased wound healing.

Over the last decade, research regarding perioperative hypothermia (PH) has revealed multiple pathophysiological effects in the surgical patient that extended well beyond the postoperative period (Kumar, Wong, Melling, & Leaper, 2005). PH is defined as a core body temperature less than 36°C and can be present in any phase of the
perioperative period (Forbes et al., 2009). The physiological factors of the core body
temperature are regulated by a negative feedback system that limits alterations in thermal
balance. “The skin surface, deep abdominal and thoracic tissue, spinal cord,
hypothalamus, and other portions of the brain each contribute roughly 20% to autonomic
thermoregulatory control” (Kurz, 2008, p. 631). According to Hart, Bordes, Hart,
Corsino, and Harmon (2011), anesthesia causes a metabolic change in thermal balance
mechanisms, thereby producing hypothermia. Hart et al. (2011) also reports that “up to
20% of patients experience unintended perioperative hypothermia” throughout the
surgical experience (p. 259). Surgery is a well-known stressor to any individual
regardless of the state of physical health. Patients are often classified for fitness of
surgery by the surgeon and the anesthesia provider. The American Society of
Anesthesiology (ASA) categorizes the physical status of patients based on state of health
prior to surgery. According to Morgan, Mikhail, and Murry (2006), patients are classified
as ASA I if they are normal healthy patients, ASA II classification includes patients with
mild systemic disease without substantive functional limitations, ASA III classifications
include patients with one or more moderate to severe systemic diseases and substantive
functional limitations and ASA IV classifications includes patient with severe systemic
disease that is consistently life threatening.

Consequences of Hypothermia

According to Mahoney and Odom (as cited Berry, Wick, & Magons, 2008, p. 24),
“adverse outcomes caused by hypothermia averaging only 1.5°C less than normal led to
increases of $2,500 to $7,000 per surgical patient”. Additionally, a 1.9°C hypothermic
shift in core body temperature triples surgical wound infection causing a 20% increase in
hospital duration (Reynolds, Beckmann, & Kurz, 2008). IPH can lead to myocardial infarction (MI), which is a leading cause of increased morbidity and mortality in the postoperative patient. Postoperative shivering is associated with a potential 300-400% increase in oxygen consumption causing increased metabolic demands of the body that is not well tolerated in patients with preoperative cardiac disease (Doufas, 2003). Furthermore, IPH increases cardiac morbidity risk due to subsequent changes in cardiac demand from the increase in systemic blood pressure, systemic vasoconstriction, and circulating catecholamine levels from the stress of surgery (Forbes et al., 2009). Blood coagulation defects are also a major concern in surgical patients with IPH. In a research study, Hart et al. (2011) reported that mild hypothermia led to an unfavorable threefold increase in the surgical blood loss causing a 20% increase in allogeneic transfusion in the intraoperative period.

*Anesthesia and Hypothermia*

Anesthesia induction causes a 20-fold increase in the body’s threshold temperature, leading to a decrease in the body’s thermoregulatory mechanism (Young & Watson, 2006). The body generally attempts to protect itself from cold stress by vasoconstriction redistribution. According to Weirich (2008), “general anesthesia causes vasodilation and limits the body’s normal protection against hypothermia” (p. 334). The core body temperature decreases 1° or 2° within the first hour of general anesthesia and decreases further depending on the length of the surgery (Morgan et al., 2006). In addition to hypothermia related to general anesthesia, 90% of heat loss in patients undergoing an open abdominal procedure occurs mostly through evaporation, radiation
and convection in the operating room environment further compounding the effects of IPH (Galvao, Marck, Sawada, & Clark, 2009).

Temperature balance is very important for pharmacodynamic properties of muscle relaxants, volatile anesthetics and intravenous drugs (IV) anesthetics, which are commonly used in the induction process for general anesthesia. Rocuronium, a muscle relaxant commonly used for induction of general anesthesia, has a prolonged duration of action in hypothermic patients thus potentially extending recovery time in the PACU. Propofol, is an IV hypnotic that is commonly used during induction of general anesthesia. “Propofol, a commonly used anesthetic is paradoxically affected by temperature; a 3 °C decrease in core temperature results in an approximate 30% increase in plasma concentration of propofol” (Reynolds et al., 2008, p. 648). Additionally, the solubility of volatile anesthetic agents are increased in the hypothermic patient, which may lead to longer recovery times because greater amounts of anesthetic gas must be exhaled for optimal emergence postoperatively (Reynolds et al., 2008).

**Temperature Management**

Thermal management can be performed by means of passive methods, which mainly decrease cutaneous heat loss and active warming or cooling methods, which actively transfer heat into or out of the body” (Kurz, 2008). Radiation (heat loss mechanism) accounts for at least 60% of the heat loss in patients in the operating room (Kurz, 2008). Despite the use of passive and active strategies for warming such as warm blankets in the preoperative phase and forced air warming devices or warm water garment use intraoperatively, postoperative hypothermia remains a major concern for anesthesia providers. According to Moola and Lockwood (2011), prevention of IPH is
based on current professional standards and guidelines are based on past (outdated) research and “do not include recent recommendations that inform how practice should change, nor facilitate change based on current evidence” (p. 340).

**Temperature Monitoring**

Perioperative clinicians need reliable monitoring devices for accurate temperature measurements in the surgical patient. “The core thermal compartment is a well-perfused compartment comprising 50% to 60% of the body mass and includes the major organs of the trunk and head (but not including skin and peripheral tissues)” (Hooper & Andrews, 2006, p. 25; Sessler, 2000). Core temperature monitoring is by far the most accurate way to measure body temperature and “is the best single indicator of thermal status in humans” (Sessler, 2008, p. 334). Additionally, core temperature can be measured orally, axillary and by bladder probe. However, the best core thermal monitoring is done with the use of a pulmonary artery catheter, nasopharynx, distal esophagus, and tympanic membrane. Temporal artery temperature monitors are commonly used in the preoperative and postoperative surgical phases with varied accuracy based on proper positioning and familiarity of the user with the device. Conversely, Sessler (2008) reports, “temporal artery systems are insufficiently accurate for clinical use” (p. 334). Intraoperative monitoring is often done with esophageal or nasal thermometer monitoring for increased continuous monitoring throughout the procedure, with nasopharynx monitoring being the most popular. Nasopharyngeal probes are considered to be an accurate reflection of the body’s core temperature in patients under general anesthesia with endotracheal tubes (ETT) because they are not breathing through the nostrils.
CHAPTER II
REVIEW OF LITERATURE

This literature narrative contains a synthesis of topics related to the effects of intraoperative warming and the incidence of hypothermia in the perioperative period. A perioperative core temperature of below 36 °C (96.8 °F), as defined by the clinical recommendations set forth by the American Society of PeriAnesthesia Nurses (ASPN), is perioperative hypothermia (Hooper et al., 2009). Hypothermia in the perioperative period is not a benign matter. According to Cobbe and colleagues (2012), inadvertent hypothermia leads to serious complications postoperatively such as myocardial infarction (MI), surgical site infection as well increased incidences of readmission-associated infections. Increased or decreased temperature leads to potential complications as well as feelings of discomfort or generalized malaise postoperatively. Therefore, temperature is a crucially important component to the overall wellbeing of a patient.

Leeth, Mamaril, Oman, and Krumbach (2010), reported in a study that multiple factors contribute to the increased risk of hypothermia including extremes of age, gender (female), the ambient temperature of the room, length and type of surgery, preexisting conditions, use of cold fluids, and type of anesthesia used. However, intraoperative warming with forced air warming gowns increased patient’s temperature (despite the aforementioned issues/conditions) upon arrival to the post anesthesia care unit (PACU). Normothermia was maintained with the use of warmed blankets upon arrival to the PACU aiding in the prevention of unplanned hypothermia in the perioperative period.

In an article by Lista, Doherty, Backstein, and Ahmad (2012) management and prevention of hypothermia in the perioperative period with the use of simple measures
such as forced air warming, warmed IVFs and limited surgical site exposure improved clinical outcomes, patient comfort and recovery following aesthetic surgical procedure. Moreover, understanding the importance of temperature regulation throughout the surgical experience is an important aspect of best surgical practice and surgical outcome. 

*Thermal Balance*

Unplanned hypothermia in the perioperative period not only affects the overall surgical outcome, infection but also has other potential effects on cost to hospital and patient. Hypothermia can lead to increased length of stay in the PACU or even overnight admissions related to increased oxygen needs and alterations in metabolism of medications for pain. Normothermia is important for surgical outcomes as well as patient comfort in the preoperative and postoperative phases. The study done by Feetes, Mulvaine, and Van Doren (2013), found that prewarming and intraoperative warming affected patient temperatures on arrival to the PACU and it played a major role in decreasing length of stay in the recovery room and it increased patient comfort.

Preventing surgical complications due to hypothermia is the priority for the surgical team (surgeon, nurses and nurse anesthetist). Primary interventions should be aimed at thermal balance with perianesthesia interventions and surgical outcomes. The prospective study by Burns, Piotrowski, Carraffa, and Wojnakowski (2010) was done to determine the incidence of postoperative hypothermia and the relationship of clinical variables such as the use of warming devices in the preoperative and intraoperative phases, ambient room temperature, and warming all fluids used during the surgical procedure. The study reported a low incidence of hypothermia (4%) related to the heightened awareness of the surgical team regarding the increased complications of
hypothermia (Burns et al., 2010). Due to the low incidence, the authors concluded that the application of the specific variables were not likely reasons for the decreased incidence in unplanned hypothermia.

Thermal imbalance in the operating room occurs through 4 mechanisms: radiation, convection, conduction and evaporation. However, radiation and convection are the primary mechanisms of heat loss in the surgical patient. Hart and colleagues (2011) reviewed literature regarding heat loss mechanisms related to inadvertent perioperative hypothermia. The article concludes that using passive and active warming measures to combat radiation and convection heat loss in the surgical patient helps with thwarting postoperative complications such as decreased/delayed wound healing, cardiac dysfunction, surgical site infection and bleeding in the intraoperative and postoperative surgical phases.

General anesthesia coupled with the effects of heat loss mechanisms in the surgical patient is also related to significant decreases in core body temperature. In prospective study done by Vaughn, Vaughn, and Cork (1981), the authors examined the relationship between duration of surgery, surgical environment, and type of surgery and whether the patient had decreased core temperatures with shivering on arrival to the recovery room (RR). The study included 198 postsurgical patients (164 classified ASA I or II and 34 classified ASA III or IV), and temperatures of the patients were measured within 5 minutes of arrival to the RR. They used 2 tympanic membrane thermometers calibrated for accuracy of +/-0.27°C (0.5°F) according to manufacturer’s instructions they used. The study excluded certain types of surgical procedures such as open heart, craniotomies, previous tympanoplasty as well as patients with history of coagulopathy
disease or preoperative hyperthermia. The average anesthesia exposure time was 121.5 +/- 0.5 minutes. The average age of cohort was 50 years of age (+/- 1.3 years). The study concluded that age along with radiation and convection was a major factor in with pronounced hypothermia in elderly patients upon arrival to RR than younger patients.

Additionally, a literature review conducted by Alderson et al. (2014), the authors reviewed 22 RCT’s related to thermal heat loss mechanisms in the prevention of hypothermia and the adverse complications caused by PH during surgery in adult patients. The aim of the review was to assess the effects of thermal insulation techniques in the pre or intraoperative phases in preventing heat loss through convection and radiation. The results of the trials varied broadly in the type of operations and patients, temperature measurements timing throughout the perioperative phases and the types of warming interventions used in the trial. The risk of bias was vague in the studies; however, there was high risk of performance bias in most of the studies and a low risk of attrition bias. In the largest comparison trial with 353 patients of standard care versus extra insulation at the end of surgery, the results showed a weighted mean difference (WMD) of 0.12°C (95% CI -0.07 to 0.31) indicating low quality evidence. However in the comparison of using forced air warming devices versus extra insulation, the evidence showed temperature increase in the immediate postoperative phase was between 0.5 and 1°C.

Prevention Strategies

IPH remains a preventable condition during the surgical experience. There are several existing strategies that assist in maintain intraoperative and postoperative normothermia. The use of warm cotton blankets in the preoperative phase, warmed
intravenous fluids in the operating room, and the use of various types of forced-air systems are methods that can significantly decrease the incidence of hypothermia throughout the perioperative phases. Also, increasing knowledge and understanding regarding the beneficial effects related to the maintenance of normothermia helps the surgical team prevent complications associated with IPH as well as improve the safety and quality of anesthesia care for patients. The study done by Feetes et al. (2013) found that prewarming affected patient temperature on arrival to the PACU, and it played a major role in decreasing the length of stay in the recovery room and increasing patient comfort.

Moola and Lockwood (2011) conducted a literature review related to the most effective and efficient strategies to manage and prevent IPH in the surgical arena. The authors used a three-step search plan to find the most relevant and high quality evidence for their review. The inclusion criteria included adult patient over 18 years of age who underwent various types of surgery. However, patients that were subjected to deliberate hypothermia had select neurosurgical intervention and cardiac surgery was not included in the review. The type of interventions included in the review process was any type of cover or linen blanket, forced air warming devices, fluid warming devices, and aluminum foil wraps. Additionally, the reviewers considered prospective studies using randomization and/or with a control group. The increase or decrease in the core body temperature was the primary outcome focus. The results from the final 19 studies that met the inclusion criteria included a collective total of 1451 patients. The increase or decrease in the core body temperature was the primary outcome focus. The authors concluded that there was significant benefits related to using a forced air warming device
such as increased patient comfort and increased core temperatures in the intraoperative and postoperative phases as well as decreased adverse outcomes associated with IPH in the surgical patient.

In a study regarding the effects of preoperative warming for the prevention of IPH, Horn et al. (2012) conducted a randomized control trial with 200 patients to evaluate the effects of active skin-surface prewarming for short periods of time for the prevention of PH and shivering in the postoperative period with the non-prewarmed control group. The authors randomly assigned patients to one of the four treatment groups scheduled to undergo general anesthesia for 30-90 minute elective surgical procedures to receive forced air skin warming or passive insulation (cotton blankets or space blankets) for 10, 20, or 30 minutes respectively in the preoperative period. All patients included in the study were classed ASA 3 or less or greater than 18 years of age. The surgery types included laparoscopic cholecystectomy, breast surgery, inguinal hernia repair, and minor orthopedic surgeries. The forced air device blanket was covered with a regular blanket, and temperature was set at 44°C then adjusted to patient comfort as needed. The device blanket was left in place when patient was transferred to the operating room. The main findings of the study were that a mere 10 minutes of prewarming was adequate to prevent hypothermia when compared with patients who were not prewarmed. Furthermore, the non-prewarmed patient group had reduced core temperatures upon arrival to the PACU despite intraoperative warming during the surgery.

In another random control trial completed by Hong-xia, Zhi-jian, Hong, and Zhiqing (2010), the authors compared infusion of IV fluid infused via a warming device versus IV fluids infused at room temperature during the intraoperative phase of
abdominal surgery. The trial was conducted to assess the effectiveness of warmed IV fluids to prevent hypothermia and maintain normothermia during the intraoperative phase. The study used 30 adult patients classified as ASA 1 or 2 undergoing general anesthesia for abdominal surgery. The test group (n=15) received normal saline via a fluid-warming device intraoperatively set at 37°C while the control group (n=15) received room temperature normal saline intraoperatively. The core temperatures were measured at the beginning of anesthesia induction and then in every 30 minutes for 2 hours or until the end of surgery (if less than 2 hour period). Preoperatively, the test group and the control core temperatures were 37.0°C +/- 0.1°C and 37.1°C +/- 1°C respectively. The results showed that the test group had small decrease in core temperature to 36.5°C +/- 1°C for the first hour of anesthesia but increased gradually to 36.9°C +/- 0.3°C by the end of anesthesia. The control group showed a decrease in core body temperature to 35.5°C +/- 0.3°C during the entire procedure. The authors concluded that normothermia during abdominal surgery can be maintained with the use of warm fluids intraoperatively during abdominal surgery which may prevent adverse outcomes due to hypothermia in this patient population.

Comparison of Warming Devices

There are multiple warming devices available on the market today. The Bair Hugger is a well-known device used intraoperatively to deliver forced warmed air to a blanket or underbody mattress with temperature settings from 33°C to 43°C. However during major abdominal surgery, multiple trauma or liver transplant, this device may not cover sufficient surface area to maintain intraoperative normothermia although it was often use as standard thermal care. Another common device used intraoperatively is the
circulating water system that has an electric water reserve and heater delivering water to a blanket or mattress with temperature setting similar to the Bair Hugger. These devices can be used to cover or wrap more body surface area, which prevent heat loss from a larger area. Comparing warming devices often addresses the practicality and usefulness of using it to prevent hypothermia in the surgical arena.

In a prospective, randomized control trial conducted by Janicki et al. (2002), the authors compared the use of a new water warming garment to the use of the upper and lower body forced air device in patients undergoing general anesthesia for open liver transplant surgery. The study included 24 adult patients ranging from 18 to 65 years of age. The test group (n=12) used the water garment and the control group (n=12) used the upper and lower body forced air device, which was the facilities standard warming practice for the particular surgery. Core temperatures for both groups were measured intraoperatively in every two hours after the surgery was completed. The core body temperature measurements during incision, one hour post incision and during closure of skin from the test group (water garment) were significantly higher than the control group with statistical significant t test p < 0.05. The researchers concluded that the water warming system maintained normothermic core body temperatures of 36.3 +/- 0.3 better than the standard forced air devices applied for the particular surgery.

Nicholson (2013) conducted a prospective study with repeated measures and randomized assignment to one of two interventions comparing warming interventions for the prevention of IPH in patients undergoing scheduled colorectal surgery. The aim of the study was to examine the effects of prewarming with warm cotton blankets versus forced air warming devices on normothermia in the intraoperative and postoperative period.
Needs Assessment

The consequences of IPH often lead to increased cost for the patient as well as the surgical department. The relationship between adverse complications and hypothermia are well documented in the literature. Normothermia maintenance is valuable to both the healthcare institution and the patient because of the reduction of morbidity and mortality in the postoperative patient. Additionally, ASPAN recommends continuous thermal monitoring as well as other methods to prevent and/or manage hypothermia (Hooper et al., 2009).

The rate of postoperative complications in patients undergoing anesthesia for non-cardiac surgery is about 6% and 130% for patients undergoing anesthesia for high-risk surgical procedures (Bratzler & Hunt, 2006; Dimick et al., 2004; Khan et al., 2006). Using a forced air-warming device intraoperatively is the current standard of care for temperature maintenance along with continuous core temperature monitoring throughout the surgical procedure. However, even with the use of this device, IPH remains a concern for the surgical team in the case of patients with open abdomens due to insurmountable heat loss through radiation and convection.

Active management of thermal imbalance throughout the perioperative phases improves patient outcomes. In a meta-analysis conducted by Mahoney and Odom (1999), the authors reported that complications associated with IPH cost the patient and healthcare facility an average of $2,500 to $7,500, depending on the surgical procedure as well as increased length of stay due to adverse outcomes. In efforts to promote accountability to patients, insurance pay for performance services for key stakeholders and many healthcare institutions are using quality metrics to improve healthcare and
healthcare standards (Chassin, Loeb, Schmaltz, & Wachter, 2010). Moreover, in an effort to improve quality perioperative temperature management and decrease adverse outcomes related to IPH, the Centers for Medicare and Medicaid (CMMS) in partnership with the Centers for Disease Control (CDC) implemented the Surgical Care Improvement Project (SCIP) as a method for measuring and assuring quality for surgical patients ("National SCIP partnership developing to reduce surgical complications," 2015). Therefore, the outcome of this study will answer the query of how anesthesia clinicians and the surgical team can implement simple yet affordable and effective measures to decrease incidences of IPH as well as continue to improve patient safety and quality healthcare.
Conceptual Framework

A theory in nursing differentiates the profession from other traditional physician oriented medical practice models (Zaccagnini & White, 2011). A theory is a generalized concept offering a systematic explanation of how various phenomena are related with the purpose of description, explanation, and/or description (as cited in Butts & Rich, 2013). The nursing process involves a systematic approach to problem solving in clinical practice with the use of theory models. By integrating a nursing theory with the doctorate of nursing practice (DNP) capstone project, nursing knowledge can be described, developed, and disseminated to guide best practices for patient care.

Identifying a problem in clinical practice is the first step in developing a capstone project. The integration of a nursing theory with clinical practice problem influences variables such as safety, quality, evidence-based practice as well as research methods. The capstone project is related to how the use of intraoperative forced air-warming devices in patients undergoing open abdominal surgery will affect the maintenance of intraoperative and postoperative normothermia. The inability of the anesthetized patient to maintain normothermia through thermogenesis is often compounded by the length of the procedure as well as the contraindication of using warm forced air devices during the surgery. In an article by Lista et al. (2012) management and prevention of hypothermia in the perioperative period with the use of simple measures (forced air warming, warmed fluids and surgical site exposure only) improved clinical outcomes, patient comfort and recovery following surgical procedures. The significance of hypothermia throughout the perioperative period is linked to deleterious outcomes such as increased cardiac injuries, wound infection as well as decreased wound healing.
The conceptual framework applied to this capstone project is Roy Adaptation Model for nursing theory. This nursing model encompasses four main concepts; environment, health, person and nursing. It involves six steps of the nursing process that include assessment of a stimulus, assessment of a behavior, a nursing diagnosis, goal setting, interventions and then the evaluation of the intervention (Andrews & Roy, 1991). The model conceptualizes the nursing care plan for the patient with perioperative hypothermia. This model views the environment as the stimuli and the patient as the adaptor. Under general surgery the patient must physiologically adapt to environment and when this does not happen, an intervention is needed. According to this theoretical model, the anesthesia providers’ responsibility is to assist the patient with adapting to the situation (Andrews & Roy, 1991). By using a forced air-warming device alone or with warmed IVFs, the provider applies the six steps of the nursing process to prevent postoperative hypothermia.

Doctorate of Nursing Practice (DNP) Essentials

As a leader in nursing practice, the DNP provider serves as a change agent to improve the quality of care in the clinical setting. The completion of this capstone project symbolizes the goal of fulfilling the DNP essentials as set forth by the American Association of Colleges of Nursing (AACN). (See Appendix D) As the complexity of healthcare increases, the role of the DNP essentials reflects the education and clinical focus that characterizes advanced nursing practice for the practice doctorate professional.
CHAPTER III

METHODOLOGY

The purpose of this capstone project was to examine and compare the differences between the use of an intraoperative forced air-warming device exclusively and a forced air warming device, in combination with warmed IVFs in the management of postoperative hypothermia, as measured by the postoperative temperatures of patients undergoing open abdominal surgery. The methodology described the proposed design that was used for the study including sampling, participant selection, and setting. This section also included instrumentation tools, procedures for data collection and analysis of the data utilization in the proposed study.

Research Design

The chosen design for this capstone project was a retrospective comparative chart review. This type of design is effective because it is relatively inexpensive with rich research data readily available and easy to collect (Gearing, Mian, Barber, & Ickowicz, 2006). Additionally, the design is fitting because it compares a single group under different conditions in an analysis. The charts to be reviewed include patients who had open intrabdominal surgeries with warmed intravenous fluid, and intraoperative warming device was used or a forced air-warming device alone was used. The data were collected from the anesthesia record in the patients’ medical chart.

Setting

The comparative retrospective chart review was conducted at a level II trauma center in the southeast region of the United States. The center has 512 beds and provides health care services to 19 counties regionally. The medical center offers a wide range of
services to multiple patient populations from neonate to geriatrics. In 2013, surgical services averaged 5,270 outpatient and 6,563 inpatient procedures (U.S. News and World Report, 2014).

Population

Population dynamics is an important aspect of a research design. The population for this retrospective analysis was unbiased on gender and ethnicity. The target group was adult male and female patients who underwent open abdominal surgery at the aforementioned surgical setting. Age is another very important aspect of the population of interest for this capstone project. Thermoregulation of the body changes as one age (Kurz, 2008). Patients 18 to 65 years of age who underwent open abdominal surgery were used for the purpose of this analysis. The retrospective chart review will use the anesthesia record to assess intraoperative thermal care with a forced air warming device alone or the addition of a warmed IVF via a fluid warmer.

Sampling

The capstone project included a sample consisting of 60 subjects who underwent general anesthesia for non-emergent open abdominal surgery for at least 2 hours. The subjects were divided into groups based on intervention received. Group A subjects received intraoperative thermal care with a forced air warming device alone. Group B includes subjects who received intraoperative thermal care with a forced air warming device and warmed IVF via a fluid warmer.

A purposeful and random sampling of charts was used. Data were collected from the archived charts of subjects who met the established inclusion criteria and underwent
open abdominal surgery from January 1, 2013 to December 31, 2014. A statistical power analysis was done to establish the appropriate sample size for the study.

The inclusion criteria for the purposes of this capstone included patients from 18 to 65 years of age; male and female gender, and underwent emergent or non-emergent open abdominal surgery. The exclusion criteria included patients with surgery less than 1 hour, a preoperative temperature less than 95°F or greater than 99°F, and history of any thermoregulation disease, including spinal cord injuries, thyroid disease and malignant hyperthermia.

Barriers

Barriers to change are often the result of gaps in knowledge regarding the certain phenomenon of interest. Diverse perceptions of clinical practice change are a common barrier for many healthcare professionals (Bostrom, Kajermo, Nordstrom, & Wallin, 2008). However, by reducing barriers associated with the understanding of the effects of IPH, education regarding prevention therapies throughout perioperative phases will need to be reinforced. Thorough assessment of gaps in knowledge provides opportunity for implementation of quality improvement initiatives in the clinical setting as well as improved patient safety and decreased cost in healthcare.

Target Outcomes

Identification of outcomes is a crucial step in initiating effective quality improvement in patient care and producing evidenced based practice changes in the clinical setting (Polit & Beck, 2008). The desired outcome for this capstone project was to determine if the use of an intraoperative forced air-warming device alone or with the addition of warmed IVF is effective for the prevention of IPH in patients who underwent
open abdominal surgery. An effective procedure and policy change through evidenced-based guidelines was another intended outcome for this capstone project. After analyzing data collected in the retrospective cohort chart review, a white paper policy was presented to the organization to improve patient safety and reduce adverse complications related to hypothermia.

Research Strategies

To explore the clinical question for this capstone project: Does the use of an intraoperative forced air-warming device alone or with the addition of warmed IVFs prevent postoperative hypothermia in patients undergoing abdominal surgery; a retrospective cohort chart review was completed. A retrospective cohort study gathers outcome information retrospectively with the use of chart reviews and/or administrative data sets (Polit & Beck, 2008).

According to Terry (2012b), the “ethical investigator” is responsible for confidentiality of all pertinent patient data (p. 54). In an effort to maintain confidentiality of any identifiable patient information, all data collected were de-identified and coded to analyze study evidence. All data were password protected in the electronic form and locked in a private file for access by the primary investigator only at all times.

Methods

After receiving approval from the university institutional review board (IRB) and the clinical facility, the principal investigator conducted a retrospective chart review upon receiving access to the electronic medical records (EMR). A query search was done from January 1, 2013 to December 31, 2014 to identify the appropriate sample of patients who underwent general anesthesia for open abdominal surgery and met the inclusion criteria
for both study groups. For the review, information was collected from the anesthesia record in the patients EMR. All information was de-identified for patient confidentiality at all times during the data collection process. The tool to be used for collecting information was a data collection tool adopted from the American Society of PeriAnesthesia Nurses (ASPAN) modified to reflect the acute care setting (Hooper et al., 2009). The variables to be collected will include the patients temperature throughout the perioperative phases (preoperative, intraoperative, postoperative), the ASA classification, the use of a forced air warming device with temperature while in use, the ambient room temperature, age, gender, body surface area, length of surgery as well as the fluid warmer temperature while in use.

Statistical Analysis

After all data were collected, a statistical analysis was performed. The data analysis compared the postoperative changes in body temperature (dependent variable) among group A and group B. Group A included subjects who received intraoperative thermal care with a forced air warming device alone and group B will include subjects who received intraoperative thermal care with a forced air warming device and warmed IVF via a fluid warming device. “The t-test for differences between groups” was used to compare the mean temperatures for each group (Terry, 2012a, p. 72). Using the aforementioned analysis will allow the investigator to determine if a difference between the thermal care methods exists. The chi square test (X^2) was used to evaluate the demographic variables between two groups such as male/female patients in each group.
Implications/Clinical Significance

The goal of this capstone was to determine the significance of unplanned perioperative hypothermia and its effects on morbidity and mortality related to this surgical complication. If the study determines statistical significance that the use of an intraoperative forced air warming device alone or the addition of warmed IVF in patients prevents postoperative hypothermia in patients undergoing open abdominal surgery, a practice change may very well be underway for medical center. According to Weirich (2008), IPH increases patient and facility healthcare cost, recovery time, wound healing, and a host of other postoperative complications for the surgical patient. A result of this capstone project could provide further implications for larger-scaled studies on the prevention of hypothermia and associated complications in the surgical patients.
CHAPTER IV
ANALYSIS OF DATA

The purpose of this capstone project was to examine and compare the differences between the postoperative normothermic core body temperatures of patients who underwent open abdominal surgery patients receiving intraoperative forced air warming only (Group A) and patients receiving forced air warming and warmed intravenous fluids intraoperatively (Group B). The variables measured include core body temperatures at different points throughout the perioperative period, length of surgery, ambient operating room temperature, age, gender, and body mass index (BMI).

In this chapter, the findings of the project study were presented. Data were collected by random sampling of 60 medical records of both men and women who received abdominal surgeries at a major hospital in Mississippi during the period between 2013-2014. The data were subsequently analyzed using SPSS 21. The results of these analyses are reported in the following sections: methods and materials, demographic comparison, and results.

Methods and Materials

The primary objective of this study was to determine if the use of the Bair Hugger forced-air warming device alone in intraoperative temperature management is just as effective as using the device in addition to warmed IVF to prevent postoperative hypothermia in patients undergoing abdominal surgery under general anesthesia. Secondary objectives include comparison of the core body temperatures pre and post anesthesia induction, comparison of temperature trends during surgery, comparison of the subjects' post anesthesia care unit temperature trends.
The design used for the capstone project was a retrospective comparative chart review. The charts reviewed included patients who had open intrabdominal surgeries with warmed intravenous fluid and intraoperative warming device, and patients using forced air-warming device only. A data collection/coding tool was developed to provide systematic recording of the information from the chart review (Appendix C).

The data were collected from the anesthesia record in the patient’s medical chart. The major criteria were: (a) patients undergoing elective open abdominal surgical procedures with an expected duration of 2 to 4 hours and requiring general anesthesia; (b) American Society of anesthesiologists (ASA) physical status I-III; and (c) patient age ranging from 18 years to 65 years. The abdominal procedure type varied widely among participant. Almost a third had exploratory laparotomies (n=18), while others had nephrectomies (n=8), hysterectomies (n=6), appendectomies (n=6), sigmoid colectomies (n=6), hernia repairs (n=7), and others (n=<10). For a complete listing of procedural types, see Appendix D.

Demographics Characteristics

Data were collected from 60 subjects who met the established surgical inclusion criteria from January 1, 2013 to December 31, 2014. The subjects were classified as ASA I, II, III, or IV (94%) and filed into two groups. Demographic results and physical characteristics of both groups were recorded (see Table 1).
Table 1

Summary of Demographic Statistics

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>60</td>
<td>48.417</td>
<td>13.0920</td>
<td>20.0</td>
<td>65.0</td>
</tr>
<tr>
<td>Gender</td>
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<td>1.583</td>
<td>.4972</td>
<td>1.0</td>
<td>2.0</td>
</tr>
<tr>
<td>BMI</td>
<td>60</td>
<td>30.313</td>
<td>7.9399</td>
<td>16.5</td>
<td>49.2</td>
</tr>
<tr>
<td>Height</td>
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<td>67.083</td>
<td>3.3053</td>
<td>60.0</td>
<td>74.0</td>
</tr>
<tr>
<td>Weight</td>
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<td>51.5137</td>
<td>99.0</td>
<td>297.0</td>
</tr>
<tr>
<td>ASA classification</td>
<td>60</td>
<td>2.62</td>
<td>.865</td>
<td>1</td>
<td>5</td>
</tr>
</tbody>
</table>

As shown in Table 1, the patients ranged in ages from 20 to 65 years. The mean age of all participants was 48.5. With regard to gender, of the 60 subjects, 25 were males, and 35 were females. The BSI for all participants ranged from 16.5 to 49.2 (m=30.3). The mean height of subjects was 67.08 inches (5 feet, seven) and weight was 194 pounds.

Demographic Characteristics of Groups

The chi square test ($X^2$) was used to evaluate the demographic variables between the two groups such as male/female patients in each group (See Table 2). The groups labeled as Group 1 and Group 2 included 30 patients. Group 1 (control group) was the group using the forced air-warming device only. Group 2 (experimental) used the forced air warming device plus the warmed IVF fluid (see Figure 1).
Figure 1. Gender differences between groups

As shown in Figure 1, Group 1 (control) was comprised of 5 males and 25 females, whereas Group 2 (experimental) had 10 males and 20 females. A summary of demographics characteristics for age, BMI, and gender for Group 1 and 2 are displayed in Table 2. Table 2 reports a summary of demographic characteristics, which includes the variables of age, BMI, and gender of each group. The subjects of Group 1 (mean age 40.66) were slightly younger than subjects of Group 2 (mean age 50.16), although not significantly different ($p = .320$) as reported in the Chi-Square test output data. With regard to sex, there was a significant difference ($p < .05$) between groups. The BMI was not significantly different ($p = .429$ or $>.05$) between groups. For Group 1, the mean BMI was 31.208. The mean BMI for Group 2 was 29.41.
### Table 2

**Summary of Group Demographics**

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>Std. Error</th>
<th>95% Confidence Interval for Mean</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Lower Bound</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Upper Bound</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>1</td>
<td>30</td>
<td>46.667</td>
<td>14.3799</td>
<td>41.297</td>
<td>20.0</td>
<td>65.0</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>30</td>
<td>50.167</td>
<td>11.6444</td>
<td>45.819</td>
<td>23.0</td>
<td>65.0</td>
</tr>
<tr>
<td>Total</td>
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<td>48.417</td>
<td>13.0920</td>
<td>1.6902</td>
<td>45.035</td>
<td>20.0</td>
<td>65.0</td>
</tr>
<tr>
<td>BMI</td>
<td>1</td>
<td>30</td>
<td>31.208</td>
<td>8.3021</td>
<td>28.108</td>
<td>18.3</td>
<td>49.2</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>30</td>
<td>29.418</td>
<td>7.5944</td>
<td>26.582</td>
<td>16.5</td>
<td>40.6</td>
</tr>
<tr>
<td>Total</td>
<td>60</td>
<td>30.313</td>
<td>7.9399</td>
<td>1.0250</td>
<td>28.262</td>
<td>16.5</td>
<td>49.2</td>
</tr>
<tr>
<td>Sex</td>
<td>1</td>
<td>30</td>
<td>1.833</td>
<td>.3790</td>
<td>1.692</td>
<td>1.0</td>
<td>2.0</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>30</td>
<td>1.333</td>
<td>.4795</td>
<td>1.154</td>
<td>1.0</td>
<td>2.0</td>
</tr>
<tr>
<td>Total</td>
<td>60</td>
<td>1.583</td>
<td>.4972</td>
<td>.0642</td>
<td>1.455</td>
<td>1.0</td>
<td>2.0</td>
</tr>
</tbody>
</table>

The data collected for comparison between groups included the patients temperature throughout the perioperative phases (preoperative, intraoperative, postoperative), the use of a forced air warming device with temperature while in use, the ambient room temperature, length of surgery, as well as the fluid warmer temperature while in use. The result of the data analysis for temperature assessment is displayed in Table 3 that follows.
Table 3

Results of T-Test

<table>
<thead>
<tr>
<th></th>
<th>Group</th>
<th>N</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>Std. Error Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preop temp (C)</td>
<td>1</td>
<td>30</td>
<td>36.67</td>
<td>.530</td>
<td>.097</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>30</td>
<td>36.64</td>
<td>.503</td>
<td>.092</td>
</tr>
<tr>
<td>Intraop beginning temp (C)</td>
<td>1</td>
<td>30</td>
<td>35.96</td>
<td>.490</td>
<td>.090</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>30</td>
<td>36.32</td>
<td>.581</td>
<td>.106</td>
</tr>
<tr>
<td>Intraop ending temp (C)</td>
<td>1</td>
<td>30</td>
<td>36.000</td>
<td>.5458</td>
<td>.0997</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>30</td>
<td>36.347</td>
<td>.6485</td>
<td>.1184</td>
</tr>
<tr>
<td>Postop temp (F)</td>
<td>1</td>
<td>30</td>
<td>97.70</td>
<td>.842</td>
<td>.154</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>30</td>
<td>98.08</td>
<td>.760</td>
<td>.139</td>
</tr>
<tr>
<td>Postop temp (C)</td>
<td>1</td>
<td>30</td>
<td>36.477</td>
<td>.4590</td>
<td>.0838</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>30</td>
<td>36.709</td>
<td>.4223</td>
<td>.0771</td>
</tr>
</tbody>
</table>

Note: Group 1=1    Group 2=2    C=Celsius    F= Fahrenheit

Table 3 displays the temperatures recorded from the medical records for both groups. It is important to note, all preoperative and postoperative temperatures were taken with a temporal thermometer. All intraoperative temperatures were taken via nasopharyngeal. Warmed IVFs were given with a Hotline device. The preoperative temperatures for both groups were nearly the same. The mean Celsius temperature was 36.67 and 36.64 respectively, indicating no significant difference ($p > .05$). The intraoperative temperature was not significantly different ($p > .05$). The mean temperatures were 35.96 and 36.32 C. respectively for Group 1 and Group 2. The intraoperative ending temperature ending was not significantly different ($p > .05$). The Bair Hugger warming device was used with both groups in the management of the subjects’ temperatures; however in addition, Group 2 was administered warmed IVFs via
a Hotline device. The Bair Hugger device was applied with a standard temperature of 43 degrees Celsius, and the IVF was 41 Celsius. The postoperative temperatures for both groups are displayed in Table 4.

Table 4

<table>
<thead>
<tr>
<th>Postoperative Temperatures</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td>-----------------------------</td>
</tr>
<tr>
<td>Postop temp (F)</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Postop temp (C)</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

As shown in Table 4, the mean Fahrenheit temperatures for both groups were 97.70 and 98.08, respectively. The postoperative temperatures for both groups were not significantly different (p>.05).

Summary of Results

The clinical question of this study examined the difference of an intraoperative forced air-warming device compared with the forced air warming device plus IVFs in the management of postoperative hypothermia in patients undergoing open abdominal surgery. The independent T-Test and Chi-square tests were used to determine whether there was a significant differences between the postoperative temperatures measured in Celsius and Fahrenheit. The findings from the retrospective comparative chart review showed no significant differences between the pre, intra, and postoperative temperatures of the subjects from both groups. With regard to the age and BMI, the findings indicated
that no significant difference (p>.05) between groups. However, the results indicated that the gender of participants was significantly different within groups (p<.05).
CHAPTER V
SUMMARY

The primary purpose of this capstone project was to determine the effects of the use of an intraoperative forced air-warming device alone versus the use of warmed IVF additional to an intraoperative forced air-warming device on the avoidance of postoperative hypothermia in patients who underwent open abdominal surgery.

Temperature balance and prevention of adverse outcomes are vitally important components for all types of general surgery (Young & Watson, 2006). Hypothermia throughout the surgical experience can be a common occurrence in patients undergoing surgery for open abdominal procedures.

A review of the literature has shown that a core body temperature of 36°C or less has been associated with adverse outcomes postoperatively. Most of the deleterious consequences of unplanned intraoperative hypothermia are often manifested in the postoperative period for most surgical patients however complications are often amplified in patients who had open abdomens during for any length of time during a procedure. However, the findings of this capstone project did not show significance in one practice over the other on patient’s temperatures upon arrival to the PACU.

Discussion

Hypothermia (core temperature < 36°C) is common during general anesthesia, owing to factors such as: impaired thermoregulation, redistribution of heat from the core to the periphery, heat loss to a cold operating room, and infusion of unwarmed fluids (Wagner, Swanson, Raymond, & Smith, 2008). Subsequently, perioperative hypothermia may result in major medical consequences, which may include myocardial ischemia,
thermal discomfort, decreased drug metabolism, increased blood loss and transfusion requirements, adverse cardiac outcomes, and prolonged recovery (Wagner et al., 2008).

Because of the major adverse consequences of perioperative hypothermia, most operating rooms are beginning to actively warm patients undergoing major surgeries with convective warming using the Bair Hugger system.

Although the Bair Hugger system and warm IVFs when used alone have demonstrated success in ensuring normothermia, postoperatively (average temperature 36.4°C), no studies to date had compared the differences when used together. Hong-xia et al. (2010) compared infusion of IV fluid infused via a warming device versus IV fluids infused at room temperature during the intraoperative phase of abdominal surgery. The authors concluded that normothermia during abdominal surgery can be maintained with the use of warm fluids intraoperatively during abdominal surgery, which may prevent adverse outcomes due to hypothermia in this patient population.

The clinical question of this study examined and compared the difference between the postoperative temperatures of patients undergoing open abdominal surgery who used intraoperative forced air-warming devices (Bair Huggers) alone and patients using forced air warming device plus IVFs in the management of postoperative hypothermia surgery. Although there are differences in the heat transfer between the two warming systems, the researcher was unable to demonstrate any significant difference in temperature outcomes among patients warmed with the Bair Hugger system alone and with IVFs. The findings from the retrospective comparative chart review showed no differences between the pre, intra, and postoperative temperatures of the subjects from both groups.
Although postoperative temperatures were not significantly different in the two groups ($P = .05$), these findings indicate that patient-controlled, forced-air warming device (Bair Paw) when used alone can enhance perioperative body temperature and improve patient satisfaction. Anesthesia providers and the surgical team should ensure that effective patient warming methods are employed in all patients, particularly in patients with abdominal surgery.

Implications for Nursing Practice

This study has several implications for nursing practice, education, and research. The literature clearly indicated that during the intraoperative and postoperative phases of surgery, countless patients are exposed to the risk of inadvertent hypothermia and its harmful effects. With the availability of state-of-the-art technologic devices such as the patient-controlled forced-air warming gown, this risk could be reduced. Warming devices plus warm IV fluids should be part of the planned interventions by the surgery team as well as the anesthesia provider from the preoperative phase, maintained by anesthesia providers intraoperatively and through to the postoperative phase of care. Active patient warming should be undertaken, especially in patients whose thermoregulating mechanisms may be less effective such as patients undergoing open abdominal surgery. Using more efficient and effective warming methods are cost saving interventions not only for the avoidance of postoperative adverse outcomes but provides patient comfort as well.

Recommendations for Future Research

Further research and replication of this study may be better served with the use of a larger sample from a retrospective chart review involving specific open abdominal
procedures. The findings indicated that the gender of participants may have potential influence on the effect of the outcome. Future research is warranted with a direct focus on examining differences between male and female.

Prewarming is another potential area of future research for anesthesia practice. Patients who are undergoing anesthesia for open abdominal procedures such as abdominoplasty and or breast augmentation are at increased risk for hypothermia in the postoperative phase. In these particular types of procedures, an upper or lower body intraoperative warming device may not be a viable option for use during the surgery. In a study Andrzejowski, Hoyle, Eapan, and Turnbull (2008), reported that the use of prewarming gown controlled by the patient produced a 0.3°C decrease in the core body temperature intraoperatively leading to decreases in IPH for patients undergoing general or regional anesthesia. Moreover, finding effective and efficient methods to maintain normothermia in plastic surgery type procedures would be beneficial to decreasing the effects of IPH in this population.

Additionally, ongoing clinical education for the perioperative team regarding the consequences of IPH is essential to understanding the efficacy and need for intraoperative warming for surgical patients. Furthermore, evidenced-based protocols and guidelines need to be created for management of perioperative hypothermia.

Limitations

The following limitations should be considered while interpreting the capstone project:
1. The inability to find documented cases for anesthesia providers using only warmed IVF during the surgical procedure (Group C). Most providers used the forced air-warming device alone or with warmed IVF’s.

2. The study findings are difficult to generalize because it was a retrospective chart review on a small sample of charts (n = 60).

3. The reliability of core body temperature measurement can be questionable since different practitioners took the temperatures in three different perioperative phases with different monitoring devices.

4. The lack of standardization of temperature monitoring devices throughout the perioperative settings. In the preoperative phase, tympanic and oral thermometers were used and documented in Celsius.

5. Extraneous variables such as ambient room temperatures were not controlled in this study. However, controlling for environmental variables would have been challenging because thermostats throughout the perioperative phases are controlled and set by staff members.

Conclusion

The purpose of this capstone project was to examine and compare the differences between the use of an intraoperative forced air-warming device and a forced air warming device plus IVFs in the management of postoperative hypothermia, as measured by the postoperative temperatures of patients undergoing open abdominal surgery. The findings from the retrospective comparative chart review showed no significant differences between the pre, intra, and postoperative temperatures of the subjects from both groups. Since nurses and nurse anesthesia providers are likely to be assessing patients for
perioperative hypothermia, implementing some type of warming method, and addressing postoperative hypothermia, it is essential for nurses to become knowledgeable of the management of postoperative hypothermia.
**APPENDIX A**

**LOGIC MODEL**

*Charlie Adderley, Summer 2014*

**PICO:** Does the use of an intraoperative warming device alone, prevent post operative hypothermia in patients undergoing open abdominal surgery.

Independent variable – intraoperative warming
Dependent variable – pt. temperatures, length of surgery, gender, forced air warmers, fluid warmers, environmental factors.
Outcome – normothermia intraoperatively and postoperatively.

<table>
<thead>
<tr>
<th>Inputs</th>
<th>Activities</th>
<th>Outputs</th>
<th>Participation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Staff involved in taking temperature at each perioperative phase</td>
<td>1. Assessing preoperative, intraoperative and postoperative temperatures</td>
<td>1. Participants (patients)</td>
<td></td>
</tr>
<tr>
<td>2. Research based</td>
<td>2. Calibration of all thermometers by biomed staff</td>
<td>2. Nursing staff and anesthesia providers</td>
<td></td>
</tr>
<tr>
<td>3. Technology</td>
<td>3. In-service staff and anesthesia provider on questionnaire to be completed</td>
<td>3. Decision makers</td>
<td></td>
</tr>
<tr>
<td>4. Time to gather data</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| | | Outcomes – Impact |
| | | Short | Medium | Long |
| 1. Awareness of hypothermia risk | 1. Practice changes | 1. Economic changes related to reduction of hospital/PACU stay |
| 2. Attitudes regarding using warming devices | 2. Policy and procedure changes | 2. Improved patient surgical outcomes |
| 3. Knowledge regarding effects of hypothermia | | |

**Assumptions**
Hypothermia causes decreased wound healing, increased postoperative recovery for patients as well as increased cost.

**External Factors**

Rev. 7/09
APPENDIX B

SWOT ANALYSIS

- **Strengths:** Current clinical practices for the use of intraoperative warming devices to prevent the complications associated with postoperative hypothermia.
- **Weaknesses:** Many clinical facilities use various practices to warm patients such as warm blankets and gowns, however there is no standardized policy for what and when to initiate hypothermia protocols for various surgeries.
- **Opportunities:** The potential site for my retrospective chart review for patients having open abdominal surgery alone or with the additional use of fluid warmers fluids. However, they don't have a policy or procedural tool to show their outcomes or that this plan of care follows EBP for the prevention of hypothermia in this patient population.
- **Threats:** Denial of IRB approval at Forrest General Hospital to complete a retrospective chart review to complete my study.
APPENDIX C
DATA COLLECTION TOOL

<table>
<thead>
<tr>
<th>Identification #</th>
<th>Procedure Date</th>
<th>Type of Procedure</th>
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<tbody>
<tr>
<td></td>
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</tbody>
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<table>
<thead>
<tr>
<th>Age [_____]</th>
<th>Sex [M/F]</th>
<th>Ht [_____]</th>
<th>Wt [_____]</th>
<th>BMI [____]</th>
</tr>
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<table>
<thead>
<tr>
<th>Previous Surgeries</th>
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</table>

<table>
<thead>
<tr>
<th>ASA [_____]</th>
<th>Mallampati Class [____]</th>
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<table>
<thead>
<tr>
<th>Anes Start</th>
<th>Anes End</th>
<th>Total Anes</th>
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<table>
<thead>
<tr>
<th>Surgery Start</th>
<th>Surgery End</th>
<th>Total Surgery</th>
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Preoperative Vital Signs:

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<thead>
<tr>
<th>Temperature (Celsius and Route)</th>
<th>HR</th>
<th>RR</th>
<th>BP</th>
<th>SpO2</th>
</tr>
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<tbody>
<tr>
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Intraoperative Vital Signs:

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<th>SpO2</th>
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</thead>
<tbody>
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<table>
<thead>
<tr>
<th>Was Bair Hugger used? [Y/N]</th>
<th>If yes, temperature</th>
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<table>
<thead>
<tr>
<th>Was IVF warmer used? [Y/N]</th>
<th>If yes, temperature</th>
</tr>
</thead>
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Postoperative Vital Signs:

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<th>SpO2</th>
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<table>
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<tr>
<th>PACU time in:</th>
<th>PACU time out:</th>
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<table>
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<tr>
<th>IVF type:</th>
<th>Total IVF:</th>
<th>EBL:</th>
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<tr>
<td></td>
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<td>mL</td>
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## APPENDIX D

### DNP ESSENTIALS

<table>
<thead>
<tr>
<th>Essential</th>
<th>DNP Capstone</th>
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</thead>
<tbody>
<tr>
<td>I. Scientific underpinning for practice</td>
<td>Utilization of Roy’s Adaptation Theory for nursing encompasses the stages of the nursing process to initiate interventions for the prevention of postoperative hypothermia in patients undergoing anesthesia.</td>
</tr>
<tr>
<td>II. Organization and systems leadership for quality improvement and systems thinking</td>
<td>Implementation of this project used advanced process that will lead to patient safety and quality improvement initiatives in temperature management of the surgical patient in the perioperative clinical setting.</td>
</tr>
<tr>
<td>III. Clinical Scholarship and analytical methods for evidenced based practice</td>
<td>This project examined the current intraoperative warming interventions for patients who underwent open abdominal procedures. After an evaluation of the current guideline, a new standardized policy may be established for specific types of surgical procedures.</td>
</tr>
<tr>
<td>IV. Information systems or technology and patient care technology for the improvement and transformation of health care</td>
<td>Demonstrated the technical skills and conceptualized ability to develop, implement and evaluate the planning of data collection from electronic medical record databases. All personal data were de-identified to maintain ethical and legal protections during review of the anesthesia record for data collection purposes.</td>
</tr>
<tr>
<td>V. Healthcare policy for advocacy in healthcare</td>
<td>Analyzed current evidenced based health care policy related to prevention of perioperative hypothermia in patients who underwent open abdominal surgery. Educated other healthcare providers on health policy and patient outcomes related to effects of IPH.</td>
</tr>
<tr>
<td>Area</td>
<td>Description</td>
</tr>
<tr>
<td>----------------------------------------------------------------------</td>
<td>---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>VI. Interprofessional collaboration for improving patient and population health outcomes</td>
<td>Engaged in collaborative associations in the implementation of current practice guidelines. Demonstrated interprofessional and leadership activities to evaluate a need for change in health care delivery of surgical patients.</td>
</tr>
<tr>
<td>VII. Clinical prevention and population health for improving the nation’s health</td>
<td>Critically analyzed biostatistical and epidemiological data related to patient having open abdominal surgery and the use of intraoperative warming to prevent adverse outcomes in the postoperative period. Conceptually synthesized a specific population to implement and evaluate health care standards for postoperative normothermia in the acute care setting.</td>
</tr>
<tr>
<td>VIII. Advance nursing practice</td>
<td>Conducted a systematic retrospective chart review of the standard of care for intraoperative warming techniques for specific surgeries. Demonstrated advanced clinical evaluations and judgment of health systems as well as health care policy throughout perioperative phases for the prevention of adverse outcomes associated with postoperative hypothermia.</td>
</tr>
<tr>
<td>Task</td>
<td>Estimated Start</td>
</tr>
<tr>
<td>-----------------------------</td>
<td>-----------------</td>
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<td>November 30, 2014</td>
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<td>IRB paperwork</td>
<td>April, 2015</td>
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<tr>
<td>Gather data</td>
<td>April – May, 2015</td>
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<td>1st draft of capstone</td>
<td>June, 2015</td>
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## APPENDIX F

### PROCEDURAL TYPES

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<th>Valid Percent</th>
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<td>Bilateral BSO</td>
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<td>1.6</td>
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<td>4.7</td>
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<td>Exploratory Laparotomy w Hemicolecotomy</td>
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<td>1.6</td>
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<td>Exploratory Laparotomy w sigmoid colectomy</td>
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<td>1.6</td>
<td>1.6</td>
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<tr>
<td>Exploratory Laparotomy w Sm bowel resection</td>
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<td>4.7</td>
<td>4.7</td>
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<td>L Colon resection</td>
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<tr>
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<td>Open Nephrectomy</td>
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</tr>
<tr>
<td>Procedure</td>
<td>Frequency</td>
<td>%</td>
<td>Valid Percent</td>
</tr>
<tr>
<td>------------------------------------------------</td>
<td>-----------</td>
<td>-----</td>
<td>---------------</td>
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<td>Partial Colectomy w sigmoid anastomosis</td>
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<tr>
<td>R Open Nephrectomy</td>
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<tr>
<td>R Radical Nephrectomy</td>
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<td>Sigmoid Colectomy and appendectomy</td>
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<td>1.6</td>
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<td>Total Abdominal Hysterectomy</td>
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<td>3.1</td>
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<td>Transverse Colectomy</td>
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<td>Total Colectomy</td>
<td>64</td>
<td>100.0</td>
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</tbody>
</table>
APPENDIX G

IRB APPROVAL LETTER FROM MEDICAL FACILITY

DATE: July 22, 2015
TO: Charlie Adderley, BSN
FROM: Forrest General Hospital Institutional Review Board
STUDY TITLE: [772630-1] THE USE OF AN INTRAOPERATIVE FORCED AIR WARMING DEVICE ALONE VERSUS WARMED INTRAVENOUS FLUID INFUSION AND FORCED AIR WARMING VERSUS WARMED INTRAVENOUS FLUID ALONE IN PATIENTS UNDERGOING OPEN INTRABDOMINAL SURGERY
SUBMISSION TYPE: New Project
ACTION: DETERMINATION OF EXEMPT STATUS
DECISION DATE: July 22, 2015
REVIEW CATEGORY: Exemption category # B4

Thank you for your submission of New Project materials for this research study. Forrest General Hospital Institutional Review Board has determined this project is EXEMPT FROM IRB REVIEW according to federal regulations.

We will post a copy of this correspondence on file in our office.

If you have any questions, please contact Michele Stanley at 601-288-4324 or mstanley@forrestdental.com. Please include your study title and reference number in all correspondence with this office.
APPENDIX H

LETTER OF SUPPORT FROM MEDICAL FACILITY

Forrest General Hospital
Forrest Health

June 12, 2015

University of Southern Mississippi
Office of Research Integrity, Institutional Review Board
118 College Drive #5147
Hattiesburg, MS 39406-0001

RE: Charlie Adderley’s Capstone Project

To Whom It May Concern:

This is a letter of support for Charlie Adderley to complete her required Doctorate of
Nurse Practice capstone project titled “THE USE OF AN INTRAOPERATIVE FORCE
AIR WARMING DEVICE ALONE VERSUS WARMED INTRAVENOUS FLUID INFUSION
AND FORCED AIR WARMING VERSUS WARMED INTRAVENOUS FLUID ALONE IN
PATIENTS UNDERGOING OPEN INTRABDOMINAL SURGERY” at Forrest General
Hospital. I give her permission to examine charts during July to September 2015,
for patients who underwent open abdominal surgery from January 1, 2013 to
December 31, 2014. I understand that the inclusion criterion also specifies the
patients to be between the ages of 18 to 65.

Ms. Adderley will gather the following information on each record:
- Procedure type and date
- Age and Gender
- Height, Weight, and Body mass index
- Current medication history
- Personal medical history
- Previous surgeries and any anesthetic complications
- ASA classification
- Mallampati classification
- Preoperative temperature
- Intraoperative temperature/vital signs
- Postoperative temperature/vital signs
- Anesthesia start and end time, Surgery start and end time, and Time in the
  PACU
- Intraoperative vital signs and any intraoperative adverse events
- Type and amount of IV fluids administered, and Estimated blood loss
- Type of forced air warming device and temperature setting
- Type of IV fluid warmer used and temperature setting
- If extubation was awake, deep, or not available
- If the patient is discharged home or transferred to an inpatient floor

P.O. Box 16389 • Hattiesburg, MS 39404-6389
6051 Highway 49 • Hattiesburg, MS 39401-7263
(800) 264-7000 • forrestgeneral.com
• Any abnormal finding in the perioperative period

I am aware that the patient information gathered will be de-identified and kept confidential using a password-protected computer and a locked box for the data collection forms. I also understand that this data will be used for her Doctor of Nursing Practice capstone project, white paper proposals, and future publications and presentations.

Sincerely,

Joe Campbell,
Chairman of Anesthesiology and Chief Medical Officer
APPENDIX I

IRB APPROVAL LETTER FROM USM

THE UNIVERSITY OF
SOUTHERN MISSISSIPPI

INSTITUTIONAL REVIEW BOARD
118 College Drive #3147 | Hattiesburg, MS 39406-0001
Phone: 601.266.5997 | Fax: 601.266.4377 | www.usm.edu/research/institutional.review.board

NOTICE OF COMMITTEE ACTION

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

- The risks to subjects are minimized.
- The risks to subjects are 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 regarding risks to subjects must be reported immediately, but not later than 10 days following the event. This should be reported to the IRB Office via the “Adverse Effect Report Form”.
- If approved, the maximum period of approval is limited to twelve months.
- Projects that exceed this period must submit an application for renewal or continuation.

PROTOCOL NUMBER: 15072004
PROJECT TITLE: The Use of an Intraoperative Forced Air Warming Device Alone Versus Warmed Intravenous Fluid Infusion and Forced Air Warming Versus Warmed Intravenous Fluid Alone in Patients Undergoing Open Intrabdominal Surgery
PROJECT TYPE: New Project
RESEARCHER(S): Charlie Addery
COLLEGE/DIVISION: College of Nursing
DEPARTMENT: Nursing
FUNDING AGENCY/SPONSOR: N/A
IRB COMMITTEE ACTION: Exempt Review Approval
PERIOD OF APPROVAL: 07/27/2015 to 07/26/2016
Lawrence A. Hosman, Ph.D.
Institutional Review Board
REFERENCES


http://dx.doi.org/10.1213/01.ANE.0000062770.73862.B7


http://dx.doi.org/10.1016/j.jopan.2011.10.005


Janicki, P. K., Stoica, C., Chapman, W. C., Wright, J. K., Walker, G., Pai, R., ...


http://dx.doi.org/10.1197/j.aem.2003.03.002

http://dx.doi.org/10.1016/j.asj.2006.08.009