TESTING PROPOSED NATIONAL GUIDELINES FOR PERIOPERATIVE NORMOTHERMIA

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DISCLAIMER STATEMENT

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ABSTRACT

Unintentional perioperative hypothermia is an unwanted but common occurrence during anesthesia. A national multidisciplinary panel developed the National Perioperative Thermoregulation Guidelines (NPTG) directed at maintaining patient normothermia perioperatively by identifying pre-operative risk factors, and instituting active warming measures early. The purpose of the study was to pilot test the proposed guidelines to identify barriers to implementation, and suggestions for improvement. Data were collected by perioperative health care providers in the ambulatory surgery unit (ASU), operating rooms (OR), and post-anesthesia care unit (PACU) for all scheduled surgeries over a period of two weeks. The sample consisted of 98%(n=115) of patients undergoing surgery. The ASU reported on 55 patients (48%), the OR 92 patients (80%), and the PACU 90 patients(78%). Twenty-four percent (n=13) of preoperative patients were found to be hypothermic in the ASU before surgery. Seventy-one percent of patients did not have a temperature recorded postoperatively in the ASU prior discharge, and of those recorded 29%(n=16), one-half were discharged from ASU hypothermic. Thirty-three percent (n=30) of patients arrived in the PACU hypothermic from the OR, and 50%(n=15) of these patients were discharged from the PACU hypothermic. ASU, OR, and PACU staff reported that the NPTG were not difficult to follow, yet apparently NPTG were not implemented or followed. No barriers to implementation were identified by ASU or PACU staff. OR staff identified four barriers to implementation, and one suggestion for improvement to NPTG.

Key Words: Hypothermia, normothermia, perioperative, thermoregulation, active warming.

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CHAPTER I: INTRODUCTION

Background

In this chapter the background, conceptual framework, and purpose of this study are presented. Roy s Adaptation Model (1984) is explained, and variables of interest are defined conceptually, and operationally. Finally, assumptions and limitations of this study are presented.

Hypothermia tends to develop in a characteristic pattern during surgery primarily due to anesthetic-induced alteration of thermoregulatory responses, and exposure to cold operating rooms (Sessler, 1997). During the first hour after the start of anesthesia, core temperature typically decreases by approximately one degree Celsius primarily due to redistribution of body heat. During the next 2-3 hours, temperature may continue to decline gradually mainly due to decreases in heat production. After 3-4 hours, core temperatures usually stabilize, and no longer decrease, typically due to re-emergence of vasoconstriction compensatory mechanism (Kurz, Goll, Marker, & Greher, 1998; Sessler, 1993).

Mild perioperative hypothermia may contribute to complications such as altered drug metabolism, post-operative discomfort, increased incidence of wound infections, increased perioperative bleeding, increased incidence of myocardial events, increased adrenergic activation, and may increase length of hospitalization (Frank et al.,1997; Sessler, 1997). The cost of preventing hypothermia perioperatively may be less than the cost of treating hypothermia induced adverse outcomes (Mahoney & Odom, 1999). Recently, the Consensus Conference on Perioperative Thermoregulation, 1998, a national multidisciplinary panel developed clinical guidelines directed at maintaining patient normothermia perioperatively (see Appendix A). These guidelines were developed to assist in prevention of hypothermia by: (a) identifying pre-operative risk factors and, (b) early institution of active warming measures to maintain normothermia. The desired outcome is to maintain patient normothermia throughout the perioperative period. Warming patients prior to the onset of hypothermia may be the best defense against inadvertent perioperative hypothermia and maintenance of perioperative normothermia (Sessler, Schroeder, Merrifield, Matsukawa & Cheng, 1995).

Purpose of Study

The purpose of this study was to pilot test the proposed National Perioperative Thermoregulation Guidelines (NPTG) to determine barriers to implementation, and suggestions for improvement identified by perioperative health care providers.

Research Questions

1. What barriers for implementing proposed perioperative thermoregulation guidelines did perioperative health care providers identify?

2. What suggestions for improvement to proposed perioperative thermoregulation guidelines did perioperative health care providers identify?

Theoretical Framework

Hypothermia is a serious concern in the perioperative period. Sister Callista Roy s Adaptation Model (Roy, 1984) is useful for explaining hypothermia in patients undergoing surgery. Roy views adaptation in a systems framework that includes input, process, and outcome variables. The patient is viewed as a biopsychosocial being in constant interaction with a changing environment. In order to respond positively to environmental changes, patients must adapt.

External as well as internal input can act as stressors, which trigger use of coping behaviors to alleviate the stress. The coping behaviors produce either adaptive or ineffective responses depending on the person s method of coping. There are two types of control processes patients can utilize for coping: the regulator and the cognator (Roy, 1984). Patients primarily use the cognator to cope with psychosocial stimuli, and the regulator to cope with physiological stimuli. These control processes produce effects manifested by four adaptive modes; physiological, self-concept, role function, and interdependence. The physiological mode of adaptation best illustrates responses to hypothermia in patients undergoing surgery.

In Roy s framework (1984), the person, as an adaptive system, receives input from the environment. This input is sensed by control processes, in particular, the regulator, which through the use of effectors attempts to adapt to the input. Adaptation is achieved primarily by using physiological functions. If the individual is able to cope effectively, then the body temperature will remain normothermic. If the individual is unable to cope effectively, then hypothermia will ensue. A person, when exposed to a cold environment(input), responds by putting on a coat, turning on the heat, and/or shivering in order to maintain normal body temperature. This is graphically depicted in Figure 1.

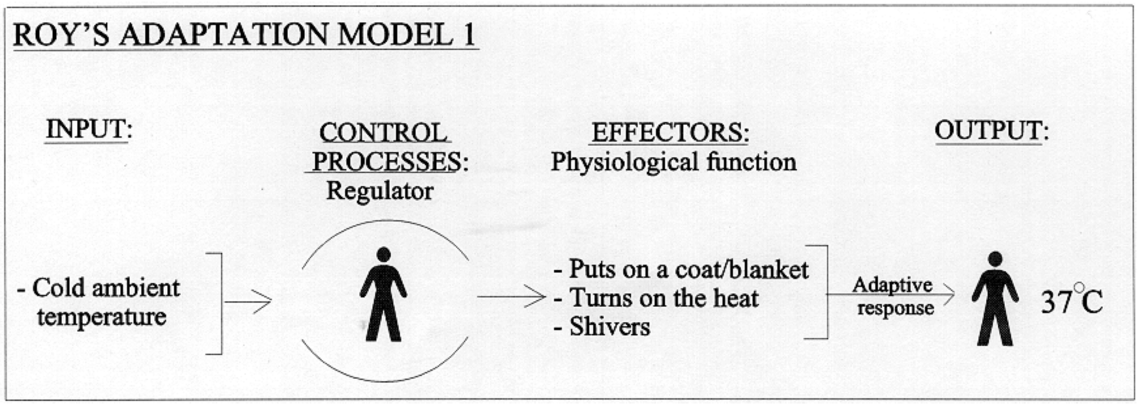

Figure 1.

Graphic depiction of Roy s Adaptation Model.

During the perioperative period, patients are exposed to cold environment and receive anesthetics which impair thermoregulatory responses. In addition, patients are unable to physically alter their environment to maintain normothermia because they are unable to increase room temperature or put on additional clothing. It is during this period that health care providers can manipulate the environment to assist patients in maintaining normothermia, since they can not do these things for themselves. This is graphically depicted in Figure 2.

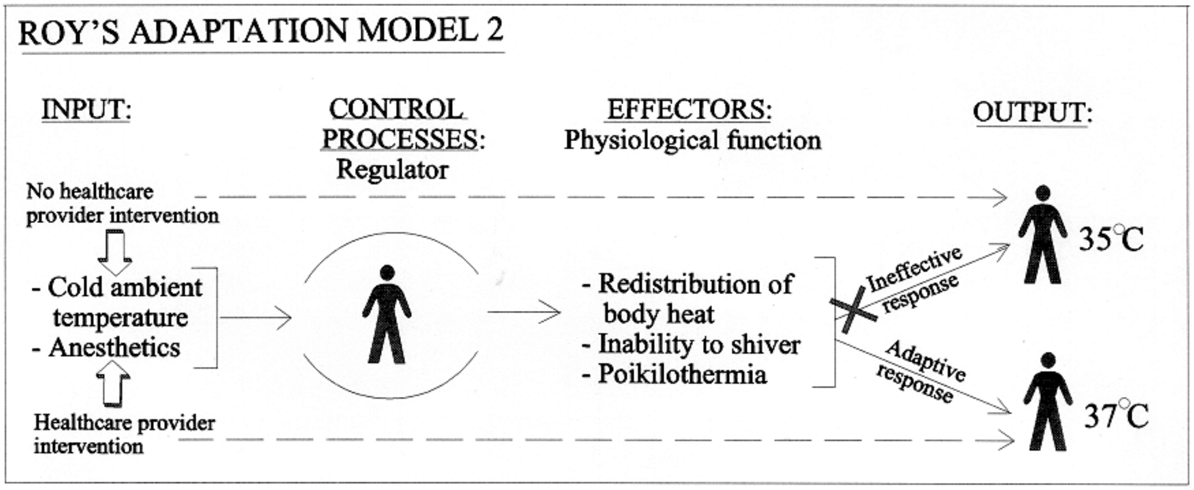

Figure 2.

Graphic depiction of Roy s Adaptation Model during anesthesia.

In this study, health care providers manipulation of the perioperative environment to prevent hypothermia was examined. Roy s theory represents a triad between the patient, the healthcare provider and the patient s desirable status (Barnum, 1998). Patients development of hypothermia is a likely response to exposure to the perioperative environment. Healthcare providers can assist patients by initiating warming measures in accordance to the proposed thermoregulation guidelines. The intentional manipulation of their environment aids patients to maintain homeostasis. The desirable outcome is normothermia, which is influenced by healthcare providers input.

Definitions: Conceptual and Operational

Conceptual definition of hypothermia. Stressors which disrupt individual s integrity leading to ineffective response.

Operational definition of hypothermia. Patients perioperative core temperature less than 36…C (96.8…F) and/or patients complain of being cold.

Conceptual definition of normothermia. Stressors which disrupt individual s integrity leading to adaptive response.

Operational definition of normothermia. Patients perioperative core temperature range between 36…C (96.8…F) and 38…C (100.4…F).

Conceptual definition of perioperative period. The environment, including input and effectors that contribute to an individual s response to stressors.

Operational definition of perioperative period. The time immediately before surgical procedure (from admittance to ambulatory care unit to time prior to induction), intraoperative time (during surgical procedure), and post-operative period in the Post-Anesthesia Care Unit(PACU) and in Ambulatory Surgery Unit(ASU) before discharge.

Conceptual definition of implementation of perioperative thermoregulation guidelines. Changes in environmental input that affect the regulator.

Operational definition of implementation of perioperative thermoregulation guidelines. Changes in environmental input resulting from implementation of Proposed National Perioperative Thermoregulation Guidelines (see Appendix A) for two weeks at a medical center.

Conceptual definition of perioperative health care providers. Health care providers who can influence input that can result in adaptive or ineffective thermoregulatory responses.

Operational definition of perioperative health care providers. Anesthesia providers, PACU personnel, and ASU personnel who have authority to alter environmental climate before, during, and immediately after surgical procedures.

Operational definition of barriers to implementation. Factors that interfere with the implementation of perioperative thermoregulation guidelines recorded on data collection sheet by perioperative health care providers.

Operational definition of suggestions for improvement. Ideas, input or commments for improvement of perioperative thermoregulation guidelines as recorded on data collection sheet by the perioperative health care providers.

Assumptions

1. Perioperative health care providers desire to maintain normothermia in patients during the perioperative period.
2. Patients desire to maintain normothermia during the perioperative period.
3. Temperatures taken are accurate.

Limitations

This was a descriptive pilot study of the perioperative environment and personnel in one hospital. Freestanding ambulatory surgery centers were not included, which limits the generalizability of findings.

Summary

Hypothermia is a major contributor to adverse perioperative outcomes. Proposed national guidelines for perioperative thermoregulation have been developed to assist patients in maintaining perioperative normothermia. In this study, the implementation of the guidelines were pilot tested before final approval and national distribution.

CHAPTER II: REVIEW OF LITERATURE

Introduction

In this chapter the mechanism of heat loss during anesthesia were presented. This is explained by a discussion of complications, risk factors, and measures used to prevent perioperative hypothermia. Finally, cost factors associated with perioperative hypothermia were presented.

Humans must maintain a constant body temperature for optimal functioning. The hypothalamus, the primary thermoregulatory control center in humans, maintains a temperature setpoint and adjusts body responses to all input to maintain core temperature within 0.2…C of setpoint. Perioperative hypothermia is a common occurrence due to disturbances in the thermoregulatory center caused by anesthesia, and exposure to a cold environment. Behavior prompted by thermal discomfort is the most effective thermoregulatory response (Sessler, 1997). For example, when ambient temperature is cold we can dress warmly or adjust ambient temperature. However, anesthesia takes away patients ability to respond to hypothermia.

Under normal circumstances, human temperature control is maintained within a very narrow range by balancing heat production with heat loss. The hypothalamus regulates body temperature by comparing thermal input from skin surface, neuraxis, and deep tissues with the threshold or setpoint for heat and cold temperatures. Threshold temperature is the temperature which the hypothalamus strives to maintain (Bowen, 1997). The thermal sensitivity of humans is the range between the highest temperature at which cold responses, such as sweating, are triggered, and the lowest temperature at which warm responses are triggered, such as shivering. This interthreshold range, over which no regulatory responses occur, is approximately 0.2°C in normal, awake humans. The interthreshold range widens to about 3.5°C during anesthesia (Bissonnette & Nebbia, 1994). Although the brain continues to sense temperature changes, compensatory mechanisms will not be triggered until the threshold is surpassed (see graphic depiction in Figure 3).

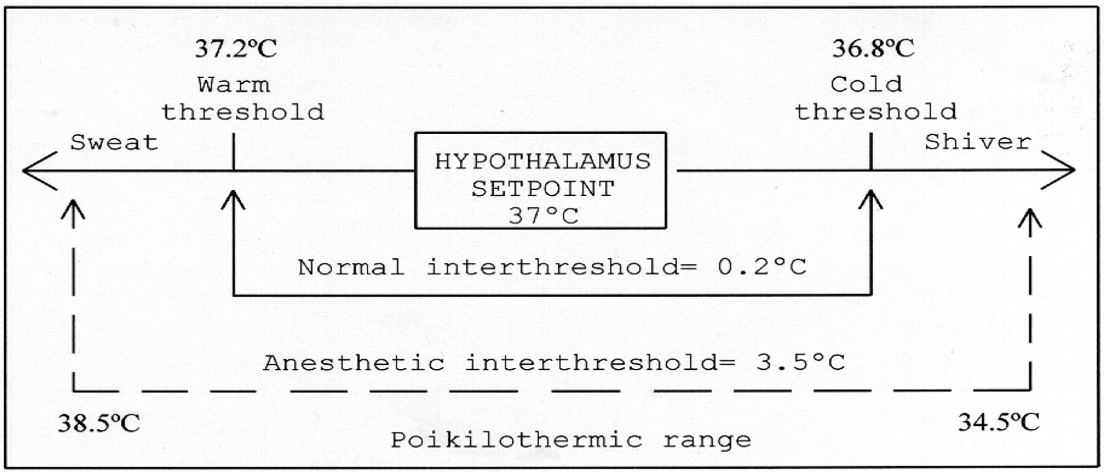

Figure 3 — Representation of thermoregulation with and without anesthesia.

Anesthetics widen the temperature interthreshold range, and do not initiate thermoregulatory responses to hypothermia until temperature drops by approximately 2.5°C (Bissonnette & Nebbia, 1994). Within this widened interthreshold range, there is a broad temperature range over which thermoregulatory responses are absent. As a result, patients are poikilothermic, which means they passively change their body temperature in proportion to the difference between heat loss and heat production.

The body can maintain a stable temperature upon exposure to a cold environment by reducing heat loss or producing more heat. Reduction of heat loss is primarily by behavioral modification, such as adding more clothing or increasing thermal ambient temperature. This response requires individuals to be conscious. Heat production consists of shivering, and nonshivering thermogenesis. Shivering thermogenesis is involuntary skeletal muscle activity that may increase heat production by 500%, and occurs when body temperature decreases below threshold level (Bowen, 1997).

Nonshivering thermogenesis is accomplished by brown adipose tissue, and skeletal muscle activity. Brown adipose tissue is the primary thermogenic tissue in infants. Skeletal muscle is the primary thermogenic tissue in adults, and is capable of shivering, and nonshivering heat production (Bowen, 1997). Both shivering and nonshivering thermogenesis are under the influence of the sympathetic nervous system which releases catecholamines that stimulate beta-adrenergic receptors and initiate shivering (Bissonnette & Nebbia, 1994; Bowen, 1997).

After behavioral maneuvers fail to maintain body temperature upon exposure to cold environment, the first thermoregulatory response activated is cutaneous vasoconstriction. This response decreases blood flow to peripheral areas like hands, feet, ears, lips, and nose. Nonshivering thermogenesis occurs next, however, this is more prominent in infants. Shivering only occurs when maximal vasoconstriction, nonshivering thermogenesis, and behavioral maneuvers have failed to maintain body temperature. Initially, vigorous shivering may increase heat production four fold, and increases oxygen consumption by approximately 125% (Bissonnette & Nebbia, 1994; Frank et al., 1995).

The four sources of heat loss are conduction, radiation convection, and evaporation. All four types occur at some point during the perioperative period, and all four can be prevented or ameliorated to prevent perioperative hypothermia (Garcia & Gantt, 1994). Heat losses via conduction occur when there is heat transferred between two objects in direct contact with each other. Little heat is lost during surgery via conduction because patients are usually well insulated from surrounding objects. However, this form of heat loss could occur if patients are in direct contact with metallic surfaces, and some heat may be lost to cool bed (Bissonnette & Nebbia, 1994; Bowen, 1997).

Heat loss via radiation occurs via electromagnetic emission from one object to another without physical contact between them (Bowen, 1997). Patients will warm up walls, and solid objects in the operating room by exchanging radiant heat. Heat loss by radiation is greatly decreased by covering patients, even if by a thin sheet or shirt (Bissonnette & Nebbia, 1994).

Heat losses by convection occur when objects of different temperatures are in contact with each other via a vector, like air or fluid. Convection occurs when there is a draft in a room, like air flow exchanges, or wind shield factor outside (Bissonnette & Nebbia, 1994). Insufflation of cold gases may lead to heat loss during endoscopic surgery (Huntington & Le Master, 1997).

Heat loss by evaporation is insensible loss from the skin, respiratory tract, and from incisions. When water evaporates from a surface, energy is absorbed during the change from liquid to gas. This heat is the latent heat of vaporization (Bissonnette & Nebbia, 1994). Some evaporation heat loss occurs when patients are wet, in contact with wet drapes, during skin preparation for surgery, and delivery of non-humidified inhalation agents or gases (Bissonnette & Nebbia, 1994).

Thermoregulatory responses are impaired during use of general anesthesia, and neuroaxial anesthesia by removing patients ability to control body temperature by behavior, and by inhibiting vasoconstriction , and shivering responses (Bissonnette & Nebbia, 1994;

Sessler, 1997). Monitored awake anesthesia (MAC) may similarly affect thermoregulatory responses because intravenous anesthetics, like alfentanil and propofol, lower the thresholds for vasoconstriction and shivering (Kurz et al., 1995; Matsukawa, Kurz, et al., 1995).

The operating room environment seems to be a major contributor to perioperative hypothermia. At ambient temperatures of less than 21°C, almost all patients lose body heat. Between 21 and 24°C, approximately one third of adult patients lose body heat. In addition, anesthesia widens the interthreshold range to 3.5°C, which results in rapid heat loss during the first hour of anesthesia when patients are exposed to a cold environment. Net losses occurring in this phase include all four mechanisms of heat loss (Bowen, 1997).

Redistribution of heat within the body also occurs during the first hour, shifting heat from the core to the periphery primarily due to vasodilation (Bissonnette & Nebbia, 1994). After draping, surgical patients loose less body heat due to a balance between heat production and heat loss. However, heat losses are still greater than heat production, and body temperature continues to decrease slowly (Bowen, 1997). Body temperature stops decreasing once thermoregulatory vasoconstriction is triggered, usually around temperatures of 34.5°C (Bissonnette & Nebbia, 1994).

General anesthesia causes redistribution of body heat from the core to the periphery, which often results in a decrease in core body temperature of 1.6…C ± 0.3°C in the first hour of anesthesia. Redistribution contributed to 81% of the core temperature decrease during the first hour of general anesthesia. During the next two hours of anesthesia, the temperature decreased an additional 1.1 ± 0.3°C (Matsukawa, Sessler, Sessler, et al., 1995).

Redistribution is also largely responsible for heat loss during epidural anesthesia. Redistribution decreases core temperature by 0.8 $\pm$ 0.3°C, an 89% contribution, during the first hour of anesthesia (Matsukawa, Sessler, Christensen, Ozaki, & Schroeder, 1995). During the next two hours of anesthesia, the temperature decreased an additional 0.4 $\pm$ 0.3°C. Over a three hour period, redistribution accounts for a total of 65% of the heat loss in general anesthesia, with an overall drop in core temperature of 2.8 $\pm$ 0.5°C (Matsukawa, Sessler, Sessler et al., 1995). In epidural anesthesia, over a three hour period, redistribution accounts for a total of 80% of the heat loss with an overall 1.2 $\pm$ 0.3°C decrease in core temperature (Matsukawa, Sessler, Christensen et al., 1995). Although there is a greater percentage of heat loss due to redistribution with epidural anesthesia, only half as much decrease in core temperature is seen.

Epidural anesthesia spares the upper extremities from sympathectomy, thus patients maintain the ability to vasoconstrict the upper extremities, which prevents some heat loss. Further, during epidural anesthesia, blood redistributes to the lower extremities, as measured by an increase in the heat content in the lower extremities (Matsukawa, Sessler, Sessler et al., 1995; Matsukawa, Sessler, Christensen et al., 1995). Patients often feel warmer during epidural anesthesia while the core temperature actually decreases (Glosten, Sessler, Faure, Karl, & Thisted, 1992). These conflicting thermal senses during epidural anesthesia may lead to undetected hypothermia. Heat loss may not be as great with an epidural as with general anesthesia, but decreases in core temperature are seen with epidural anesthesia.

No single factor is responsible for causing perioperative hypothermia. However, the cumulative effect of all sources of heat loss, particularly during the first few hours of surgery, may lead to inadvertent perioperative hypothermia. Reduction of heat loss, and active warming measures during the immediate perioperative period may be one way to prevent perioperative hypothermia. Once hypothermia ensues, it may be difficult to treat because applying heat externally takes significant time to reach the core. Thus, some form of active warming may be necessary to prevent perioperative hypothermia (Sessler, 1997).

Complications of Hypothermia

Mild hypothermia has been associated with adverse outcomes, including cardiac events, coagulopathies, wound infections, and prolonged hospitalizations. Mild perioperative hypothermia may be easily prevented by careful preoperative assessment of risk factors and active warming. Unless hypothermia is specifically indicated for a surgical procedure, core temperature should be maintained above 36…C (Sessler, 1997).

The most serious complications in anesthesia are cardiac events and cerebral vascular accidents. Frank et al. (1993) first demonstrated an association between unintentional hypothermia and myocardial ischemia. One hundred patients undergoing lower extremity vascular surgery received continuous Holter monitoring for the first 24… postoperatively. Hypothermia was defined as a temperature ≤35…C and normothermia was defined as a temperature of >35…C. The two groups, hypothermic (n=33) and the normothermic (n=67) had similar preoperative risk factors for perioperative cardiac morbidity except for patients age (70 ± 2 years in the hypothermic group and 62 ± 1 year in the normothermic group).

Although the elderly are at higher risk for both hypothermia and cardiac events (Teppen & Andre, 1996), this study found that temperature remained an independent predictor of ischemia when subgroup and multivariate analysis was applied to adjust for differences in age. The incidence of postoperative angina was greater in the hypothermic group (18%) than in the normothermic group (1.5%, P=.002). Also, the incidence of PaO_2 <80mmHg was greater in the hypothermic group (52%) than in the normothermic group (30%, P=.03). Hypothermic patients may have a greater total body oxygen consumption or possibly increased pulmonary shunting during early postoperative period which may be a contributory factor to ischemia.

Further evidence of cardiac detriment due to hypothermia was demonstrated in a randomized clinical trial conducted by Frank et al. (1997), which concluded that maintenance of perioperative normothermia reduces the incidence of morbid cardiac events. Three hundred patients, over 60 years of age, who were scheduled for peripheral vascular, abdominal or thoracic surgery with planned admission to the intensive care unit (ICU), were studied. All had a confirmed history of coronary artery disease or were at high risk for coronary disease. Subjects were randomly assigned to hypothermic care (standard care, n=158) or normothermic care(standard care plus forced-air warming during surgery and two hours postoperatively, n=142).

The hypothermic group had a mean core temperature of 1.3…C lower than the normothermic group on admission to the ICU. The frequency of intraoperative ventricular tachycardia (VT) and myocardial ischemia was similar for the two groups. However, postoperatively, the hypothermic group had more ischemia and VT than the normothermic group (7.9% vs. 2.4%; P=.04). The results show that maintenance of perioperative normothermia decreases the incidence of early postoperative cardiac events in patients with increased coronary risk factors because unintentional hypothermia is associated with myocardial ischemia, angina, and decreased arterial oxygen pressure.

Even in surgeries where maintaining hypothermia was the standard of care, research has demonstrated that maintaining normothermia may be just as effective as hypothermia in preventing neurological sequelae after coronary bypass surgery. Singh, Bert, Feng, and Rotenberg (1995) retrospectively compared the outcomes of 2,585 patients who underwent myocardial revascularization using warm-body, cold-heart technique with 1,605 patients who underwent myocardial revascularization using hypothermic technique. The normothermic group included more elderly patients (over 70 years), more patients with left ventricular dysfunction, unstable angina, and more frequent use of internal mammary artery conduit. The neurologic complications, such as hemiparesis, visual or gait disturbance, alteration in memory, and alteration in cognitive function were 1% and 1.3%, not statistically significant, for the normothermic and hypothermic groups, respectively. The incidence of overt neurologic injuries was no higher with normothermic perfusion than hypothermic perfusion.

A call to maintain normothermia during elective abdominal aortic aneurysm (AAA) repair came after multiple adverse outcomes were attributed to perioperative hypothermia (Bush et al.,1995). A retrospective review of 262 elective AAA repairs found similar preoperative risk factors in the hypothermic (temperature <34.5…C) and the normothermic (temperature >34.5…C) groups except for higher risk of hypothermia in women ($P<.05$). Volumes of autotransfused blood, banked red blood cells, platelets, and fresh frozen plasma given during the first 24… of surgery were all significantly higher in the hypothermic group compared with the normothermic group. Additionally, intraoperative hypothermia was significantly predictive of both prolonged hospital stay and the development of organ failure ($P<.05$). The mortality rate was also significantly higher ($P<.01$) in the hypothermic group (12.1%), than in the normothermic group (1.5%). The most important observation in this study is that intraoperative hypothermia during elective AAA repair is associated with increased morbidity and mortality rates during the postoperative period, unrelated to other risk factors.

Maintenance of intraoperative normothermia was associated with a reduction in requirement of blood products in patients undergoing total hip arthroplasty (Schmied, Kurz, Sessler, Kozek, & Reiter, 1996). In this study the investigators tested the hypothesis that mild hypothermia increases blood loss, and transfusion requirements during hip surgery. Blood loss and transfusion requirements were evaluated in 60 patients randomly assigned to the normothermia group (final intraoperative temperature of 36.5…C) or the mild hypothermia group (final intraoperative temperature of 35…C). Final intraoperative core temperature was approximately 1.5…C warmer in the normothermia group than in the hypothermia group. At two hours postoperatively, the core temperature remained significantly lower in the hypothermia group. Blood loss was significantly greater in the hypothermia group at the end of surgery, and at 3, 12, and 24 hours after surgery due to hypothermia induced coagulopathy. Of the 30 hypothermic patients, seven required eight units of allogenic packed red blood cells, whereas of the 30 normothermic patients, only one required a unit of allogenic blood ($P<.05$ for volume infused). Bock et al. (1998), support these findings, reporting significantly lower blood loss intraoperatively, and less blood transfusions post-operatively in the normothermic group than the hypothermic group ($P \leq .05$).

In a study designed to test the hypothesis that hypothermia increases susceptibility to infection and lengthens hospitalization, 200 patients undergoing colonrectal surgery were randomly assigned to the hypothermia group (routine thermal care) or to the normothermia group (additional warming)(Kurz, Sessler, & Lenhardt, 1996). A double-blind protocol was followed to evaluate patients wounds until discharge, and at the clinic two weeks post discharge. Any positive culture from the wound discharge was accepted as infected. The results showed surgical-wound infections in 18 of 96 patients in the hypothermia group (19%), but only 6 out of 104 patients in the normothermia group (6%; P=.009). Sutures were removed one day later in the hypothermia group, and the duration of hospitalization in the hypothermia group was prolonged by 2.6 days (20%; P=.01).

Hypothermia may delay healing and predispose the patient to wound infections by reducing levels of oxygen in tissues, impairing oxidative killing by neutrophils, and decreasing wound healing by reducing deposition of collagen. Perioperative hypothermia of approximately 1°C suppressed mitogen-induced activation of lymphocytes, and reduced the production of certain cytokines (Beilin et al., 1998). Maintaining perioperative normothermia may reduce immune response alterations, and possibly improve patients outcome.

In an effort to identify reasons for increased cardiovascular morbidity associated with hypothermia, Frank et al. (1995) conducted a randomized prospective clinical trial to examine the relationship between body temperature, neuroendocrine response, and hemodynamic changes during the perioperative period. Seventy-four elderly patients undergoing abdominal, thoracic or lower extremity vascular procedures were randomly assigned to routine care (hypothermia group, n=37) or forced-air warming (normothermia group, n=37). Both groups were similar demographically. Mean temperature was lower in the routine care group on admission to the post-anesthesia care unit(PACU)(35.3 ± 0.1…C), compared to the forced-air warming group (36.7 ± 0.1…C; P=.0001), and remained lower during the early postoperative period. Peripheral vascular constriction, norepinephrine concentration, systolic, mean, and diastolic arterial blood pressures were all significantly higher in the routine care group.

Epinephrine levels were not significantly different between groups. However, within the group who did not received any warming, epinephrine concentration was greater than the preoperative baseline level on admission to PACU, at 60, and at 180 minutes postoperatively (P<.05). No significant changes in epinephrine levels were found within the forced-air warming group (P=.14). Cortisol levels in both groups were significantly increased in the early postoperative period compared to the preoperative baseline (P=.01), although differences between the groups were not significant (P=.51). Temperature management does not affect the adrenocortical response as indicated by no changes in cortisol levels between both groups. The adrenomedullary response is affected by hypothermia as demonstrated by changes in epinephrine levels within the control group, but not between groups.

Additional support for these findings was demonstrated by Frank et al. (1997) in a study of nine young male subjects (ages 18-26 years) in which core cooling was conducted in the absence of cutaneous cold exposure. Mild core temperature (35.2 ± 0.3°C) was induced by cold saline intravenous infusion (4…C, 30ml/Kg and 40ml/Kg), and warm saline intravenous infusion (37…C, 30ml/Kg) on three different days while maintaining external temperature with a forced-air warming device to prevent vasoconstriction. Mild core cooling (0.7-1.3…C) without external cooling is associated with a four to seven fold increase in respiration, oxygen consumption, and metabolic rate. In addition, increased arterial blood pressure, and vasoconstriction occur with no changes in heart rate. No increases in epinephrine or cortisol levels were found in any of the groups. Core hypothermia without peripheral cooling induces sympathetic activation without adrenomedullary or adrenocortical activation. This study was conducted on young healthy males; the elderly s adrenergic and metabolic responses to core hypothermia remain to be elucidated.

Hypothermia also alters drug pharmacokinetics and may prolong duration of postoperative recovery (Lenhardt et al., 1995; & Leslie, Sessler, Bjorksten, & Moayeri, 1995). Leslie et al. (1995) studied the effects of mild hypothermia on propofol pharmacokinetics, duration of action of atracurium, and hepatic blood flow in six healthy young volunteers. Subjects were demographically homogeneous. They were randomly assigned on two different days to core temperature group of 34…C or 37…C. Hepatic blood flow difference between groups was not significantly different. Mean propofol blood levels were 28% higher at 34…C than at 37…C core temperature (P=.05). Core hypothermia increased recovery time of first twitch in train-of-four after administration of atracurium by approximately 60% (P<.05), prolonging recovery time from 44 ± 4 minutes to 68 ± 7 minutes. It is possible that other anesthetic drugs may be affected by hypothermia. These factors can lead to prolonged stay in the PACU. According to Lenhardt et al. (1995), hypothermic patients required a longer period to meet discharge criteria even when normothermia is not included as a criterion (normothermia 38 ± 39, hypothermia 58 ± 57; P<.01). Maintaining normothermia during the perioperative period could decrease time spent in the PACU, and possibly decrease the cost of care.

Although patient discomfort is not life threatening, the sensation of being cold is very unpleasant. Most patients vividly remember being cold, and some report it as being the worst aspect of their surgical experience (Sessler, 1993). Kurz et al. (1996) measured thermal comfort using a visual-analog scale (0mm=intense cold, 50mm=thermal comfort, and 100mm=intense warmth) in the hypothermia and normothermia groups. Thermal comfort was found to be greater in the normothermia group than in the hypothermia group (73 $\pm$ 14 vs. 35 $\pm$ 17mm). This difference remained statiscally significant for up to 3 hours postoperatively. Patient comfort is extremely important, and in light of all the other potential dangers caused by hypothermia, normothermia should be the goal for every patient who presents for surgery regardless of age or risk factors.

Risk Factors

Any patient undergoing anesthesia is potentially at risk for developing hypothermia. However, some patients are at greater risk than others. The elderly have been identified to be at higher risk due to multiple factors, including use of antihypertensive medications, and decreased metabolic and vasomotor functions (Dennison, 1995). Even healthy older adults who function well under normal conditions are vulnerable under stress. They often do not have the physiological reserve to compensate, and are at greater risk for complications than younger patients (Tappen et al., 1996). The time required for older patients to rewarm to 36°C after hypothermia is significantly greater ($P = .0003$) than for younger patients (Frank et al., 1992). Infants are also at greater risk for hypothermia due to their large surface area to volume ratio when compared to adults (Buczkowski-Bickman, 1992). Other risk factors include complex surgeries lasting long periods of time due to prolonged exposure to cold environment, and certain surgical positioning which require greater body surface areas to be exposed to room temperature. Thinner patients are at higher risk for hypothermia due to less insulation (Denninson, 1995).

Healthy young patients may also suffer from the effects of hypothermia as reported by Garrett (1997). In this study, young, healthy females, with an average age of 37, were losing close to 0.85…C during gynecological surgical procedures lasting about 40 minutes.

Prevention

A common recommendation found in anesthesia literature is to maintain patient normothermia perioperatively (Bush et al., 1995; Denninson, 1997; Frank et al., 1993 & 1997; Garrett, 1997; Kurz et al., 1996; Lenhardt et al., 1995; Schmied et al., 1996; Sessler, 1997). Any patient admitted to the recovery room with a temperature of 36…C or less is considered to be hypothermic (Garcia & Gantt, 1994). Maintaining normothermia entails monitoring temperature intraoperatively. Temperature is frequently monitored during general anesthesia. One study reports that temperature is monitored only 33% of the time during regional anesthesia (Frank, Nguyen, Garcia, & Barnes, 1999). It is likely that hypothermia is greatly undetected, and therefore untreated in patients undergoing regional anesthesia. Ways to prevent perioperative hypothermia include: warm operating rooms, reflective blankets, radiant lights, warming blankets, airway humidification, fluid warmers, and forced-air convective heating.

The administration of unwarmed intravenous fluids can quickly decrease body temperature. Heating fluids to 37…C can help prevent hypothermia (Sessler, 1997). Actively warming intravenous fluids as opposed to allowing warm fluids to cool to room temperature during short procedures, did not cause differences in patients body temperatures (Ellis-Stoll, Anderson, Cantu, Englert, & Carlile, 1996). This study had several limitations, including small sample size, and lack of control for several confounding variables that may have affected results. Smith et al. (1998) did not corroborate these findings when evaluating efficacy of warmed intravenous fluids in thirty eight adult patients undergoing elective gynecological surgery. The patients were randomly assigned to the fluid warming group (42°C) or the control group (room temperature fluids at about 21°C). All patients received general anesthesia. Results were a core temperature lower in the control group (35.6 ± 0.1°C) than in the warm fluid group (36.2 ± 0.1°, $P < .05$). Also, more patients had a final core temperature of <35.5°C in the control group than in the warm fluid group (35% vs. 0%, $P < .05$).

A study comparing four intraoperative warming devices (Ouellette, 1993) found forced-air warming (Bair Hugger¤) to be more effective than reflective blankets, humidistat, or heated humidifier in maintaining body temperature. Heated warm blankets were also ineffective and short-lived when compared to active warming devices (Sessler & Schroeder, 1993). When forced-air warming was compared to circulating water mattresses in a group of infants, children, and adults, core temperatures were found to be 1.6…C higher in patients warmed with forced-air, $P < .01$ (Kurz et al., 1993). In a study testing the effects of hypothermia in elective AAA repair (Busch et al., 1995), intervention by the use of forced-air blankets decreased the incidence of hypothermia to 11% vs. 25% ($P < .05$), prior to the use of the forced-air blankets. In another study by Krenzischek, Frank, and Kelly (1995), forced-air warming resulted in higher core temperature both intraoperatively, and postoperatively.

Forced-air warming is the most effective method of warming and maintaining patient s body temperature intraoperatively. Passive warming measures may slow heat loss, but can not add heat to a cooling patient. Berti et al.(1997) found that active warming, not passive heat retention, maintains normothermia better during surgery. In a randomized, controlled study, 30 patients, ASA classification I and II, who were scheduled for hip or knee arthroplasty using combined epidural-general anesthesia were assigned to three different groups. The control group (n=10) received low-flow anesthesia only, the blanket group (n=10) received low-flow anesthesia and reflective blanket, and the forced-air group (n=10) received low-flow anesthesia and active forced-air warming. There were no significant differences between the three groups. Temperatures were measured on arrival to the operating room (OR), at 30, 60, 90, 120 minutes, and at the end of surgical procedure. No significant differences in temperature were observed on arrival to OR.

After induction of anesthesia with epidural and general anesthesia, a significant decrease in temperature was seen in all three groups during the first 30 minutes. Temperature decreased 0.9°C in control group, 0.7°C in blanket group, and 0.8°C in forced-air group ($P < .01$). The temperature in the control and the blanket group continued to decrease to 2.0°C and 1.6°C, respectively, by the end of surgery ($P = .004$). In contrast, the forced-air group, after the initial decrease in temperature, gradually increased to 35.8 ± 0.6°C, which was similar to pre-operative values, and significantly higher than either of the other two groups ($P = .004$).

Perioperative health care providers should focus on prevention of hypothermia, rather than treatment. Once hypothermia ensues, it is much more difficult to treat because it takes time to reach the core, and overly aggressive external thermal heating may cause thermal injuries (Busch et al., 1995; Sessler et al., 1995). Thirty minutes of forced-air warming increases peripheral tissue heat by more than the heat redistributed during the first hour of anesthesia, thus cooling caused by redistribution, may be prevented by prewarming (Sessler et al., 1995).

Cost

Because effective methods of warming patients exist, perioperative changes in body temperature should undergo the same risk-benefit analysis as any other medical procedure or intervention (Sessler, 1997). Does the risk of hypothermia induced complications outweigh the cost related to maintain perioperative normothermia?

Mahoney and Odom (1999) conducted a meta-analysis to find out what happens once a patient becomes hypothermic. They conducted a review of the literature, and the conclusions were as follows: The difference in outcomes between normothermic and hypothermic patients is significant across studies, forced-air warming is more effective in maintaining normothermia than other warming modalities, and normothermia decreases the risk of adverse outcomes. Maintenance of normothermia may reduce the cost to the patients, health care providers, and health insurance companies.

Quantifying cost is very difficult due to multiple variables affecting cost. Intraoperative hypothermia of approximately 2…C below normothermia delays discharge from PACU by 40 minutes. Prolonged recovery may be costly because most PACU costs are comparable to ICU costs. However, decreasing recovery time alone by keeping the patient normothermic may not produce substantial savings considering personnel costs are the largest expense in a PACU, not the length of patient stay (Lenhardt et al., 1995). Further, some PACU policies require the patient to remain for a predetermined amount of time prior to discharge. In a study designed to evaluate cost and economic benefit of intraoperative normothermia during laparotomies, hypothermic patients lost more blood, required more transfusions, and remained in the PACU longer than normothermic patients. Maintenance of normothermia accounted for a 24% reduction in cost of care for the anesthesia department, and in turn, the hospital. This study primarily focused on quantifying the costs of hypothermia (Bock et al., 1998).

Defina and Lincoln (1998) found that hypothermic patients had longer PACU stays than patients who arrived normothermic. Despite having longer procedures, patients who were treated by active warming intraoperatively were less likely to arrive in the PACU hypothermic. The calculated added cost of staying in the PACU longer in the hypothermic group was $98.06 per patient. In contrast to these findings, Smith et al. (1998) found no differences in discharge time from PACU between hypothermic, and normothermic patients.

An added benefit not included in cost analysis studies is patient comfort. It is very difficult to quantify comfort in terms of cost. Patient satisfaction and a positive surgical experience is extremely important. The monetary advantage of maintaining normothermia perioperatively is not clearly delineated. However, the numerous adverse patient outcomes related to hypothermia seem to be straightforward.

Conclusion

In this chapter, the mechanisms of heat loss were reviewed. Complications, risk factors, and means used to prevent perioperative hypothermia were presented. Finally, cost factors of maintaining normothermia versus hypothermia during perioperative period were presented.

CHAPTER III: METHODOLOGY

Research Design

To describe the implementation of the proposed perioperative thermoregulation guidelines, a pilot study was conducted using a descriptive research design. Participants provided suggestions for improvement and barriers to implementation of the guidelines.

Sample

Data collection for this study took place at a hospital on the East Coast. Hospital personnel involved in the study included perioperative health care providers in Operating Rooms (OR), Ambulatory Surgery Unit (ASU), and Post-Anesthesia Care Unit (PACU). Data collection included all scheduled surgeries during duty hours over a period of two weeks.

Methods

Perioperative health care providers (nurses in ASU, PACU, and OR, and all anesthesia providers) involved in the study were informed about the study, and the proposed perioperative thermoregulation guidelines during their scheduled department meetings. Copies of the proposed perioperative thermoregulation guidelines were distributed to perioperative health care providers during those meetings, and reviewed, in detail, by investigator. Discussion and clarification were provided until all involved stated they understood the purpose of the study, and their role in data collection.

Data Collection

Three separate data collection tools were designed for the purpose of this study, and were presented to all participants in the same meeting. The Intraoperative Hypothermia Form was designed for intraoperative data collection by anesthesia providers or perioperative nurses (see Appendix B). The PACU Form (Post-operative Stage I Form) was used for data collection in the PACU, by recovery room nurses (see

Appendix C). The Preoperative/Ambulatory Care Unit Form was developed for data collection in the ASU (see Appendix D). This form has a preoperative section to be completed by the ASU health care provider prior to surgery, and a postoperative/ambulatory stage II section to be completed postoperatively in the ASU.

Each form contained specific questions derived from the proposed perioperative thermoregulation guidelines. The purpose of the guidelines is to identify patients at risk for perioperative hypothermia, and then initiate warming measures early. Perioperative health care providers were asked to identify barriers to implementation of perioperative thermoregulation guidelines, and to provide comments or suggestions for improvement of the guidelines

The proposed perioperative thermoregulation guidelines define hypothermia as a core temperature less than 36°C and/or patient complaint of feeling cold. Normothermia is defined as a temperature range of 36-38°C. Preoperatively, patients temperature were taken, and patients were asked if they felt cold. According to the guidelines, temperature measurement methods should be accurate and consistent, which means the same method and site should be used preoperatively and postoperatively.

Risk factors for perioperative hypothermia were identified during the preoperative period. Risk factors identified in the perioperative thermoregulation guidelines include: extremes of age, comorbities, low ambient room temperature, cachexia, pre-existing conditions (peripheral vascular disease, endocrine disease, pregnancy), significant fluid shifts, intracavitary surgery, general surgery, cryosurgery, and use of cold irrigants.

According to the guidelines, warming measures should be instituted for patients who are hypothermic, and those who are identified to be at risk for perioperative hypothermia. Unless contraindicated, several warming methods may be used. These include warm blankets, active warming blankets (electric, water, forced-air), socks, warming lights, ambient temperature, IV fluid warmers, head covering, and reflective blankets. In addition, patients should have limited skin exposure.

Intraoperatively, warming methods should continue, and anesthesia providers should follow their professional associations standards of practice for temperature monitoring. In cases in which an anesthesia provider is not present, and the patient is under the care of a perioperative nurse (local minor surgery or conscious sedation), temperatures should be monitored at the beginning and end of procedures. Serial temperature measurement to monitor trends in patients whose surgical procedures last longer than 30 minutes or who are hypothermic, or complain of being cold should be based on clinical judgement of the perioperative nurse.

Postoperatively, the anesthesia provider or perioperative nurse should report temperature trends to PACU or ASU nurse. Upon admission to PACU or ASU, patients temperatures should be taken. If patients are hypothermic on arrival, active warming measures should continue, and serial temperature measurements continued. If patients are normothermic on arrival, temperature should be checked prior discharge. Patients should not be discharged from PACU or ASU until they are normothermic (36°C).

Demographic information, such as patient age, gender, and ASA categories were recorded to describe the sample. Patients names and identification numbers were not recorded.

Protection of Human Rights

Institutional Review Board approval was obtained from the Uniformed Services University of Health Sciences, and from hospital involved prior to initiation of this study. Perioperative health care providers were fully informed of the purpose of the study. This study involved no risk to participants or patients since no additional interventions were implemented. The only apparent risk involved was not preventing perioperative hypothermia from occurring.

Data Analysis

The data collected over two weeks by use of the three data collection tools were analyzed descriptively. Means, modes, and standard deviations are reported.

Conclusion

In this chapter, the proposed study was explained, and methods for data collection discussed. After Institutional Review Board approval from the Uniformed Services University of Health Sciences, and involved hospital, data was collected on all scheduled surgical procedures preformed during two weeks. The data were collected using three different data collection tools and recorded by OR, PACU, and ASU perioperative health care providers. Data were analyzed using Statistical Package for Social Sciences (SPSS)(SPSS¤ for Windows“, 1998).

CHAPTER IV: ANALYSIS AND INTERPRETATION OF DATA

Introduction

In this chapter the sample used in the study was be described. The data collected over two weeks through the use of three data collection tools and a descriptive analysis of the data was be presented.

Sample

The sample (n=115) in this study consisted of patients who had surgical procedures within a two-week period during duty hours. Three separate data collection forms were used. An Intraoperative Form was designed for data collection intraoperatively by anesthesia providers and OR nurses (see Appendix B). A PACU Form (Post-operative Stage I Form) was used for data collection in the PACU by recovery room nurses (see Appendix C). A Preoperative/Ambulatory Care Unit Form was developed for data collection in the ASU (see Appendix D). This form has two parts, one to be completed preoperatively by the ASU nurses, and the second part to be completed postoperatively by ASU nurses.

A total of 117 scheduled surgeries were performed during duty hours over the two-week study period. The types of surgeries performed were general, vascular, ENT, orthopedic, ophthalmology, plastic, GYN, urology, and podiatry. The sample (n=115) consisted of males and females, ASA categories I-IV, with mean age of 46 (range 3-88) years.

Preoperative/Ambulatory Care Data

ASU nurses using the Preoperative/Ambulatory Care Unit Form (see Appendix D), obtained the following data pre and postoperatively in the ASU. Data was collected for 55 patients; 32 males, 22 females, and one whose gender was not recorded. Mean age of 42 (range 3-88) years. Sixty patients were missing from ASU data collection. A small number of patients start out as in-patients and are never admitted to the ASU, but the majority were simply not collected by the ASU staff.

The risk factor for perioperative hypothermia most frequently identified (n=12) by ASU nurses preoperatively was age (<7 or >65 years). The second risk factor for hypothermia most frequently identified (n=4) by ASU nurses preoperatively was long procedures, and comorbidities, such as diabetes, was third (n=2). Ambient room temperature, and pre-existing conditions, such as peripheral vascular disease, were equally identified (n=1) by ASU nurses as a risk factor for perioperative hypothermia. Cachexia was not identified by ASU nurses as a risk factor for hypothermia for any of the patients.

Preoperative temperature was taken on 95% of the patients (n=52)admitted to ASU. All temperatures were taken by tympanic method except for one, which was taken orally. Twenty-four percent of patients (n=13) were hypothermic (temp. <96.8°F) preoperatively. Patients reportedly were asked if they were cold pre-operatively approximately 91% of the time (n=50). Of the patients that were found to be hypothermic preoperatively 24%(n=13), only two stated they also felt cold when asked if they were cold.

Preoperative warming measures included giving patients socks 86%(n=47), blankets 26%(n=14), and limiting skin exposure 24%(n=13). Active warming blankets, ambient temperature, IV fluid warmers, head covering, reflective blankets, and warming lights were reportedly not used preoperatively on any patient.

Discharge temperatures were only recorded for 29% of the patients (n=16). Again, all temperatures were measured tympanically except for one, which was measured orally. Seventy percent of the patients discharged did not have a temperature taken, or the temperature that was taken was not recorded on data collection form. Patients reportedly were asked if they were cold postoperatively only 31% of the time (n=17). Patients reportedly were not asked if they were cold postoperatively, nor was anything recorded about this on data collection form, 69% (n=38).

Post-operative warming measures in the ASU (Second Stage Recovery) consisted of limiting skin exposure 56%(n=31), blankets 37%(n=21), and socks 31% (n=17). Active warming blankets, IV warmers, head covering, reflective blankets, and warming lights were reportedly not used postoperatively on any patients.

When ASU staff were asked if the National Perioperative Thermoregulation Guidelines (NPTG) were difficult to follow 7% (n=4) reported no, and 51 times (93%) this question was not answered. No barriers to implementation of the NTPG were identified by ASU staff. Only one comment was provided by ASU staff regarding guidelines: Current standard in ASU is to take patients temperature upon arrival to ASU (preop), and immediately upon arrival post-op. If temperature is 96°F or less, we will warm patients and re-take temperature. All patients are given socks, gown, and robe while waiting for surgery. Patients will go to OR with socks and gown."

Intraoperative Data

Using the Intraoperative Hypothermia Form (Appendix B), the following data were obtained intraoperatively by OR nurses and anesthesia providers. Data were collected on 92 of 115 patients; 50 males, and 42 females. Data were not collected on twenty-three patients for unknown reasons. Of the data collected, mean age was 42(range 3-84) years. ASA categories included: ASA I (33%, n=30), ASA

II (54%, n=50), ASA III (11%, n=10), ASA IV (n=1), and not recorded (n=1).

The risk factors for intraoperative hypothermia identified by OR nurses and anesthesia providers were cold ambient room temperature 74%(n=68), age 39%(n=36), long procedure 28% (n=26), pre-existing conditions 8%(n=7), comorbidities 8% (n=7), and cachexia 3%(n=3). Patients were reportedly asked if they were cold in the OR 76% of the time (n=70). Patients were reportedly not asked if they were cold 23% of the time (n=21), and this item was not recorded for one patient. The type of anesthesia delivered was general 62%(n=57), MAC 24% (n=22), regional 13%(n=12), and combined (n=1). An anesthesia provider was present during procedures 100% of the time, and standards of practice were reportedly followed 99% of the time (n=91).

Reported intraoperative warming measures consisted of limited skin exposure 82% (n=75), warm blankets 80% (n=74), active warming blankets 44% (n=40), humidified gases 25% (n=23), and fluid warming 23% (n=21). Reportedly, neither warming lights nor carbon dioxide warming were used. When staff was asked if guidelines were difficult to follow, 86% recorded no (n=79), 10% recorded yes (n=9), and four gave no answer.

Four comments were obtained regarding barriers to implementation of the NTPG by intraoperative staff. The comments were:

- Ambient room temperature cold secondary to surgeons comfort.
- No temperature taken prior entering OR.
- Being in a hurry sometimes.
- Difficult to warm room.

One comment or suggestion about guidelines was provided by intraoperative staff:

- The OR nurses should be encouraged to facilitate the warming of the patient.

Post-Anesthesia Care Unit Data

Using the PACU (Post-operative stage I) Form (see Appendix C), the PACU nurses obtained the following data postoperatively in the PACU. The data were collected on 90 of 115 patients; 45 males, and 45 females. The mean age was 42 (range 3-84) years. Data were not collected on twenty-five patients. Again, some patients by-passed PACU and went straight to ASU, and some data was simply not collected.

Reportedly, the anesthesia provider, or OR nurse, included the temperature in the oral report to PACU nurse only 45% of time (n=40), and 52% of the time it was reportedly not included (n=47). The temperature of the patient was taken on admission to PACU 100% of the time (n=90). All temperatures were measured tympanically except for one measured axillary. By NPTG definition, thirty-three percent (n=30) of the patients arrived in the PACU hypothermic (temp.<96.8°F).

When patients were asked if someone inquired if they were cold in the OR, 22% (n=20) reportedly stated yes, 7% (n=6) reportedly stated no, 10% (n=9) reportedly did not remember, two were reportedly too young to respond. Fifty-nine percent of the time (n=53), this item was not recorded by PACU nurses. Warming measures reportedly used in the PACU included warm blankets 88% (n=79), limited skin exposure 83% (n=75), socks 62% (n=56), head covering 6% (n=5), active warming blankets used only on one patient. Fluid warming, carbon dioxide warming, humidified gases, and warming lights were reportedly not used. Discharge temperatures were taken and recorded for 90% of the patients (n=81). This item was not recorded for nine patients. All temperatures were measured tympanically except for two, which were measured axillaryly. Twenty patients (22%) were discharged from the PACU hypothermic. Yet, when the PACU staff were asked if the NTPG were difficult to follow, 100% responded that they were not difficult to follow. No barriers to implementation or suggestions for improvement were offered by PACU nurses.

CHAPTER V: SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Introduction

In this chapter, a summary of the results was presented, followed by a discussion of conclusions. Possible explanations for occurrences was be presented. Finally, recommendations for future studies was provided.

Summary

Anesthetized patients commonly experience perioperative hypothermia. The National Perioperative Thermoregulation Guidelines (NPTG) were developed in an attempt to maintain patient normothermia throughout the perioperative period. This pilot study was used to determine barriers to implementation, and suggestions for improvement of the guidelines.

The guidelines were implemented for a period of two weeks at a hospital on the East Coast. All patients who had scheduled surgeries performed during duty hours for a period of two weeks were included in the study (n=117).

Conclusions

The National Perioperative Thermoregulation Guidelines (NPTG) were developed to assist in the prevention of perioperative hypothermia by identifying pre-operative risk factors, and early institution of active warming measures to maintain normothermia. The desired outcome is to maintain normothermia throughout the perioperative period.

In this pilot study of the NPTG, patients experienced hypothermia perioperatively.

Several findinds from the study are noteworthy. First is that 24%(n=13) of the preoperative patients were found to be hypothermic in the ASU prior to surgery. Two out of the 13 patients that were hypothermic preoperatively also stated they felt cold prior to surgery.

The other 11 patients, while hypothermic, reportedly stated they did not feel cold. Upon tracking these patients throughout the perioperative period, four of the 13 patients (30%), also arrived hypothermic in the PACU. Two out of the 13 patients (15%) were also discharged from the ASU hypothermic. The other 11 patients did not have their temperatures taken or recorded on the data collection form prior discharge from the ASU. Perhaps these patients represent a normal variance or some patients possibly become hypothermic preoperatively due to cold rooms and scant clothing.

In the ASU, discharge temperatures were not taken or recorded on data collection form on 71%(n=39) of the patients. Of the 29% of the patients whose temperatures were recorded on discharge (n= 16), 14%(n=8) were found to be hypothermic at discharge. Most patients (71%) did not have a temperature recorded postoperatively in the ASU; therefore it is unknown how many patients were actually hypothermic at discharge from ASU. But, of those recorded (29%), one-half were discharged home from the ASU hypothermic according to the NPTG. Even if using ASU s own guidelines, 12.5%(n=2) were discharged hypothermic from the ASU. NTPG were not implemented, and even their own guidelines were not followed. In addition, 69% of the patients in the ASU (n=38) were reportedly not asked if they were cold postoperatively nor was anything recorded on data collection form about this. A number of patients were never asked if they were cold postoperatively along with not having their temperatures taken prior to discharge from the ASU.

Another finding is that 33%(n=30) of the patients arrived in the PACU hypothermic from the OR, and 50%(n=15) of these were discharged from the PACU cold. Perhaps more aggressive institution of warming measures should be initiated intraoperatively, and continued postoperatively. According to one study, 60% of patients not treated intraoperatively by convection warmers arrived hypothermic (temp. <36°C) in the PACU (Defina & Lincoln, 1998). While in another study, 26% of the patients arrived in PACU hypothermic (temp. <36°C) despite use of conventional warming measures (Garrett, 1997).

In this pilot study, 17% of patients who arrived hypothermic to PACU were not re-warmed prior discharge from PACU, which is not consistent with either unit guidelines or NPTG guidelines. In addition, ten percent (n=6) of the patients who arrived in the PACU normothermic from the OR were allowed to become hypothermic and were discharged hypothermic from the PACU.

The type of anesthesia was not recorded on PACU data collection form, so it is not possible to know if patients who received general anesthesia had a higher incidence of hypothermia. Most surgeries (62%) were performed under general anesthesia.

Interestingly, almost a quarter (22%) of the patients (n=20) left the PACU hypothermic. The goal of the NPTG is to prevent hypothermia from occurring. Apparently, the NPTG were not followed. If guidelines were followed, patients would not be discharged from PACU until they were normothermic. The ASU and PACU staff reported that the NPTG were not difficult to follow, and yet apparently NTPG were not implemented or followed by both ASU and PACU staff.

In this pilot study, non-compliance with guidelines was a major obstacle to implementation. This may be due to the fact that staff do not consider hypothermia to be detrimental to patients. This may be because the problems caused by hypothermia are not obvious or readily apparent, and therefore staff may be working under the misconception that it is not an important factor. Active warming measures, the most effective method of preventing hypothermia (Sessler, 1997), was used on only one patient in the PACU while it was used on 40 patients intraoperatively.

Education of staff, and increased awareness of the consequences of hypothermia may help lessen the problem. Sometime after data collection period was completed, the PACU nurse manager stated to me that she observed that after study completion, the PACU staff appeared to be more aware of temperatures and more concerned about hypothermia. Perhaps just participating in the study increased their awareness of the problem.

No barriers to implementation of the NPTG were identified by the ASU staff, while four comments were provided by the intraoperative staff, and again no barriers to implementation were identified by the PACU staff. The four barriers to implementation of NPTG identified by the intraoperative staff were:

- Ambient room temperature cold secondary to surgeon s comfort.
- No temperature taken prior entering OR.
- Being in a hurry sometimes.
- Difficult to warm room.

In this study, cold ambient room temperatures was considered to be the biggest risk factor for hypothermia by intraoprative providers. Increasing room temperature is one way to prevent hypothermia from occurring, however surgeons with gowns and gloves under bright lights complain of being too hot. Active warming of patient has been found to be the most effective method of preventing hypothermia from occurring (Sessler, 1997).

Being in a hurry sometimes could be a significant barrier to implementation of guidelines. How much extra time does it take to implement warming measures? Data to answer to that question is not available, and perhaps could be collected in a future study. Staff offered no other barriers to implementation of NPTG.

Only one comment was received about suggestions for improvement of the proposed perioperative thermoregulation guidelines. The comment by intraoperative staff was the OR nurses should be encouraged to facilitate warming of the patient. Maintaining perioperative normothermia is a team effort, and everyone involved with the patient perioperatively has the responsibility of aiding in the process. Encouragement of all involved to maintain normothermia is the goal of the perioperative guidelines.

One other comment was received from the ASU staff, but it was not a suggestion for improvement, but more a statement of how they do business in the ASU. Resistance to change is a very strong barrier to implementation, which was not directly stated by staff, but perhaps implied by the ASU statement.

According to Sister Calista Roy Adaptation Model (Roy, 1984), when individuals are able to cope effectively with their environment, an adaptive response occurs; when individuals are not able to cope effectively with their environment, an ineffective response occurs. During the perioperative period, patients are exposed to cold environment, and receive anesthetics, which impair thermoregulatory responses. Patients are also unable to physically alter their environment, which may lead to hypothermia, an ineffective response. During this period, healthcare providers should manipulate the environment to assist patients in maintaining normothermia, the desired adaptive response.

Recommendations

In this study patients identification numbers or names were not recorded which made tracking the data from one area to the next very difficult and cumbersome. Future studies should include a way of identifying patients to facilitate tracking throughout perioperative period. One item in the data collection form for the ASU and PACU, should be changed from IV fluid warmers to warm IV fluids to avoid confusion. Most patients received warm IV fluids intraoperatively, however, IV fluid warmers are used less frequently. In the intraoperative data collection form, two sections for IV fluids should be made, one for warm IV fluids, and another for fluid warmers. Both are used intraoperatively and should be separated. In addition, intraoperative temperatures should be recorded in data collection forms for completeness.

Mild perioperative hypothermia may contribute to complications such as myocardial events, post-operative discomfort, altered drug metabolism, and increased perioperatively bleeding. In the PACU form, if the type of anesthesia used was recorded, correlations between type of anesthesia could be made with temperature. Also, warming methods used in the PACU should eliminate carbon dioxide warming since it is not used in the PACU.

Concurrent chart audits would help to determine if temperatures were not taken at all or just not recorded in the data collection forms. A limitation of this study were the data collection forms. Asking staff to collect data in an environment where too much paperwork may already exist, may have contributed to non-compliance.

Twenty-four percent of the patients were hypothermic preoperatively. In a future study patients who arrive hypothermic should be tracked to determine if they are at greater risk for perioperative hypothermia. One barrier to implementation was stated as being in a hurry sometimes. A future study focusing on the cost of preventing perioperative hypothermia in terms of resources and time spent in the implementation of perioperative warming measures could be conducted.

Mild perioperative hypothermia continues to be a problem perioperatively. If followed the National Perioperative Thermoregulation Guidelines will help patients maintain normothermia perioperatively. In order to decrease the incidence of perioperative hypothermia, the guidelines, if adopted as standards of care, should be followed at all times.

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LIST OF APPENDICES

APPENDIX A

PROPOSED NATIONAL PERIOPERATIVE THERMOREGULATION GUIDELINES

PROPOSED NATIONAL PERIOPERATIVE THERMOREGULATION GUIDELINES

Definitions:

Hypothermia: Patient s core temperature is less than 36…C and/or if patient complains of being cold (this includes non-verbal signs of hypothermia).

Normothermia: Temperature range of 36…-38…C (96.8…-100.4…F) Core temperature will be measured in Celsius and may be converted to Fahrenheit.

Recommendations for preoperative Interventions:

Preoperative Patient Assessment	Identification of Risk Factors
-Take temperature*	-Age
-Ask patient if they are cold	-Comorbidities
	-Ambient room temperature
	-Long procedures
	-Cachexia
	-Pre-existing conditions (peripheral vascular disease,endocrine disease, pregnancy)
	-Significant fluid shifts
	-Intracavitary surgery
	-Orthopedic surgery
	-General anesthesia
	-Cryosurgery
	-Cold irrigants

*Survey and published literature indicate that tympanic is the most commonly used means of measuring/taking temperature.

Sites for temperature measurement include: core, tympanic, skin, oral, rectal, and bladder.

1. Preoperative Interventions:

Institute warming measures for patients who are hypothermic(see definition). The desired outcome is to achieve or maintain normothermia. A variety of warming methods may be used unless contraindicated, including blankets, active warming blankets(electric, water, forced air), socks, warming lights, ambient temperature, IV fluid warmers, head covering, and reflective blankets. Patients should have limited skin exposure.

Basic Recommendations:

When feasible, temperature measurement should be accurate and consistent(i.e. the same method and the same site should be used pre-operatively and post-operatively). It is up to the practitioner to determine the best method of monitoring.

2. Intraoperative Interventions:

Prevention

Ambient room temperature- maintain ambient temperature as warm as acceptable

Active warming methods:

Warm blankets

Active warming blankets(electric, water, and forced air)

CO_2 warming

Fluid warming(IV, parenteral, irrigants, and prep solutions)

Humidified gases

Warming lights(radiant heat)

Limited skin exposure.

Determination of patient comfort level.

Basic recommendation:

Intraoperatively the anesthesia provider should follow their professional associations standards of practice for temperature monitoring.

In those cases in which an anesthesia provider does not participate in the care and the patient is under the care of a perioperative nurse(local minor surgery or conscious sedation), the temperature should be monitored at the beginning, and at the end of the procedure.

Serial temperature measurements to monitor trends in patients whose surgical procedures last more than 30 minutes or who are hypothermic, or complain of being cold are based on clinical judgement of the perioperative nurse.

3. Postoperative interventions:

Anesthesia provider or perioperative nurse to include correlation/trends of temperature in report to PACU nurse.

Frequency- On admission:

If hypothermic- active warming, serial measurements,and monitor trends.

If normothermic- check temperature prior discharge.

Active warming methods:

Warm blankets

Active warming(electric, water, and forced air)

Fluid warming(IV, parenteral, irrigants, and prep solutions)

Humidified gases

Warming lights(radiant heat)

Limited skin exposure

Determination of patient comfort level.

Socks

Head covering.

Discharge criteria and instructions:

Patient s temperature should be 36…C(normothermic) prior discharge from Phase I PACU. After transfer to Ambulatory Care Unit, temperature should be taken upon admission and discharge. Patients should not be discharged until normothermic.

*Adapted from: Consensus Conference on Perioperative Thermoregulation, 1998, NY, NY. (Unpublished Manuscript)

APPENDIX B

INTRAOPERATIVE HYPOTHERMIA FORM

Intraoperative Hypothermia Form

Date:					
Surgical procedure					
Age					
Gender					
ASA category					
Check all risk factors for hypothermia					
Age					
Comorbidities					
Ambient room temperature					
Long procedure					
Cachexia					
Pre-existing conditions*					
Was pt asked if cold in OR? Write Yes or No					
Type of anesthesia (Write general, regional, MAC)					
Was anesthesia provider present during procedure? Yes/No					
Were anesthesia standards of practice for maintainging temp. followed intra-op? Write Yes/No					
If anesthesia provider was not present, was temp. taken before and after procedure?Write Yes/No					
a. What was temp before procedure? (include method, site(ex. 36.2, tympanic)					
b. What was temp after procedure? (include method, site(ex 36.2, tympanic)					
c. If pt. was hypothermic or complained of being cold were serial temps taken? Yes/No					
Check all warming methods used in OR.					
Warm blankets					
Active warming blankets**					
CO2 warming					
fluid warming***					
humidified gases					
warming lights (radiant heat)					
limited skin exposure					
Were guidelines difficult to follow? Yes/No					
List any barriers to implementation of guidelines					
Any comments or suggestions about guidelines?					

* (PVD, endocrine, pregnancy, etc) ** (E=Electric, W=water, F=Forced air) *** (I=IV, P=parental, IP=Irrigant and prep solutions)

APPENDIX C

POST-OPERATIVE STAGE I FORM

PACU Form (Post-Operative Stage I)

Date:					
Surgical procedure					
Age					
Gender					
Did anesthesia provider or peri-op nurse include temp in report to PACU? Write Yes/No					
Was temp taken on admission to PACU? Yes/No					
What was 1st temp taken? (include method, site) (ex. 36.2, tympanic)					
Was pt asked if cold in OR? Yes/No					
Check all warming methods used in PACU.					
Warm blankets					
Active warming blankets**					
CO2 warming					
Fluid warming***					
Humidified gases					
Warming lights (radiant heat)					
Head covering					
Socks					
Limited skin exposure					
What was pt's temp. upon discharge from PACU? (include method, site)					
Where guidelines difficult to follow? Yes/No List any barriers to implementation of guidelines					
Any comments or suggestions about guidelines?					

** (E=Electric, W=water, F=Forced air)

*** (I=IV, P=parental, IP=Irrigant and prep solutions)

APPENDIX D

PREOPERATIVE/AMBULATORY CARE UNIT FORM

Pre-operative/ Ambulatory Care Unit Form

Date:					
Surgical procedure					
Age					
Gender					
Check all risk factors for hypothermia					
Age					
Comorbidities					
Ambient room temperature					
Long procedure					
Cachexia					
Pre-existing conditions*					
Pre-op temp taken? Yes/no					
What was pre-op temp.(include method & site)					
Was pt asked if cold pre-op? Write Yes or No					
What was pt's response? Write cold or not cold					
Check all following warming interventions iniated pre-op.					
Blankets					
Active warming blankets**					
Socks					
Ambient temperature					
IV fluid warmers					
Head covering					
Reflective blankets					
Warming lights (radiant heat)					
Limited skin exposure					
Was temp taken upon discharge from Amb Care unit? Write Yes/No					
What was discharge temp? (include method, site)					
Was pt. asked if cold post-op? Write Yes/no					
Check all following warming interventions iniated post-op.					
Blankets					
Active warming blankets**					
Socks					
Ambient temperature					
IV fluid warmers					
Head covering					
Reflective blankets					
Warming lights (radiant heat)					
Limited skin exposure					
Were guidelines difficult to follow? Write Yes/No					
List any barriers to implementation.					
Any comments or suggestions about guidelines?					
* (PVD, endocrine, pregnancy, etc)	** (E=Electric, W=water, F=Forced air)				

Post-Operative/ Ambulatory Care Stage II