Clinical Practice Guideline for Preoperative Warming to Prevent Hypothermic Complications

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DNP Project

Background

Inadvertent perioperative hypothermia (IPH) is defined as, "a core temperature less than 36°C [96.8°F]" (Hooper et al, 2010 p. 348). IPH is an international and national problem that is estimated to occur in 50-90% of adult surgical patients (Moola & Lockwood, 2011; Roberson, Dieckmann, Rodriguez, & Austin, 2013). IPH is associated with complications such as impaired anesthetic metabolism, coagulopathy and altered immune responses (Flood, Rathmell & Shafer, 2015). IPH contributes to delays in emergence from anesthesia, and to increases in surgical site infections (SSI), surgical costs and cardiovascular events (Good, Verble, Secrest, & Norwood, 2006).

The induction of general anesthesia or general anesthesia combined with regional anesthesia has been identified as a significant IPH factor (Flood, Rathmell & Shafer, 2015). The induction of general anesthesia is associated with the general dilation of blood vessels, which can blunt compensatory mechanisms for temperature regulation and facilitate heat redistribution from the core to periphery (Flood). The induction of general anesthesia or general anesthesia combined with regional anesthesia can contribute to reduction in core temperature by 1.6°C in the first hour, and by 2.8°C during three hours in a 22°C room (Flood). Therefore, the induction of general anesthesia can lead to temperature reductions that precipitate IPH (core temp <36°C) (Hooper).

Intensive Care Unit (ICU) patients undergoing major abdominal surgical procedures that last greater than two hours, and require the induction of general anesthesia or general anesthesia combined with regional anesthesia, are particularly vulnerable to IPH (core temp <36°C) (Flood; Hart, Bordes, Corsino, & Harmon, 2011). Major surgical procedures, such as abdominal and colorectal surgeries, are often performed through large open abdominal incisions and are

associated with radiative and evaporative heat losses. Major abdominal surgical procedures performed through large open abdominal incisions are also associated with large intravascular and extravascular fluid shifts, which may exaggerate hemodynamic changes and/or necessitate postoperative ICU stay. The intraoperative use of cold surgical site preparations, irrigation solutions and contact with cold surfaces/air (<22°C/71.6°F), also contribute to convective and conductive heat losses (Flood).

Preoperative warming has been shown to more effectively prevent IPH than intraoperative warming alone (Torossian, Bräuer, Höcker, Bein, Wulf & Horn, 2015). Therefore, there is opportunity to help prevent/reduce IPH and/or intraabdominal infections at one large academic teaching institution on the east coast of the United States, where IPH-vulnerable patients presenting for surgery are primarily warmed in the intraoperative phase (Personal communication with an institution anesthesiologist, 2016). The anesthesiologist also highlighted an opportunity to assist the anesthesiology department, to maintain normal intraoperative temperature in this population. Maintaining normal intraoperative temperature was emphasized as particularly important, because "many ICU patients are hypothermic on arrival or rapidly become hypothermic in the operating room (OR)" (Personal communication, 2016).

The Centers for Disease Control (CDC) and the Healthcare Infection Control Practice Advisory Committee adopted best practice strategies to prevent and treat surgical site infections from the National Institute for Health and Clinical Excellence (NICE), and subsequently presented these strategies, including preoperative warming recommendations (Anderson et al., 2014). Therefore, a Doctor of Nursing Practice (DNP) project to develop and evaluate a clinical

practice guideline (CPG), which contains best practice strategies for preoperative warming, was proposed to the leadership of this institution's anesthesiology department.

The development and use of this CPG for preoperative warming is anticipated to provide guidance and standardized approaches for the preoperative temperature management of ICU patients, presenting for major abdominal surgery. This CPG is also anticipated to prevent and/or reduce IPH and IPH-associated complications such as shivering, impaired anesthetic metabolism, coagulopathy and altered immune responses (Flood, 2011). Additionally, the use of this CPG is anticipated to prevent and/or reduce hypothermic increases in surgical wound infections, surgical costs, cardiovascular events and morbidity and mortality (Flood).

Theoretical Framework

The nursing theory chosen for this DNP project is the *Model for Change to Evidence Based Practice* [EBP] (Rosswurm & Larrabee, 1999). *The Model for Change* provided six steps that were operationalized to guide this CPG development. The six steps, as per Rosswurm & Larrabee, (1999) are: 1) an assessment of the need for change in current clinical practice, 2) establishment of the connection between the clinical practice problem, identification of intended interventions and anticipated outcomes, 3) synthesis of the best available evidence, 4) design of the intervention to effect a change in current practice, 5) implementation and evaluation of the intervention for change, and 6) the integration and sustenance of the practice change. The first step, the need for change in current clinical practice was assessed through the review of three-months of de-identified temperature data in colorectal surgical patients, which was provided by the institution's anesthesia department. Despite intraoperative warming interventions, the data set revealed post-operative temperatures ranging between 31.8°C and 35.1°C in ICU patients, as presented in Appendix A. The temperatures were consistent with

preoperative hypothermia and highlighted the need for a different temperature management strategy. The second step, the establishment of the connection between the clinical practice problem, identification of intended interventions and anticipated outcomes, was accomplished through a preliminary review of literature. The preliminary review of literature yielded moderate/strong evidence in support of preoperative warming, which was sufficient to formulate a hypothesis. Torossian, Bräuer, Höcker, Bein, Wulf & Horn (2015), found that intraoperative warming alone was not sufficient for the prevention of IPH. This finding was consistent with the occurrence of IPH in the ICU patients from the provided data set, despite intraoperative warming. Therefore, the hypothesis formed was that a lack of preoperative warming strategies at the institution was associated with the occurrence of IPH, particularly in ICU patients. The third step, synthesis of the best available evidence, was accomplished through an extensive literature review in electronic databases. The fourth step, design of the intervention to effect change in current practice, was accomplished via a guideline development team (GDT). The CPG was identified as the intervention for IPH at this institution, and the CPG design occurred over several weeks and multiple revisions. The fifth step, implementation and evaluation of the intervention, involved the completion of CPG development and feasibility evaluations by the GDT and CPG end users. The GDT completed three separate rounds of development evaluations and provided feedback on CPG structure and content. The GDT also helped to identify potential challenges to CPG implementation and strategies to customize best practice recommendations on preoperative warming to the surgical ICU or ICU (S/ICU) at this institution. Additionally, CPG end users were identified for the completion of one round of feasibility evaluation. The sixth/final step, the integration and sustenance of the practice change, was beyond the scope of this DNP project. However, a 90-day pilot program was recommended

to yield process and outcome data for the institution, similar to the CDC's pilot program for SSI prevention. Outcome and process data gathered during the recommended 90-day pilot could provide further CPG modifications to promote the sustained use of preoperative warming strategies at this institution.

Literature Review

To develop the CPG for preoperative warming, a review of literature was conducted using keywords including: "ICU patients", "major abdominal surgical patients", "major abdominal surgery", "preoperative warming", " prewarming", "prewarming guideline", "prewarming strategies", "prevention of IPH", "prevention of hypothermia", "hypothermic complications" and "IPH complications". The review of literature was conducted online through medical-nursing databases including, but not limited to, the Cumulative Index of Nursing and Allied Health Literature (CINAHL). Studies conducted within the last ten years were included for review. The resulting studies were then screened for topic relevance, phase of surgical care and surgical population. Studies focused solely on ambulatory care patients or sponsored by warming device manufacturers, were excluded.

A considerable body of evidence within the review of literature was found on preoperative warming, including six randomized control trials (RCTs), two systematic reviews and four clinical practice guidelines (CPG). In the RCT by Wong, Kumar, Bohra, Whetter, & Leaper (2007), the authors examined the effects of additional perioperative systematic warming on postoperative morbidity involving (N=103) adult patients, who had elective major open abdominal surgery requiring bowel resection. Patients who received 120 minutes of preoperative warming via Inditherm conducting carbon polymer mattress, had a 22% lesser rate of IPH complications than the control group ($p=0.027$).

In the RCT by Andrzejowski, Hoyle, Eapen, & Turnbull (2008)the authors evaluated the effect of prewarming on post-induction core temperature and the incidence of IPH. This RCT involved (N=68) adult patients, who had spine surgery under general anesthesia. Patients receiving approximately 60 minutes of preoperative warming using Bair Paws 1000 BTU/h device, and full or surgical access warming blanket, maintained temperatures >36°C. The RCT D'Angelo Vanni, Braz, Modolo, Amorim, & Rodrigues Jr (2003), evaluated the effects of intraoperative skin-surface warming in preventing intraoperative and postoperative hypothermia, shivering and delayed tracheal extubation involved (N=30) female patients, who had elective abdominal surgery. Patients who received 60 minutes of preoperative warming had higher core temperatures during the first two hours of anesthesia as compared to the control group.

Scheck, Kober, Bertalanffy, Aram, Andel & Hoerauf (2004), explored the frequency, intensity and possibility of treating hypothermia in critically ill transported patients. This RCT involved (N=30) critically ill patients who were actively warmed. Patients who were warmed using carbon fiber heating blanket during transport to the CT scan room had core temperatures that were higher by 1.5°C than the control group (p=0.01). In the RCT by Benson, McMillan & Ong (2012), the authors explored the efficacy of a patient-controlled active warming gown, the sample population was comprised of (N=30) orthopedic patients who received patient-controlled active preoperative warming gowns or standard blankets. Patients who received active preoperative warming gowns had higher temperatures at 30 and 60 minutes after admission, and upon discharge from the Postoperative Anesthesia Care Unit (PACU) (p=<0.001). Patients receiving active preoperative warming also reported more satisfaction with their thermal comfort than patients who received standard blankets (p=0.004).

The multicenter RCT by Schell-Chaple, Puntillo, Matthay, Liu & The National Heart,

Lung, and Blood Institute Acute Respiratory Distress Syndrome Network (2015), examined the relationship between body temperature and outcomes in critically ill early Acute Respiratory Distress Syndrome (ARDS) patients. A secondary analysis of body temperature for (N=969) patients with ARDS for ≤48 hours was conducted using data from the National Heart, Lung and blood Institute (NHLBI) ARDS Network Fluid and Catheter Treatment trial. After adjusting for primary cause ARDS on the Acute Physiology and Chronic Health Evaluation III (APACHE III), hypothermia and temperatures >39°C were found to be associated with increased mortality (P = 0.02). Additionally, for every 1°C increase in baseline temperature up to 39°C, mortality deceased by 15% (p=0.03).

A systemic review by Poveda, Clark & Galvao (2012), analyzed available research on the effectiveness of prewarming to prevent perioperative hypothermia, and identified knowledge gaps for future research. The sample size in this review included adult patients (N=14) who received active forced air warming or passive warming via cotton blankets during various elective surgeries. In four prewarming studies, no statistically significant difference was noted in postoperative temperatures (Jadad scores of 2-3). Madrid et al. (2016) sought to assess the effectiveness of active body surface warming systems (ABSW) for preoperative and/or intraoperative prevention of unintended hypothermia and its complications. This was completed via an RCT, which included 5438 patients in (N=67) studies of patients who received different ABSW system methods of warming, as well as, additional perioperative warming interventions during open abdominal surgeries. In (N=7) RCTs, data indicated patients who received preoperative warming had a lower rate of IPH complications; reductions in major cardiovascular complications and total fluids infused during surgery, as well as, a reduction in shivering and improved thermal comfort (standardized mean difference (SMD) 0.76, 4 trials, 364 participants).

The CPG by Hooper et al. (2010) was used to develop consensus on recommendations for a revision of the 2001 American Society of PeriAnesthesia Nurses guideline promoting perioperative normothermia, and to improve outcomes in adult surgical patients. This CPG contained recommendations for temperature route and measurement, assessment of risk factors and clinical signs of IPH and preoperative warming procedures. These procedures were derived from a meta-analysis of several RCTs and systematic reviews on temperature management. In the CPG by Moola & Lockwood (2011), the authors recommend the most effective strategies for the prevention and management of hypothermia in the adult perioperative environment. This CPG contained recommendations for IPH screening and preoperative warming procedures derived from (N=19) studies with a sample population of 1451 adult patients, undergoing diverse surgical procedures under general and regional anesthesia for a duration > 2 hours.

The CPG by National Institute of Health Care and Excellence (NICE) (2008) provided guidelines on best practices for the care of adult surgical patients undergoing general, regional or combined anesthesia. Additionally, this CPG contained recommendations for IPH screening and assessment, and warming procedures derived from evidence based studies involving adult patients undergoing elective or emergency surgeries under general or regional anesthesia. The CPG by Torossian, Bräuer, Höcker, Bein, Wulf & Horn (2015) was used to guide prevention of hypothermic complications, and contained recommendations on IPH screening and preoperative warming procedures, derived from multiple systematic reviews and over 26 RCTs with a sample size of (N>2569) men and women in Europe and the US, undergoing diverse surgical procedures under regional and general anesthesia.

This body of evidence was reviewed for content, and evaluated for strength and quality of data/research, using Melnyk & Fineout-Overholt (2005) and The Johns Hopkins Nursing

Evidence-Based Practice (2005) rating scales (Newhouse, Dearholt, Poe, Pugh & White, 2015) (Appendix B). The Melnyk & Fineout-Overholt (2005) rating scale includes seven levels of evidence-strength, while the Johns Hopkins Nursing Evidence-Based Practice rating scale included three levels of evidence-quality. In the (Melnyk) scale, a strength rating of I is allocated to the strongest evidence from systematic reviews, while a strength rating of VII is allocated to the weakest evidence from the opinions of subject experts. The Johns Hopkins scale provides a quality rating of A for high quality evidence, while a quality rating of C is allocated to evidence with major flaws. The review of literature was synthesized, summarized, organized in an evidence review table, as presented in Appendix C.

This synthesized body of evidence was found to address the EBP concerns for the efficacy of preoperative warming, as well as other considerations. These considerations included the adverse effects of preoperative warming, the assessment of IPH risks, the appropriateness of preoperative warming for ICU surgical patients, selection of warming device, duration of preoperative warming, standardization and documentation of preoperative warming processes and the use of a guideline checklist.

Efficacy/adverse effects

Based on the evidence presented (Appendix C), preoperative warming was shown to be effective for the prevention/reduction of IPH and hypothermic complications of SSI, cardiovascular events, shivering and anxiety. Preoperative warming also reduced hospital length of stay and improved patient-reported thermal comfort and satisfaction (Andrzejowski, Hoyle, Eapen, & Turnbull, 2008; D'Angelo Vanni, Braz, Modolo, Amorim, & Rodrigues Jr, 2003; Hooper et al., 2010; Madrid et al., 2016; Moola et al., 2011; National Institute of Health Care and Excellence (NICE), 2008; Torossian et al., 2015; Wong, Kumar, Bohra, Whetter, & Leaper,

2007). Madrid et al. (2016) found adverse effects were not observed with preoperative warming. Additionally, the authors surmised forced air warming (FAW) does not pose a significant risk to patient's skin and health (Madrid). However, Flood cautioned that preoperative warming might cause vasodilation and hemodynamic changes that require interventions of fluids and the administration of vasopressors.

Screening

The body of evidence within the review of literature provided guidance to support the screening and assessment of IPH risks. Three guidelines recommended the screening and assessment of all patients for IPH risks. Risk factors for IPH were identified by the American Society of Anesthesiology (ASA) and includes patient classifications of III or greater, preexisting cardiovascular risks, preoperative core temperature <36°C, combined general and regional anesthesia, surgical duration of two hours or greater, major or intermediate surgery, frail or malnourished patients and elderly/geriatric patients (Moola et al., 2011; NICE, 2008; Torossian at al., 2015). Torossian et al. (2015) also recommended patients should receive pre-surgical information about IPH and associated risks.

At-risk population

The appropriateness of preoperative warming for ICU surgical patients was addressed in the body of evidence within the review of literature. Although, no RCT specifically focused on the preoperative warming of ICU surgical patients, Schell-Chaple, Puntillo, Matthay, Liu, & The National Heart, Lung, and Blood Institute Acute Respiratory Distress Syndrome Network (2015), described the benefit of higher temperatures for the improvement of prognosis and mortality in ICU patients. In the prospective study by Scheck, Kober, Bertalanffy, Aram, Andel, & Hoerauf (2004) the effectiveness of pre-procedure warming, for the maintenance of normothermia

(temperatures ≥ 36°C/96.8°F) in ICU patients who were transported for a computed tomography (CT) scan procedure was demonstrated. Torossian et al. (2015) identified IPH risk factors of frailty and malnourishment, which presents in many ICU patients. Therefore, the translation of preoperative warming principles for use in ICU patients undergoing major abdominal surgical procedures was deemed appropriate.

Warming methods

Recommended warming methods and devices, were addressed in the body of evidence within the review of literature. The systematic review by Hooper et al. (2010) found FAW to be more effective than passive warming. Additionally, the combination of preoperative active warming strategies that included warmed fluids and FAW, together, were found to be more effective at preventing IPH in geriatric patients and in surgeries with duration of two hours or greater (Moola et al., 2011; Torossian et al., 2015).

The guideline by Hooper et al. (2010) contained a recommendation for the use of active warming measures to include FAW, circulating water mattresses, radiant warmers and resistive heating blankets such as conductive carbon polymer mattress (CCPM). However, radiant warmers were found to be less effective than FAW in maintaining optimal body temperature during surgeries with duration greater than two hours (Moola et al., 2011). Additionally, Moola et al. reported CCPM to be effective, and passive warming was found to be ineffective at preventing significant hypothermia. The use of convective heating methods before induction of general and regional anesthesia was found to be very effective in preventing perioperative hypothermia, and was therefore recommended in the guideline by Torossian et al. (2015).

Warming timeframe

The recommended duration of preoperative warming ranged from 15-120 minutes

(Andrzejowski et al., 2008; D'Angelo Vanni et al., 2003; Hooper et al., 2010; Moola et al., 2011; NICE, 2008; Torossian et al., 2015; Wong et al., 2007). Preoperative warming was recommended for duration of 10-30 minutes in the guideline by (Torossian). Preoperative warming was recommended for duration of 15-60 minutes in the guideline by (Moola). Preoperative warming was recommended for duration of at least 30 minutes in the guideline by (Hooper) and (Nice). D'Angelo Vanni and Andrzejowski conducted RCTs to evaluate the effects of skin surface warming and prewarming on post-induction core temperatures, respectively, in which patients were preoperatively warmed for approximately 60 minutes. Wong conducted a RCT to examine the effects of additional perioperative systematic warming, in which patients were preoperatively warmed for 120 minutes. However, the rationale for the various duration of preoperative warming used/recommended in these RCTs and guidelines was not stated.

Standardization/documentation

The body of evidence within the review of literature contained recommendations for the standardization and documentation of the preoperative warming processes, including the use of a guideline checklist. Although, there were slight variations in the recommendations for measurement and documentation of patient's temperature, the use of same temperature measurement route and the assessment and communication of IPH risk factors were emphasized in four guidelines (Hooper et al., 2010; Moola et al., 2011; NICE, 2008; Torossian et al., 2015). The authors of the four guidelines also recommended the assessment of thermal comfort, the commencement of active warming for patients with body temperatures < 36°C (96.8°F) and passive and/or active warming in patients with body temperatures ≥36°C (96.8°F). Additionally, these guidelines included recommendations on the assessment and documentation of preoperative warming tolerance, in addition to standardized documentation and communication

using a guideline checklist.

Challenges

The comparison of systematic reviews and guidelines revealed an example of challenges inherent in the development of recommendations for standardized and measurable processes to prevent IPH. An example of such a challenge was found with two guidelines containing recommendations for the measurement of core or near-core temperature using the oral route, throughout the entire perioperative period (Hooper et al, 2010; Torossian et al., 2015). However, the use of the same temperature route throughout the perioperative period may be impractical or unfeasible (Flood, Rathmell & Shafer, 2015).

Synopsis

The authors of the RCTs, systematic reviews and guidelines provided recommendations for best practice for preoperative warming. The recommendations were based on the body of evidenced within the review of literature, and contained variations in the recommended warming devices, temperature measurement routes, warming duration, warming criteria and warming processes for preoperative warming. However, the body of evidence within the review of literature, showed consistency in its support for the use and efficacy of preoperative warming, for the prevention of IPH (Andrzejowski et al., 2008; Benson, McMillan, & Ong, 2012; D'Angelo Vanni et al., 2003; Hooper et al., 2010; Madrid et al., 2016; Moola et al., 2011; NICE, 2008; Poveda, Clark & Galvao, 2012; Scheck et al., 2004; Torossian et al., 2015; Wong et al., 2007).

Methods, Design, Setting and Sample

This DNP project design was to develop and evaluate a CPG for preoperative warming to prevent hypothermic complications in ICU patients undergoing major abdominal surgical procedures. The setting for this CPG was the ICU of a large academic teaching institution on the

east coast of the United States. This DNP project had a sample size of (n=4) for the GDT, a sample size of (n=8) for the CPG end users, for a total sample size of (n=12).

CPG Development Procedure

The CPG development occurred in eight stages between July 2016 and March of 2017. The eight stages of CPG development were: 1) meeting with administrative stakeholders, 2) formation of guideline development team (GDT), 3) development of CPG recommendations, 4) first round of development evaluation by the GDT, 5) second round of development evaluation by the GDT, 6) third round of development evaluation by the GDT, 7) checklist development, and 8) feasibility evaluation by end users. The initial timeline for the CPG development was between September 2016 and December 2016, however, multiple CPG revisions necessitated an adjustment of the CPG development time line, as reflected in Appendix D.

Meeting with administrative stakeholders

On July 27, 2016, the DNP student project leader met with administrative stakeholders at the large academic teaching institution. The administrative stakeholders included the chairman of the anesthesiology department, the chief patient safety & quality officer (CPSQO), the director/chief nurse anesthetist and a specialty manager for nurse anesthetists. The meeting included a power point presentation on the scope of the DNP project, as well as, a discussion on the efficacy of the proposed preoperative warming interventions. At the conclusion of the meeting, the chairman of the anesthesiology department directed the CPSQO to provide the DNP student project leader with internal warming data for colorectal surgical patients, and to serve as the liaison between the anesthesiology leadership and the DNP project team. The CPSQO provided de-identified institutional internal warming data to the DNP student project leader in August of 2016. The institutional warming data facilitated the identification of patients with the

highest warming needs, as well as, the development of recommendations for this CPG. The CPG recommendations are presented in Appendix E.

Formation of guideline development team

In August of 2016, the formation of the GDT began with identification of potential members. Five CPG stakeholders at the large academic teaching institution were identified and contacted to determine agreement for voluntarily participation on the GDT. The DNP student project leader introduced and described the project, team goals, member responsibilities, estimated time commitment, and also discussed the requirement to attend two to three weekly, one-hour in-person, video conferences or teleconferences.

The DNP student project leader presented communication methods, the possibility of additional meetings, extension of and early termination of the project. Of the five stakeholders identified by the DNP student project leader, three stakeholders agreed to voluntarily participate in the CPG development. Therefore, the GDT comprised a sample size (n=4), which included the DNP student project leader, an anesthesiologist (MDA), a DNP prepared certified registered nurse anesthetist (CRNA) and an operating room RN who led a previous preoperative warming effort for non-ICU patients at this same institution.

CPG development

In September of 2016, the DNP student project leader scheduled and held the first meeting with GDT members. Two GDT members attended the in-person meeting, and were provided an evidence review table. Additionally, preliminary CPG recommendations developed by the DNP student project leader were presented to the group. The evidence review table and recommendations were emailed to the third GDT member, who was unable to attend the meeting. All GDT members were requested to review the documents within a two week time

period, and to complete an electronic evaluation using the Appraisal of Guidelines for Research & Evaluation II (AGREE II) tool, as presented in Appendix F.

The AGREE II tool is an open source appraisal instrument, used worldwide to assess CPG structure, content and quality by guideline developers and users (AGREE Next Steps Consortium, 2009). The AGREE II tool consists of 23 items in six independent domains. The six domains were: 1) scope and purpose, 2) stakeholder involvement, 3) rigor of guideline development, 4) clarity of guideline presentation, 5) applicability of guideline, 6) editorial independence of GDT, and an overall assessment of guideline. The 23 items were rated on a seven point likert scale, ranging from 1 –strongly disagree and 7 –strongly agree to indicate the extent to which an evaluator believed a CPG contained information that adequately addressed each item.

The AGREE II tool has been found to meet accepted validity and reliability standards, with Cronbach's alpha scores that ranged between 0.64 and 0.89 (AGREE). The validity of the AGREE II tool is an indication that its 23 items can be used to accurately assess CPG structure, content and quality. The reliability of the AGREE II tool is an indication that its 23 items yield consistent and reproducible results. The AGREE II tool was chosen to evaluate the developed CPG, to ensure the CPG met acceptable standards for structure, content and quality.

Formulation of CPG Recommendations

The recommendations for best practice from the reviewed RCTs, systematic reviews and pre-existing preoperative warming guidelines, were adopted for the development of this CPG. The recommendations were derived from studies conducted on similar patient populations, surgical and anesthetic types and comparable facilities, thus making them specifically applicable to this institution. To guide the CPG development and customization for this institution, best

practice recommendations were combined with the workflow and input of ICU registered nurses (RNs). This CPG recommended the use of warming strategies currently available at this institution, as the review of literature did not reveal superiority in the use of any particular FAW device (Madrid et al, 2016). Additionally, this CPG was formatted with a template currently in use within this institution, to maintain consistency and to promote the ease of CPG use and adoption.

The RCT by Wong et al. (2007) examined the effects of additional perioperative systematic warming, and demonstrated statistically significant reductions in global postoperative complications associated with IPH. The global postoperative complications included SSI, chest infections, ileus, urinary tract infections, pelvic collection, cardiac complications, Clostridium Difficile infection, pressure ulcer and increased length of stay. To obtain similar outcomes, warming methodology/exclusion criteria were incorporated from Wong et al. (2007), this CPG similarly excluded laparoscopic procedures, hemodynamic instability (systolic blood pressure <90, heart rate >110, mean arterial pressure <60), and the presence of sepsis/septic shock, bowel obstruction, and the use of corticosteroids or other immunosuppressive drugs. However, the anesthesia leadership at this large academic institution requested a deviation from these exclusions. After consultation with critical care physicians who concluded and confirmed that the benefits of preoperative warming exceeded potential risks to the excluded patients, this CPG was modified to include laparoscopic abdominal surgeries with duration >2hrs and other major non-abdominal surgeries including vascular, spine, trauma, orthopedic procedures. Other recommendations derived from the feedback of GDT members and end users/stakeholders was the exclusion of lower-body warming devices on patients with critical limb ischemia, who are at risk of thermal burns to their lower extremities.

Development evaluations

The GDT members opted to communicate primarily via email to mitigate the difficulty and inconvenience of in-person, videoconference or teleconference meetings. The DNP student project leader received the first round of AGREE II development evaluations by the GDT members, revised the CPG recommendations, and emailed the revised document to the GDT members. For the second round of CPG evaluations, weekly email reminders were sent to the GDT members requesting comments on document revisions. Three GDT members completed the second round of AGREE II evaluations by the end of October of 2016. A fourth GDT member withdrew from the project. A replacement was found for the GDT member who withdrew. This new GDT member was oriented to the DNP project, and was provided with the necessary information and access to complete the first and second round AGREE II evaluations.

The CPSQO requested the DNP student project leader to include recommendations to supplement and sustain temperature regulation intraoperatively and postoperatively (Personal communication, 2016). An additional review of literature on this subject matter was completed in November of 2016. The best practice warming recommendations for the intraoperative and postoperative phases were excluded from this CPG, and provided in a separate document to the CPSQO. In December of 2016, the second round of GDT evaluations were reviewed and feedback incorporated into the CPG. The revised CPG was then returned the CPG to the GDT for a third round of evaluation using the AGREE II tool. By the end of December of 2016, the CPSQO provided suggestions and additional modifications to the recommendations, including formatting of the CPG.

Checklist development

A common theme provided by the GDT, was the need to create a checklist to facilitate compliance of end users with the recommendations and steps of the CPG (Personal communication, 2017). Therefore, a checklist was developed, which mirrored the steps and recommendations from the CPG. Once the checklist was completed, GDT members were requested to provide comments. These comments were reviewed and incorporated into the checklist. Additionally, a faculty advisor familiar with the large academic teaching institution and its CPG development process, recommended further revisions to the content and format of the checklist, which were also incorporated to finalize the development of the CPG checklist.

Feasibility evaluation

The CPG, CPG checklist and an end user evaluation tool were provided to an anonymous group of advanced practice nurses (APRNs) and S/ICU RNs, who were designated as potential end users and were therefore, requested to provide feedback on the feasibility of the CPG. The end user evaluation tool is an Acceptability/Applicability evaluation sheet (AAES), as presented in Appendix G. The AAES is an open source appraisal instrument contained in the ADAPTE resource toolkit, used by CPG developers to meet specific appraisal needs (The ADAPTE Collaboration, 2009). The ADAPTE resource toolkit has been widely validated, however, validity and reliability scores specific to the AAES, were not found in the literature review. The AAES was chosen to specifically assess CPG support and feasibility on the S/ICU.

The AAES was modified to contain instructions for completion, demographic/comment sections, and eight appraisal items. Four Acceptability appraisal items on the modified AAES focused on: 1) clarity and evidence-based underpinning of the CPG recommendations, 2) perceived benefit of preoperative warming to patients, 3) compatibility of preoperative warming

with ICU workflow, and 4) ease of using CPG. Four Applicability appraisal items on the modified AAES focused on: 1) feasibility of preoperative warming in the ICU, 2) feasibility of obtaining preoperative warming equipments, 3) expertise/ability of ICU nurses to use CPG, and 4) barriers would prevent CPG use. The Overall Acceptability/Applicability of the CPG elicited with two appraisal items on a seven point likert scales ranging from 1 –lowest and 7 –highest.

After the end users reviewed the CPG, the comments provided were used to complete additional revisions to the CPG, the CPG checklist and the AAES. Once revisions were approved, plans were made to conduct the CPG presentation and end user evaluations at the large academic teaching institution. The CPG presentation and end-user evaluations at the large academic teaching institution, was precluded by logistical challenges, which resulted in the use of an alternative implementation/evaluation strategy. The DNP project committee approved an alternative strategy that involved the deployment of the CPG, CPG checklist, evidence review table and the AAES by the faculty advisor to potential end-users.

Data Collection and Analysis

Data collection utilizing the AGREE II tool was not anonymous, as this tool included the names and email address of the GDT evaluators. To analyze AGREE II tool data, all scores on individual items in each domain were added and scaled as percentages of the highest possible scores in the respective domains. Scaled domain scores are calculated as follows: [(obtained score − minimum possible score) ÷ (maximum possible score − minimum possible score)] (AGREE Next Steps Consortium, 2009). All GDT members completed electronic versions of the AGREE II tool, which enabled automated analyses/calculations of scores for the six AGREE II domains.

Data collection utilizing the AAES was anonymous to the DNP student project leader, as

completed AAES were returned to the faculty advisor without any personal information. To analyze AAES data, descriptive statistics of mean, median and mode were calculated for the nominal, demographic and non-demographic data on the completed AAES. Qualitative data was reviewed and analyzed separately for emerging themes.

Results

The raw scores, scaled scores and comments provided for the six domains of the AGREE II tool are presented (three rounds of development evaluation) in Appendix H, I and J, respectively. Raw scores were converted into scaled domain and overall assessment scores, which provided quantitative appraisal of how well the CPG met accepted standards on content, structure and quality (AGREE Next Steps Consortium, 2009). Domain scores lower than 60% indicated areas on the CPG that were found to need improvement, need additional information, or were missing item scores from GDT members.

The scaled scores from the six domains of the AGREE II tool were not considered an accurate reflection of support for this CPG, as raw scores were not provided by a GDT member in up to six domains in the 1st and 2nd rounds of development evaluation, this impacted the overall score and skewed it lower. Additionally, two GDT members completed the 3rd round of AGREE II development evaluation. The comments provided by all GDT members provided a superior reflection of CPG support, as they provided context for the scaled domain scores and specific feedback for CPG revisions. Overall, all GDT members recommended the developed CPG for use.

The modified AAES was completed by (n=8) end users and analyzed quantitatively and qualitatively. The scores for the four Acceptability items on the modified AAES were as follows: 1) 63% for clarity and evidence-based underpinning of the CPG recommendations, 2)

86% for perceived benefit of preoperative warming to patients, 3) 75% for compatibility of preoperative warming with ICU workflow, and 4) 50% for ease of using CPG. The scores for the four Applicability items on the modified AAES were as follows: 1) 100% for feasibility of preoperative warming in the ICU, 2) 63% for feasibility of obtaining preoperative warming equipments, 3) 100% for expertise/ability of ICU nurses to use CPG, and 4) 100% for unsure barriers would prevent CPG use.

The end users provided substantive comments about the CPG, which supplemented and clarified quantitative responses on the AAES. One AAES evaluator suggested the elimination CPG steps where possible and another evaluator suggested the use of an algorithm/flow chart format, to improve the ease of use. These suggestions can be incorporated into future CPG revisions. Overall, the CPG received favorable feasibility scores from (n=8) end users comprised (n=5) advanced practice registered nurses (APRNs) and (n=3) perioperative S/ICU RNs. Most of the end users had been employed at the institution for 21-30 years. All comments on the AAES were reviewed, synthesized, grouped and are presented as Appendix K. additionally, demographic data is presented in Appendix L. The longevity and comments from these end users indicated they were knowledgeable about the institutional, preoperative warming and were credible evaluators. These end users provided an overall Acceptability/Applicability score on a seven point likert scale ranging between 1 –lowest and 7 –highest of (mean=5), which was considered a strong and positive indication of CPG feasibility.

Discussion

Facilitators

The facilitators for the development and implementation of this DNP project were: 1) A dedicated GDT, 2) the availability of information and resources from previous warming efforts,

3) the availability of a CPG template for the large academic teaching institution, 4) a manufacturer representative for the preoperative warming device, and 5) a supply of preoperative warming equipment provided at no cost to the patient or institution during a CPG implementation trial period (Personal communication, 2017).

Cost considerations

GDT members provided feedback on the potential financial cost of conducting preoperative warming at the institution. The large academic teaching institution and the manufacturer had established a partnership that predates this DNP project. The DNP student project leaders and the faculty advisor contacted the manufacture representative, who provided an updated cost quote and discussed the logistics for acquiring additional warming equipment in order to complete a cost data analysis to present to the institution.

The manufacturer provided an assurance in writing, they would provide warming units at no additional cost to the institution, as long as the institution continued the contract. Additionally, the manufacturer representative agreed to provide two cases of full body blankets for the proposed pilot at no initial cost and subsequent full body blankets at $10/case (this cost is absorbed by patients) (Personal communication, 2017). The initial cost of a 90-day preoperative FAW pilot via full body blanket ($0/patient/encounter) is lower than the approximate cost of purchasing, heating and laundering cotton blankets for the same duration, which is approximately $50/patient/encounter for an average of five blankets use per patient (Jardeleza, Fleig, Davis, & Spreen-Parker, 2011; Personal communication, 2017). Subsequently, the cost of preoperative FAW via full body blanket ($10/case of 10 blankets) would be at a lower than the cost of cotton blanket utilization ($50/patient).

The cost/benefit ratio of preoperative FAW via full body blankets is lower than that of

IPH and IPH-associated complications. Complications of IPH can include the following: impaired anesthetic metabolism, coagulopathy and altered immune responses, delayed emergence from anesthesia, increased hospital length of stay, SSI, and cardiovascular events. The estimated cost per patient of these complications can increase total hospitalization expenses by up to $7,500 (Good, Verble, Secrest, & Norwood, 2006).

Barriers

Barriers to the development and implementation of this DNP project included the complex and gradual processes for implementing practice change at the large academic teaching institution. After initial administrative stakeholder's permission was granted to the DNP project team to conduct this CPG guideline development, full consensus and demonstrable support of the steps required for further CPG development and evaluation varied at times, resulting in multiple revisions and an alternative evaluation process. Deliverables by school and varied email response time added to delays in development and implementation of this DNP project. Additionally, one student project leader made the completion of project tasks more challenging.

One member left the GDT during the 1st round of AGREE II evaluation. Another GDT member was unavailable for an extended period during the 3rd round AGREE II of evaluation and had limited communication access during this period of time. One GDT member provided feedback that the AGREE II website was initially difficult to navigate. The difficulty experiences with the navigation of the AGREE II website, contributed to delays in CPG development evaluations. The absence of the GDT member(s), further contributed to delay and lower 3rd round domain scores. Additionally, the expansion of the scope of this DNP project to include the intraoperative and postoperative phases added to the DNP project workload, and slowed progress on the preoperative warming phase of this CPG.

CPG sustainability

The CPG and cost/benefit advantage of preoperative FAW supported the recommendation of a 90-day pilot for the use of this CPG on the S/ICU. A 90-day pilot use would allow for the collection of process and outcome data, which could provide further CPG modifications for the sustained use of preoperative warming strategies, at this large academic teaching institution. It is hoped that the use of this CPG's best practice recommendations will become this institutions' standard of practice for preventing IPH and hypothermic complications.

Human Subjects Protection

Protection of human subjects' rights began with a submission of the DNP project proposal to an Institutional Review Board (IRB) for a Not Human Subjects Research determination (Query). The IRB reviewed the project proposal and made a Not Human Subjects Research determination as presented in Appendix M. The Appraisal of Guidelines for Research & Evaluation II (AGREE II) tool and the modified Acceptability/Applicability evaluation sheet (AAES) contained no personal identifiers of patients, staff, faculty or stakeholders. GDT and end user participation in the CPG development and evaluation was voluntary. The faculty advisor delivered the AASE to end user evaluators who remained anonymous to the DNP student project leader. As the AASE were returned by secured email or secured fax, after de-identification, they were delivered to the DNP student project leader for data analyses. Once data analyses were complete, the AASE were destroyed.

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Appendix A
Internal Warming Data

	A	B	C	D	E	F	G	H	I
1	Chart Review	Bed_Log	Surgery_Start	Surgery_Stop	CPT	PACU_Temp_C	ASA	NHSN	PostOPL
2	ASA 5. Initial OR temp 34.3. Active warming, fluid warmer	Removed	10/4/15 13:56	10/4/15 17:44	49000-EXPLORATORY	31.8	5	COLO	SICU
3	ASA 5E. initial OR temp 34.9. active warming, fluid warmer	Removed	1/6/16 1:00	1/6/16 2:22	LAPAROTOMY EXPLO	33.9	5	COLO	SICU
4	ASA 3E. From ED with free air and free fluid concistent with feculent material on CT, elevated lactate, hypotensive. Recent colorectal surgery 11/30. Initial temp 36.2. Active warming, fluid warmer. Transport to CSICU.	Removed	12/12/15 3:15		EXPLORATION LAPAR	34.6	3	COLO	CSICU
5	ASA 5E. Initial OR temp 34.6. Active warming, fluid warmer.	Removed	10/15/15 8:08	10/15/15 9:10	49000-EXPLORATORY	34.9	3	COLO	SICU
6	ASA 4. Initial OR temp 35. Active warming, fluid warmer	Removed	1/5/16 9:25	1/5/16 11:09	RESECTION BOWEL	35.1	4	COLO	SICU
7	ASA 3. Initial OR temp 36.2. Active warming, fluid warmer	Removed	12/3/15 9:30	12/3/15 15:37	PROCTECTOMY LAPA	35.7	3	COLO	PACU-NOR
8	From SICU. Initial OR temp 35.5. Active warming, fluid warmer	Removed	10/22/15 9:12	10/22/15 11:05	49000-EXPLORATORY	35.8	4	COLO	SICU
9	Initial OR temp 35.8. Active warming, fluid warmer	Removed	12/9/15 10:42	12/9/15 12:06	RESECTION COLON ^	35.8	3	COLO	PACU-NOR
10	Initial OR temp 34.9. Active warming. Ruptured diverticulitis. Fluid warmer	Removed	1/12/16 9:41		RESECTION SIGMOID	35.8	3	COLO	PACU-GOR
11	Initial OR temp 37.2. No monitors and equipment documented	Removed		11/16/15 14:17	PR EXCISION/DESTRU	35.9	3	COLO	PACU-GOR
12	Initial OR temp 36. Last OR temp 35.7. Active warming and fluid warmer.	Removed	1/6/16 13:04	1/6/16 17:05	RESECTION COLON SI	35.9	3	COLO	PACU-NOR

Appendix B

Melnyk & Fineout-Overholt/The Johns Hopkins Nursing Evidence-based Practice Rating Scales

Levels of Evidence

Rating System for the Hierarchy of Evidence: Quantitative Questions

Level I: Evidence from a systematic review of all relevant randomized controlled trials (RCT's), or evidence-based clinical practice guidelines based on systematic reviews of RCT's

Level II: Evidence obtained from at least one well-designed Randomized Controlled Trial (RCT)

Level III: Evidence obtained from well-designed controlled trials without randomization, quasi-experimental

Level IV: Evidence from well-designed case-control and cohort studies

Level V: Evidence from systematic reviews of descriptive and qualitative studies

Level VI: Evidence from a single descriptive or qualitative study

Level VII: Evidence from the opinion of authorities and/or reports of expert committees

Above information from "Evidence-based practice in nursing & healthcare: a guide to best practice" by Bernadette M. Melnyk and Ellen Fineout-Overholt. 2005, page 10.

QUALITY of the Evidence		
A High	Research	consistent results with sufficient sample size, adequate control, and definitive conclusions; consistent recommendations based on extensive literature review that includes thoughtful reference to scientific evidence.
	Summative reviews	well-defined, reproducible search strategies; consistent results with sufficient numbers of well defined studies; criteria-based evaluation of overall scientific strength and quality of included studies; definitive conclusions.
	Organizational	well-defined methods using a rigorous approach; consistent results with sufficient sample size; use of reliable **and** valid measures
	Expert Opinion	expertise is clearly evident
B Good	Research	reasonably consistent results, sufficient sample size, some control, with fairly definitive conclusions; reasonably consistent recommendations based on fairly comprehensive literature review that includes some reference to scientific evidence
	Summative reviews	reasonably thorough and appropriate search; reasonably consistent results with sufficient numbers of well defined studies; evaluation of strengths and limitations of included studies; fairly definitive conclusions.
	Organizational	Well-defined methods; reasonably consistent results with sufficient numbers; use of **reliable and valid** measures; reasonably consistent recommendations
	Expert Opinion	expertise appears to be credible.
C Low quality or major flaws	Research	little evidence with inconsistent results, insufficient sample size, conclusions cannot be drawn
	Summative reviews	undefined, poorly defined, or limited search strategies; insufficient evidence with inconsistent results; conclusions cannot be drawn
	Organizational	Undefined, **or** poorly defined methods; insufficient sample size; inconsistent results; undefined, poorly defined or measures that lack adequate reliability or validity
	Expert Opinion	expertise is not discernable or is dubious.

**A study rated an A would be of high quality, whereas, a study rated a C would have major flaws that raise serious questions about the believability of the findings and should be automatically eliminated from consideration.*

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Appendix C
Evidence Review Table

Author, year	**Study objective**	**Design/ Intervention or exposures compared**	**Sample (N)**	**Outcomes studied (How measured)**	**Results/ Recommendations**	**Limitations**	**Level and Quality Rating**
Wong et al., 2007	To examine the effects of additional perioperative systematic warming on postoperative morbidity.	RCT 2-hours of preoperative/ intraoperative warming, using Inditherm conducting carbon polymer mattress and warm fluids.	N= 103 Patients >18 years undergoing elective major open abdominal surgery requiring bowel resection, with or without anastomosis.	Global postoperative complications (SSI, chest infections, ileus, UTI, pelvic collection, cardiac complications, C. Diff, pressure ulcer and length of stay). Blood loss.	Lower complication rates (32 %) in preoperative warming group vs. (54 %) in the control group. (P =0·027). Patients in the warming group had lower blood loss (median 200 (range 5–1000) ml versus median 400 (range 50–2300) ml in the control group; P = 0·011).	The rationale for exclusion criteria was not provided. Only elective surgeries were included.	IIA
D'Angelo Vanni et al., 2007	To evaluate the effects of intraoperative skin-surface warming in preventing intra- and postoperative hypothermia, shivering and delayed tracheal extubation.	Prospective blinded RCT 1 hour of preoperative warming.	N=30 Female patients with ASA patient classification < III, undergoing elective abdominal surgery.	Mean skin, body and core temperatures at 15-minute intervals, using thermocouple probes. Shivering. Tine to tracheal extubation.	The patients who were warmed preoperatively and intraoperatively had core temperatures significantly higher than other patients during the first two hours of anesthesia. All patients warmed intraoperatively were normothermic only at the end of the surgery. No patient shivered in the intervention group, while 5 unwarmed patients shivered. No significant difference was found. Majority of warmed and unwarmed patients met generally accepted criteria for extubation, and were extubated in the operating room.	Small sample size. Only female patients were studied. Only elective surgeries were included.	IIB

Scheck et al., 2004	To determine frequency, intensity and possibility of treating hypothermia in critically ill transported patients.	Prospective blinded RCT Carbon fiber heating blanket was used during transport to the CT scan room.	N=30 Critically ill patients who were actively warmed during transport vs. control group.	Tympanic membrane temperature.	All patients were normothermic before leaving ICU (36-37°C). Core temperatures in the warmed group was higher by more than 1.5°C. (p=0.01). However, control group patients remained nearly normothermic at 35.9+/-0.3°C.	Small sample size.	IIB
Poveda et al., 2012	To analyze available research on the effectiveness of prewarming to prevent perioperative hypothermia and identify knowledge gaps for future research.	Systematic Review of English, Spanish or Portuguese RCTs published between January 1990 and November 2011. FAW vs. cotton blankets for passive warming.	N=14 RCTs Patients >18 years undergoing elective surgery.	Body temperature primarily via tympanic measurement. Effectiveness of FAW vs. Passive warming using cotton blankets. Incidence of hypothermia.	In the 4 prewarming-only studies, there was an unspecified statistically significant difference in postoperative temperatures (Jadad scores of 2-3). The authors concluded superior body temperature maintenance when using FAW in comparison with cotton blanket (Jadad scores of 1-3). Overall, a combination of preoperative and intraoperative FAW was more effective at maintaining body temperature >36°C.	Small sample size. Included RCTs >10 years.	IC
Andrzejowski, et al., 2008	To evaluate the effect of prewarming on post-induction core temperature and the incidence of IPH.	RCT ~60mins of preoperative FAW using Bair Paws 1000 BTU/h device and full or surgical access warming blanket".	N=68 Adult patients with ASA classification <III, undergoing spine surgery under general anesthesia.	Incidence of IPH. Core temperature difference >0.2°C at 40, 60 and 80mins post-induction.	Decreased incidence of IPH, with 68% of prewarmed patients maintaining temp >36°C, compared with 43% in the control group, throughout surgery (P<0.05). Prewarmed patients had a decrease in mean temperature that was smaller by 0.3°C than the control group (P<0.005, power of 0.8). The authors commented on the ability of FAW to effectively restore core temperature within 2 hours, which would eliminate the significance or clinical relevance of the temperature difference found, after 80mins.	Small sample size. A combination of general and regional anesthesia techniques. Did not include either technique alone.	IIB

Benson, et al., 2012	To determine efficacy of Patient-Controlled active warming gown.	Prospective RCT Intervention of patient-controlled Forced-air warming device and gown.	N=30 Orthopedic patients who were capable of operative a preoperative controlled FAW device.	Oral temp difference of 0.2°C. Patient satisfaction with the thermal comfort using 1-to-5 Likert rating scale. 48-hour opioid consumption difference. Post-op pain at 12 and 24 hours after surgery.	Patients who received warming gowns had higher temperatures ($P < 0.001$) at 30 and 60mins after admission and upon discharge from the PACU. Patients who received warming gowns, reported more satisfaction ($P = 0.004$) with their thermal comfort than did patients who received standard blankets. The standard blanket group used more total opioid on average than the warming gown group (53.6 ± 37.9 mg versus 31.9 ± 11.7 mg, respectively; $P = 0.05$) during the first 48 hours postoperatively on the unit. Pain scores were not significantly different in the two groups ($P = 0.08$).	Only addressed orthopedic surgery patients, who were capable of operating a preoperative controlled FAW device. Small sample size.	IIB
Schell-Chaple et al., 2015	To examine the relationship between body temperature in critically ill early Acute Respiratory Distress Syndrome (ARDS) patients with or without infection, and mortality.	Multicenter randomized study. Secondary analysis of body temperature by using data from the National Heart, Lung and blood Institute (NHLBI) ARDS Network Fluid and Catheter Treatment Trial.	N=969 Adult patients with ARDS ≤48hrs, who were randomized to receive a central venous catheter or pulmonary artery catheter and liberal or conservative fluid management strategies, per protocol.	Acute/ 90-day mortality based on 5 temperature groups (Temperature <34°C=deep hypothermia, Temperatures 34-35.9°C =mild hypothermia, Temperatures 36-38.2°C =normothermia, Temperatures 38.3-39.4°C =fever and Temperatures ≥39.5°C =high fever)".	After adjusting for primary cause ARDS on the Acute Physiology and Chronic Health Evaluation III (APACHE III), hypothermia and temperatures >39°C were associated with increased mortality ($P = 0.02$). For every 1°C increase in baseline temperature up to 39°C, odds of death deceased by 15% ($P=0.03$). The overall 90-day mortality rate of the sample was 267/969 (28%). Mean body temperature showed a modest but significant difference between survivors and non-survivors (37.6ºC vs. 37.3ºC.) ($P < .001$).	The logistics of intra-transport warming may make this intervention impractical Results may not be valid for translation to non-early ARDS critically ill patients.	IIIB

Madrid et al., 2016	To assess the effectiveness of active body surface warming systems (ABSW), for the preoperative and/or intraoperative prevention of unintended hypothermia and its complications	Systematic review of RCTs. Different ABSW systems and additional perioperative warming interventions.	N=67 RCTs n= 5438 patients n=7 RCTs on prewarming RCTs. n= 9 pre-and intraoperative RCTs. n= 23 RCTs of open abdominal surgeries.	Surgical site infection and complications. Major/other cardiovascular complications (bradycardia, hypotension, arrhythmias). Transfusions (number of participants transfused; blood product usage). Intraoperative IV fluids infused. Shivering (number of participants). Participant-reported thermal comfort. Adverse effects (including thermal burns). Superiority of ABSW systems (Bair Hugger, Bair Paws and Inditherm conductive carbon polymer mattress).	A reduction in global complication rates, including surgical site infections (32% versus 54%; P = 0.027). A reduction in major cardiovascular complications, particularly in patients with high cardiovascular risk. No significant reduction in the number of participants being transfused or the average amount of blood transfused. A reduction in total fluids infused during surgery (MD -144.49 mL) A reduction in shivering (29 studies, 1922 participants) Improved thermal comfort (standardized mean difference (SMD) 0.76, 4 trials, 364 participants). There were limited data on adverse effects (the most relevant being thermal burns). While some trials included a narrative report mentioning that no adverse effects were observed, the majority made no reference to it. Nothing so far suggests that ABSW involves a significant risk to patients. No evidence was found to support the superiority of any system in terms of clinical outcomes, except for extending systemic warming to the preoperative period in participants undergoing major abdominal surgery.	Only 23 of 67 and 16 of 67 RCTs focused on open abdominal surgeries and preoperatively warming, respectively. Only one study demonstrated statistically significant differences for all outcomes measured.	IA

Hooper et al., 2010	To develop consensus recommendation for the revision of the 2001 American Society of PeriAnesthesia Nurses guideline for promotion of perioperative normothermia and improved outcomes in adult surgical patients.	Guideline derived from the meta-analysis of published evidence.	Several RCTs and systemic reviews on temperature management.	Efficacy of preoperative warming. Route and temperature measurement. (Admission and Core temperatures). Assessment of IPH-risk factors and clinical signs. Warming procedure	Preoperative warming decreases IPH incidence, anxiety, surgical costs and other IPH complications. Prewarming improves patient satisfaction. Without active prewarming, a period of hypothermia typically occurs even if active warming is started after intraoperative administration of anesthesia. Temperature is best measured in the pulmonary artery, distal esophagus or tympanic membrane, via thermistor. Perioperative temperature should be measured using the same route. Risk factors, clinical signs and symptoms of hypothermia are shivering, piloerection and cold extremities. Also, determine patient's thermal comfort. Commence active warming for patients with body temperatures < 36°C (96.8°F). Active warming measures include FAW, circulating water mattresses, radiant warmers and resistive heating blankets etc. Patients requiring emergency procedures should be warmed as soon as is clinically feasible. Prewarming should be conducted for at least 30 minutes, with assessments of thermal comfort. Temperature should be attained before transfer to the operating room. Document and communicate all perioperative risk factor findings to all members of the surgical and anesthesia team.	100% consensus on all guideline recommendations or a presentation of majority and minority views on clinically important topic for which 100% consensus could not be reached.	IB

Moola et al., 2011	To recommend the most effective strategies for the prevention and management of hypothermia in the adult perioperative environment.	Guideline derived from the systematic review of RCTs and prospective studies.	N=19 studies. n=1451 adult patients >18 years, undergoing regional and general anesthesia for diverse surgical procedures with duration > 2 hours.	Core temperatures, shivering, morbid cardiac events, thermal comfort, Blood loss, surgical site infections, and hospital length of stay. Screening Warming procedures	Preoperative FAW compared to routine thermal care, effectively reduced the incidence of surgical wound infections, postoperative cardiac complications and increased length of hospital stay. All surgical patients, particularly, geriatric and patients undergoing surgeries > 2 hours are at risk for IPH, and should be preoperatively warmed, using standardized and measurable processes. Active warming should be built into care pathways, initiated as soon as patients arrive, last 15-60 minutes and continue intraoperatively. Multiple warming strategies such as active FAW plus warmed fluids should be used in older patients and those undergoing longer surgeries. Passive warming is not effective in reducing the incidence and magnitude of hypothermia, while radiant warming is not as effective as forced air warming in maintaining optimal body temperature during surgeries >2hrs. Conductive carbon polymer mattress is effective in preventing hypothermia.	There was no agreement on the superiority of a FAW method.	IB

NICE, 2008	To provide a guideline on best practice for the care of adult surgical patients undergoing general, regional or combined anesthesia	Guideline derived from the review of best available evidence.	N=Patients>18 years, undergoing general or regional anesthesia for elective or emergency surgeries.	Adverse effects of hypothermic complications, wound infections and morbid cardiac events. Screening and assessment. Warming procedures.	Preoperative warming prevents/reduces IPH and its associated complications. All patients should be assessed for individual risk of IPH. Patients with higher ASA classification, cardiovascular risks, preoperative core temperature <36°C, undergoing combined general and regional anesthesia for major or intermediate surgery should be managed as having higher IPH risk. Patient's temperature should be obtained and recorded within an hour before leaving for the operating room. Forced air warming should be preoperatively used for 30 minutes in non-emergent situations where patient's temperature is <36°C. Patients with temperature >36°C may be kept comfortably warm, using passive insulation. Patient's temperature should be ≥36°C before transfer to the operating room, and maintained intraoperatively.	Guideline may contain recommendations based on outdated evidence >10 years old.	1B

Torossian et al., 2015	Guideline to prevent hypothermic complications	Guideline based on >3 Systematic reviews and >26 RCTs.	N>2569 Men and Women undergoing regional and general anesthesia during diverse surgical procedures in European and US hospitals.	Complications of cardiac events, coagulation disorders, wound infection, pressure ulcers and post-operative shivering. Screening Warming procedure	Preoperative warming prevents/reduces IPH and its associated complications. All adult surgical patients undergoing regional and general anesthesia techniques are at risk for IPH. Patients should receive pre-surgical information about IPH and associated risks. A checklist should be used to implement IPH guideline. Actively prewarming patients for 10 to 30 minutes before induction of general and regional anesthesia is very effective in preventing perioperative hypothermia. Core body temperature should be measured 1-2 hours before a patient is moved into the OR and anesthesia administration commences. Perioperative core body temperature should be measured using the same method at the same site. Oral temperature measurement is less invasive and correlates well with core temperature.	There was no agreement on the superiority of a FAW method.	IB

Appendix D
Timeline

- Proposal was submitted and presented to committee members in April 2016.
- Proposal was submitted to IRB in May 2016.
- Project was developed between July 2016 and February 2017.
- Project was evaluated for feasibility in March 2017.
- Data was analyzed, synthesized and evaluated in March 2017.
- Project manuscript was submitted to committee in April 2017.
- Project report was presented to committee on April 10th, 2017.

Appendix E

Clinical Practice Guideline for Preoperative Warming

Background: Inadvertent perioperative hypothermia (IPH) is defined as, "a core temperature less than 36°C [96.8°F]" (Hooper et al, 2010 p. 348). IPH is an international and national problem that is estimated to occur in 50-90% of adult surgical patients (Moola & Lockwood, 2011; Roberson, Dieckmann, Rodriguez, & Austin, 2013). IPH is associated with complications such as impaired anesthetic metabolism, coagulopathy and altered immune responses (Flood, Rathmell & Shafer, 2015). IPH contributes to delays in emergence from anesthesia, and to increases in surgical site infections (SSI), surgical costs and cardiovascular events (Good, Verble, Secrest, & Norwood, 2006).

The induction of general anesthesia or general anesthesia combined with regional anesthesia has been identified as a significant IPH factor (Flood et al., 2015). The induction of general anesthesia is associated with the general dilation of blood vessels, which can blunt compensatory mechanisms for temperature regulation and facilitate heat redistribution from the core to periphery (Flood et al., 2015). The induction of general anesthesia or general anesthesia combined with regional anesthesia can contribute to reduction in core temperature by 1.6°C in the first hour, and by 2.8°C during three hours in a 22°C room (Flood et al., 2015). Therefore, the induction of general anesthesia can lead to temperature reductions that precipitate IPH (core temp <36°C) (Hooper et al., 2010).

The prevention of IPH is particularly important in patients who are frail, malnourished and undergoing major surgical procedures that last longer than two hours (Hart, Bordes, Corsino, & Harmon, 2011). Major surgical procedures such as abdominal and colorectal surgeries are often performed through large open abdominal incisions, and are associated with radiative and evaporative heat losses (Flood et al., 2015). Major abdominal surgical procedures performed

through large open abdominal incisions are also associated with large intravascular and extravascular fluid shifts, which may exaggerate hemodynamic changes and/or necessitate postoperative surgical or intensive care unit (S/ICU) stay (Flood et al., 2015). The intraoperative use of cold surgical site preparations, irrigation solutions and contact with cold surfaces/air (<22°C/71.6°F) also contribute to convective and conductive heat losses (Flood et al., 2015). Therefore, ICU patients undergoing major abdominal surgical procedures lasting longer than two hours, and require the induction of general anesthesia or general anesthesia combined with regional anesthesia, are particularly vulnerable to IPH (core temp <36°C) (Flood et al., 2015; Hart, et al., 2011).

Purpose: To provide guidance for preoperative temperature management of ICU patients, who present for major abdominal surgical procedures. The objectives, indications for use, inclusion/exclusion criteria, detailed steps for warming and checklist are addressed in the following clinical practice guideline (CPG).

Objectives:

- To facilitate the identification of patients who are most vulnerable to IPH (core temp <36°C).
- **To standardize the perioperative use of best practice strategies, for temperature management of ICU who present for major abdominal surgery.**
- To prevent/reduce complications associated with IPH, such as impaired anesthetic metabolism, coagulopathy, altered immune responses and hypothermic increases in surgical wound infections, surgical costs, cardiovascular events and morbidity and mortality.

- To buffer the occurrence of redistributive heat loss during the induction of general anesthesia and/or general anesthesia combined with regional anesthesia techniques.
- To prevent and/or reduce preoperative shivering, which can increase oxygen consumption by up to 400%, and deplete oxygen/energy stores in already frail patients with/without cardiac dysfunction (Flood et al., 2015).

Indication for Use: The recommendations within this CPG are a resource to be used by anesthesia clinicians and ICU registered nurses (RNs), for the preoperative temperature management of ICU patients presenting for major abdominal surgery. However, this guideline may apply to other types of surgical patients and procedures. Anesthesia clinicians include anesthesiologists (MD/DO), anesthesia residents and fellows (MD/DO), certified registered nurse anesthetists (CRNA) and student registered nurse anesthetists (SRNA). The ICU RN may delegate tasks associated with guideline implementation to Patient Care Technicians (PCT), as appropriate.

A 90-day pilot is proposed for the implementation of this CPG in the surgical ICU (S/ICU). Process and outcome measures are to be tracked for quality improvement purposes, using data recorded in the electronic health record and on guideline implementation checklists.

CLINICAL PRACTICE GUIDELINE FOR PREOPERATIVE WARMING

This section contains inclusion and exclusion criteria, and preoperative instructions for screening, warming preparation, warming steps and documentation/compliance.

A. Identification of **INCLUSION** criteria.

ABSOLUTE inclusion criteria:

- Open/"possible-open" abdominal and colorectal surgeries.
- Core/non-core temperature <36.0°C with shivering.

RELATIVE inclusion criteria:

- Laparoscopic abdominal surgeries with duration >2hrs.
- Other major non-abdominal surgeries (vascular, spine, trauma, orthopedic).
- Age >60 OR ASA classification >III AND the presence of cardiovascular disease.

B. Identification of **EXCLUSION** criteria**.**

ABSOLUTE exclusion criteria:

- Core/non-core temperature >37.5°C.
- Recent cardiac arrest (<7 days).
- Spinal cord and/or brain injury with risk of cerebral edema or herniation.
- Lower-body warming devices on patients with critical lower limb ischemia.

RELATIVE exclusion criteria:

- Emergent surgery with <30 minutes of preoperative time.
- Patients with heat intolerance e.g. moderate to severe hyperthyroidism

CLINICAL PRACTICE GUIDELINE FOR PREOPERATIVE WARMING

Procedure for preoperative phase warming

1). <u>Screening.</u>

- The presence of one absolute or two relative **inclusion** criteria indicates preoperative warming.
- The presence of one absolute or two relative **exclusion** criteria contraindicates preoperative warming.

2). <u>Warming preparation.</u>

- Equip eligible patients who are not already on a Bair Hugger underbody blanket, with a full body Bair Hugger blanket and Bair Hugger warming unit.
- If applicable, place a cotton blanket on top of the full body blanket to hold full body blanket in place, as needed.
- Obtain temperature in the hour preceding preoperative warming.

3). <u>Warming steps.</u>

- Begin active forced air warming (FAW) as soon as is feasible.
- Begin warming at the setting of 42°C on the Bair Hugger unit, when there is <30 minutes available for preoperative warming.
- Keep Bair Hugger warming unit temperature between 38-42°C.
- FAW should last for 15-60 minutes.
- Ensure that the hose of the Bair Hugger warming unit is not in direct contact with patient's skin.
- Obtain and document temperature at approximately 30-minute intervals (PA/Esophageal/rectal route is preferred).

- Assess for new onset of diaphoresis, tachycardia, temperature >37.9°C and vasodilatory hypotension.
- ICU RN may consult with ICU management team to treat symptoms of preoperative warming intolerance (SBP <90mmHg/MAP<60mmHg/HR>110) as needed.
- The Bair Hugger warming unit may be adjusted or turned off if preoperative warming intolerance occurs/persists.
- Obtain and document final temperature prior to patient transport to the operating room.
- Disconnect Bair Hugger warming unit before patient is transported to the operating room.
- Leave Bair Hugger warming blanket in place to preserve heat during transport to the operating room.

4). <u>Documentation/compliance.</u>

- Document assessment information and vital signs, including temperature and route in the electronic health record.
- Document eligibility and compliance with guideline steps on the guideline checklist.
- During presurgical hand-off, the ICU and OR RN/anesthesia clinician will verify the completion and tolerance of preoperative warming.

Preoperative ICU warming checklist

1). <u>Screening (check/circle all that apply).</u>

☐ Patient met one absolute inclusion criteria for preoperative warming.

☐ Patient met one relative inclusion criteria for preoperative warming.

☐ Patient met two or more inclusion criteria for preoperative warming.

2). <u>Warming preparation (check all that apply).</u>

☐ The patient was equipped with a____ full body or ____ underbody Bair Hugger blanket and Bair Hugger warming unit.

☐ Cotton blanket was placed on top of the full body blanket to hold full body blanket in place, if applicable/needed.

☐ Temperature was obtained and documented in the hour preceding preoperative warming.

3). <u>Warming steps (check all that apply).</u>

☐ FAW was started as soon as feasible before patient departed to the operating room.

☐ FAW was started ≥ 30 minutes before departure to the operating room.

☐ The Bair Hugger warming unit was set and maintained between 38-42°C.

☐ Hose of the Bair Hugger warming unit was not in direct contact with patient's skin.

☐ Temperature was obtained and documented at approximately 30-minute intervals (PA/Esophageal/rectal route is preferred).

☐ FAW occurred for ≤30 minutes to obtain/maintain temperatures of 37.0-37.9°C.

☐ FAW occurred for 30-60 minutes to obtain/maintain temperatures of 37.0-37.9°C.

☐ FAW occurred for ≥60 minutes to obtain/maintain temperatures of 37.0-37.9°C.

☐ New onset of diaphoresis, tachycardia, temperature >37.9°C and vasodilatory hypotension are assessed.

☐ The ICU RN consults with ICU management team to treat symptoms of prewarming intolerance (SBP <90mmHg/MAP<60mmHg) as needed (___Yes, ___No).

☐ The Bair Hugger warming unit was adjusted or turned off per continued warming intolerance (___Yes, ___No).

☐ Temperature was obtained in the hour before patient departed to the operating room.

☐ Bair Hugger unit was disconnected before transport, but warming blanket is left in place to preserve heat during transport to operating room.

☐ The ICU and OR RN/anesthesia clinician verified the completion and tolerance of preoperative warming during presurgical hand-off.

4). <u>Documentation/compliance.</u>

☐ Assessment information and vital signs, including temperature and route are documented in the electronic health record (or equivalent).

☐ The following deviations from the preoperative recommendations of this guideline occurred (if applicable):

_____

_____

_____

Appendix F
AGREE II Tool

Domain 1: Scope and Purpose (1-3) (For each question below, please circle the your choice).

1. The overall objective(s) of the CPG is specifically described.
   Strongly Disagree 1 2 3 4 5 6 7 Strongly Agree
   Comments:
2. The health question(s) covered by the CPG is specifically described.
   Strongly Disagree 1 2 3 4 5 6 7 Strongly Agree
   Comments:
3. The population to whom the CPG is meant to apply is specifically described.
   Strongly Disagree 1 2 3 4 5 6 7 Strongly Agree
   Comments:

Domain 2: Stakeholder Involvement (4-6)

4. The guideline development group includes individuals from all relevant professional groups.
   Strongly Disagree 1 2 3 4 5 6 7 Strongly Agree
   Comments:
5. The views and preferences of the target population and stakeholders have been sought.
   Strongly Disagree 1 2 3 4 5 6 7 Strongly Agree
   Comments:
6. The target users of the guideline are clearly defined.
   Strongly Disagree 1 2 3 4 5 6 7 Strongly Agree
   Comments:

Domain 3: Rigor of Development (7-14)

7. Systematic methods were used to search for evidence.
   Strongly Disagree 1 2 3 4 5 6 7 Strongly Agree
   Comments:
8. The criteria for selecting the evidence are clearly described.
   Strongly Disagree 1 2 3 4 5 6 7 Strongly Agree
   Comments:
9. The strengths and limitations of the body of evidence are clearly described.
   Strongly Disagree 1 2 3 4 5 6 7 Strongly Agree
   Comments:
10. The methods for formulating the recommendations are clearly described.
    Strongly Disagree 1 2 3 4 5 6 7 Strongly Agree
    Comments:
11. The health benefits, side effects, and risks have been considered in formulating the recommendations.
    Strongly Disagree 1 2 3 4 5 6 7 Strongly Agree
    Comments:
12. There is an explicit link between the recommendations and the supporting evidence.
    Strongly Disagree 1 2 3 4 5 6 7 Strongly Agree
    Comments:
13. The guideline has been externally reviewed by experts prior to its publication
    Strongly Disagree 1 2 3 4 5 6 7 Strongly Agree
    Comments:
14. A procedure for updating the guideline is provided.
    Strongly Disagree 1 2 3 4 5 6 7 Strongly Agree
    Comments:

Domain 4: Clarity of Presentation (15-17)

15. The recommendations are specific and unambiguous.
Strongly Disagree 1 2 3 4 5 6 7 Strongly Agree
Comments:
16. The different options for management of the condition or health issue are clearly presented.
Strongly Disagree 1 2 3 4 5 6 7 Strongly Agree
Comments:
17. Key recommendations are easily identifiable.
Strongly Disagree 1 2 3 4 5 6 7 Strongly Agree
Comments:

Domain 5: Applicability (18-21)

18. The guideline describes facilitators and barriers to its application.
Strongly Disagree 1 2 3 4 5 6 7 Strongly Agree
Comments:
19. The guideline provides advice and/or tools on how the recommendations can be put into practice.
Strongly Disagree 1 2 3 4 5 6 7 Strongly Agree
Comments:
20. The potential resource implications of applying the recommendations have been considered.
Strongly Disagree 1 2 3 4 5 6 7 Strongly Agree
Comments:
21. The guideline presents monitoring and/or auditing criteria.
Strongly Disagree 1 2 3 4 5 6 7 Strongly Agree
Comments:

Domain 6: Editorial Independence (22-23)

22. The views of the funding body have not influenced the content of the guideline.
Strongly Disagree 1 2 3 4 5 6 7 Strongly Agree
Comments:
23. Competing interests of guideline development group members have been recorded and addressed.
Strongly Disagree 1 2 3 4 5 6 7 Strongly Agree
Comments:

Overall Assessment

For each question, please choose the response which best characterizes the guideline addressed:
1. Rate the overall quality of this guideline.

Lowest possible quality 1 2 3 4 5 6 7 Highest possible quality

2. I would recommend this guideline for use:
Yes Yes with modifications No

Notes:

Appendix G
Modified Acceptability/Applicability Evaluation Sheet for Preoperative Warming CPG

Instruction: Please answer the questions below, then place completed sheet in the designated secure envelope.

Purpose: To obtain anonymous evaluation of the attached Preoperative Warming CPG, for potential pilot use.

Anonymous Demographic data section

End user/stakeholder's age range:

☐20-29 ☐30-39 ☐40-49 ☐50-59 ☐>60

End user/stakeholder's current clinical role:

☐Anesthesiologist (MD/DO) ☐Nurse Anesthetist (CRNA) Advanced Practice RN (APRN)
☐Student Nurse Anesthetist (SRNA) ☐Anesthesia Resident/Fellow (MD/DO) ☐Perioperative/S/ICU RN

End user/stakeholder's years of clinical practice:

☐0-10 ☐11-20 ☐21-30 ☐31-40 ☐>40

End user/stakeholder's total length of hospital employment:

☐0-10 ☐11-20 ☐21-30 ☐31-40 ☐>40

Instruction: Please review the attached clinical practice guideline for preoperative warming, and use this modified sheet to evaluate the recommendations within the guideline. To select a 'yes', 'unsure' or 'no' response, mark 'X' on the appropriate box.

Modified Acceptability questions:	Yes	Unsure	No
1) The recommendations within the CPG are clear and evidence-based.	☐	☐	☐
2) Patients will likely derive sufficient benefit from preoperative warming.	☐	☐	☐
3) The recommendations are compatible with the workflow of the ICU	☐	☐	☐
4) The CPG for preoperative warming is user friendly	☐	☐	☐
5) **Please write overall Acceptability comment/Circle overall score**	Lowest *1 2 3 4 5 6 7* Highest		

Modified Applicability questions:	Yes	Unsure	No
1) Preoperative warming of ICU patients is possible.	☐	☐	☐
2) Preoperative warming equipments can be obtained	☐	☐	☐
3) ICU nurses have the expertise to use this CPG for preoperative warming	☐	☐	☐
4) Resources, policies, time or views of the ICU RN will prevent CPG use	☐	☐	☐
5) **Please write overall Applicability comment/Circle overall score**	Lowest *1 2 3 4 5 6 7* Highest		

Appendix H
AGREE II Raw Domain Scores

1st round raw scores

Domain 1	Domain 2	Domain 3	Domain 4	Domain 5	Domain 6	OA 1	OA 2
79%	72%	48%	52%	48%	62%	50%	Yes - 0, Yes with modifications - 3, No - 1

Domain 1. Scope and Purpose

	Appraiser 5	Appraiser 1	Appraiser 3	Appraiser 2	Appraiser 6
Item 1	7	7	4	5	7
Item 2	5	7	4	6	7
Item 3	7	4	6	6	4

Domain 2. Stakeholder Involvement

	Appraiser 5	Appraiser 1	Appraiser 3	Appraiser 2	Appraiser 6
Item 4	5	4	6	6	4
Item 5	4	7	4	5	7
Item 6	6	5	6	6	5

Domain 3. Rigour of Development

	Appraiser 5	Appraiser 1	Appraiser 3	Appraiser 2	Appraiser 6
Item 7	7	7	5	5	7
Item 8	5	-	1	5	5
Item 9	6	-	1	5	6
Item 10	4	-	1	5	6
Item 11	5	-	1	5	6
Item 12	6	-	1	5	5
Item 13	5	-	6	5	6
Item 14	5	-	1	6	5

Domain 4. Clarity of Presentation

	Appraiser 5	Appraiser 1	Appraiser 3	Appraiser 2	Appraiser 6
Item 15	4	-	4	6	5
Item 16	6	-	4	6	5
Item 17	6	-	5	6	5

Domain 5. Applicability

	Appraiser 5	Appraiser 1	Appraiser 3	Appraiser 2	Appraiser 6
Item 18	5	-	4	4	5
Item 19	5	-	4	5	5
Item 20	7	-	4	4	4
Item 21	6	-	5	6	4

Domain 6. Editorial Independence

Appraiser 5	Appraiser 1	Appraiser 3	Appraiser 2	Appraiser 6

Item 22	6	-	7	4	6
Item 23	7	-	4	6	7

Overall Assessment

	Appraiser 5	Appraiser 1	Appraiser 3	Appraiser 2	Appraiser 6
OA1	5	-	4	6	5

2nd round raw scores

Domain 1	Domain 2	Domain 3	Domain 4	Domain 5	Domain 6	OA 1	OA 2
77%	72%	53%	54%	56%	53%	47%	Yes - 3, Yes with modifications - 1, No - 0

Domain 1. Scope and Purpose

	Appraiser 6	Appraiser 5	Appraiser 1	Appraiser 2	Appraiser 4	Appraiser 9
Item 1	7	-	7	7	5	7
Item 2	7	-	7	7	6	7
Item 3	7	-	7	7	6	7

Domain 2. Stakeholder Involvement

	Appraiser 6	Appraiser 5	Appraiser 1	Appraiser 2	Appraiser 4	Appraiser 9
Item 4	5	-	7	7	6	7
Item 5	5	-	7	7	6	6
Item 6	6	-	7	6	7	7

Domain 3. Rigour of Development

	Appraiser 6	Appraiser 5	Appraiser 1	Appraiser 2	Appraiser 4	Appraiser 9
Item 7	6	-	7	7	7	7
Item 8	6	-	-	7	6	6
Item 9	5	-	-	7	6	7
Item 10	5	-	-	7	4	6
Item 11	5	-	-	7	3	7
Item 12	5	-	-	7	4	7
Item 13	5	-	-	7	6	7
Item 14	5	-	-	7	6	7

Domain 4. Clarity of Presentation

	Appraiser 6	Appraiser 5	Appraiser 1	Appraiser 2	Appraiser 4	Appraiser 9
Item 15	6	-	-	7	4	7
Item 16	6	-	-	7	5	7
Item 17	7	-	-	7	6	7

Domain 5. Applicability

	Appraiser 6	Appraiser 5	Appraiser 1	Appraiser 2	Appraiser 4	Appraiser 9
Item 18	7	-	-	7	6	7

Item 19	7	-	-	7	5	7
Item 20	7	-	-	6	5	7
Item 21	6	-	-	7	7	6

Domain 6. Editorial Independence

	Appraiser 6	Appraiser 5	Appraiser 1	Appraiser 2	Appraiser 4	Appraiser 9
Item 22	6	-	-	7	3	6
Item 23	7	-	-	7	7	7

Overall Assessment

	Appraiser 6	Appraiser 5	Appraiser 1	Appraiser 2	Appraiser 4	Appraiser 9
OA1	6	-	-	6	5	6

3rd round raw scores

Domain 1	Domain 2	Domain 3	Domain 4	Domain 5	Domain 6	OA 1	OA 2
42%	42%	42%	42%	42%	40%	13%	Yes - 2, Yes with modifications - 0, No - 0

Domain 1. Scope and Purpose

	Appraiser 2	Appraiser 5	Appraiser 4	Appraiser 6
Item 1	7	-	-	7
Item 2	7	-	-	7
Item 3	7	-	-	7

Domain 2. Stakeholder Involvement

	Appraiser 2	Appraiser 5	Appraiser 4	Appraiser 6
Item 4	7	-	-	7
Item 5	7	-	-	7
Item 6	7	-	-	7

Domain 3. Rigour of Development

	Appraiser 2	Appraiser 5	Appraiser 4	Appraiser 6
Item 7	7	-	-	7
Item 8	7	-	-	7
Item 9	7	-	-	7
Item 10	7	-	-	7
Item 11	7	-	-	7
Item 12	7	-	-	7
Item 13	7	-	-	7
Item 14	7	-	-	7

Domain 4. Clarity of Presentation

	Appraiser 2	Appraiser 5	Appraiser 4	Appraiser 6
Item 15	7	-	-	7

Item 16	7	-	-	7
Item 17	7	-	-	7

Domain 5. Applicability

	Appraiser 2	Appraiser 5	Appraiser 4	Appraiser 6
Item 18	7	-	-	7
Item 19	7	-	-	7
Item 20	7	-	-	7
Item 21	7	-	-	7

Domain 6. Editorial Independence

	Appraiser 2	Appraiser 5	Appraiser 4	Appraiser 6
Item 22	7	-	-	6
Item 23	7	-	-	7

Overall Assessment

	Appraiser 2	Appraiser 5	Appraiser 4	Appraiser 6
OA1	-	-	-	7

Appendix I
AGREE II Scaled Domain Scores

Domain	Round 1 Score (%)	Round 2 Score (%)	Round 3 Score (%)
1) Scope and purpose	79	77	42
2) Stakeholder involvement	72	72	42
3) Rigor of guideline development	48	53	42
4) Clarity of guideline presentation	52	54	42
5) Applicability of guideline	48	56	42
6) Editorial independence of GDT	62	53	40
Overall guideline assessment	50	47	13

Appendix J
AGREE II Domain Comments

1st round comments

Domain 1. Scope and Purpose

Item 1

- Appraiser 3: Purpose: to develop a preoperative Clinical Practice Guideline (CPG) for the standardization of warming measures to prevent hypothermic complications in ICU patients and outpatients presenting for major abdominal surgery.

  Overall goal: to prevent and reduce the incidence and complications of Inadvertent Perioperative Hypothermia (IPH) (core temp <36°C) in vulnerable surgical populations using standardized warming procedures.

Item 2

- Appraiser 5: some of the specifics of when to commence warming and who and where warming commences need to be clarified.

Item 3

- Appraiser 1: "Select" critically ill and major abdominal surgical patients are identified, but the inclusion criteria for preoperative warming are not clear.

Domain 2. Stakeholder Involvement

Item 4

- Appraiser 5: An ICU and Preoperative nurse/management contribution needs to be added.
- Appraiser 1: Content experts are included appropriately in the development group and review/evaluation includes a broader range of end-users, which is appropriate. Ideally, stakeholders such as ICU and preoperative RNs would be included in the development/evaluation of the logistics of the guideline's proposed actions.

Item 5

- Appraiser 5: This is not a prospective study. This question is not applicable.
- Appraiser 1: Appropriate for patient population. Literature concerning patient comfort was included appropriately.

Item 6

- Appraiser 5: It should be further clarified which aspects of the guideline is implemented by the ICU, Preoperative nurse and CRNA/MDA.
- Appraiser 1: Consider more specifically identifying the areas that this should be used - outpatient surgery prep unit? PACU holding area for surgical inpatients? ICUs? TRU?

Domain 3. Rigour of Development

Item 8

- Appraiser 5: Cochrane review provided the Wong Study, which showed statistically significance for outcomes of preoperative warming. This guideline is modeled after the Wong study.
- Appraiser 3: I didn't see this in your write up

Item 9

- Appraiser 5: This is addressed in the evidence review table. Strengths were primarily/more emphasized than limitations.

Item 10

- Appraiser 5: The Wong Study methodology was used as well as critically thought-out customization of actually perioperative steps.

Item 11

- Appraiser 5: The benefits of preoperative warming were emphasized. Literature did not suggest risks associated with preoperative warming. Studies addresses patients' thermal comfort as potentially affected if patients are warmed for too long. In critically ill patients, warming can cause vasodilation and hemodynamic changes. This changes may/are often corrected with the administration of vasopressors such as phenylephrine which will both vasoconstrict and increase hemodynamic pressures.
- Appraiser 3: This was not included in your guideline
- Appraiser 2: I have provided feedback on the materials made available to me directly to the investigator

Item 12

- Appraiser 5: The steps in this guideline are evidence-based and modeled after empirical studies and clinical knowledge.
- Appraiser 2: I have made specific suggestions directly to the investigator

Item 13

- Appraiser 5: The "experts" in this context are members of the small implementation team, who have provided feedback for modification of this guideline.
- Appraiser 2: Suggestions have been made directly to the investigator

Item 14

- Appraiser 5: It is recommended that the Anesthesia/Anesthesiology department use evidence-based approach for modifying this guideline as needed, in the future.

Domain 4. Clarity of Presentation

Item 15

- Appraiser 5: Some ambiguity was present in this first version. Feedback provided by "experts" will be used to clarify and modify areas of ambiguity.

Item 16

- Appraiser 5: Preoperative, intraoperative and postoperative modalities are included for thermal regulation.

Item 17

- Appraiser 5: Clarity can be improved.

Domain 5. Applicability

Item 18

- Appraiser 5: Barriers can be clearer identified.
- Appraiser 2: There must be a clear by in by the providers that will implement this practice guideline. I have not seen a clear and simplified checklist for the providers to follow provided for review.

Item 19

- Appraiser 5: To be further clarified using "expert" feedback.
- Appraiser 2: These recommendations are contained within the final 4 pages of the document. It is not certain how easy these will be for all providers to follow, Simplification of the amount of steps and the wording is recommended.

Item 20

- Appraiser 2: It needs to be made clear how many additional warming units will be required to implement these guidelines on all appropriate patients. It is not clear how much additional money will be required purchase these blankets and if it will be willing to do so. Ideally, alternative methods to pre-warm patients should be discussed. Is it possible to utilize warmer pre-op holding rooms or other renewable sources of temperature control?

Item 21

- Appraiser 5: A checklist is included.

Domain 6. Editorial Independence

Item 22

- Appraiser 5: The views of institution experts have been incorporated.
- Appraiser 2: This was not clearly identified in the body of work. However, it is not expected that external funding will be present in this CPG implementation.

Overall Assessment

- Appraiser 2: It is necessary that the actual guidelines for this project be put in a clear and concise format. It is not wise to assume there will be no additional expenses associated with prewarming of all patients who meet inclusion criteria for this CPG. There must be an estimate of how many additional forced air warmers be purchased to successfully implement this CPG. Will the institution be willing to budget more money to provide the supplies. The facilitators or champions of this project need to be clearly identified. Are there enough to make success for this CPG likely?

CLINICAL PRACTICE GUIDELINE FOR PREOPERATIVE WARMING

2nd round comments

Domain 1. Scope and Purpose

Item 1

- Appraiser 2: The literature supports a CPG for this patient care issue.

Item 2

- Appraiser 2: All of the necessary elements are covered.

Item 3

- Appraiser 1: Please update to recognized degree abbreviations (e.g. MD, DO) or use physician to refer collectively to these. Alternately, consider use of "clinician" to describe CRNAs and MD/DO anesthesiologists collectively.
- Appraiser 2: All of the necessary elements are included.

Domain 2. Stakeholder Involvement

Item 4

- Appraiser 2: The CPG includes a description of the necessary provides and the description of their duties.

Item 5

- Appraiser 2: This was made clear in previous iterations surrounding the development of the CPG
- Appraiser 4: Views of target population were not sought. This was addressed in CPG.

Item 6

- Appraiser 2: It is worthwhile to consider inclusion of key members of the surgical team in this as well. Particularly since they play a key role in the development of IPH.

Domain 3. Rigour of Development

Item 7

- Appraiser 2: The literature review was thorough.

Item 8

- Appraiser 2: This was presented in previous iterations

Item 9

- Appraiser 2: This was provided in previous iterations

Item 10

- Appraiser 2: Yes.
- Appraiser 4: A description of the methods for formulating recommendations could be expanded. How was it customized for institution?

Item 11

- Appraiser 2: This was clearly laid out in previous iterations.
- Appraiser 4: Exclusion criteria (presence of a bowel obstruction)- why are these patients being excluded/any evidence of contraindication for bowel obstructions?

Item 12

- Appraiser 2: Yes
- Appraiser 4: Will preoperative warming for Same Day Surgery patients be clinically significant with current data? Are these patients generally hypothermic after open abdominal surgery with standard intraoperative warming devices? Should critically ill/ICU patients be the main focus?

Item 13

- Appraiser 2: A description of this process was presented.

Item 14

- Appraiser 2: There will be a daily re-assessment as well as a 90-day pilot of the CPG.

Domain 4. Clarity of Presentation

Item 15

- Appraiser 2: Yes
- Appraiser 4: Guidelines use three different options for preoperative warming. Should specify or narrow down to options that already exist on nursing units. Are Inditherm carbon fiber blankets available at institution? Would this be adaptable if there are large costs associated with this method of warming?

Item 16

- Appraiser 2: This was presented in the body of the CPG
- Appraiser 4: Intraoperative warming process- 2.5- Clarify this method of warming. Would cotton blanket over underbody warming blanket pose a risk to skin integrity?

  Will preoperative areas have access to machines for Bair Hugger blankets?

Item 17

- Appraiser 2: Yes

Domain 5. Applicability

Item 18

- Appraiser 2: Yes.
- Appraiser 4: Fitting prewarming into the existing workflow of the preoperative/intraoperative staff is essential to the success of these implemented guidelines.

Item 19

- Appraiser 2: Yes.
- Appraiser 4: An example of the RN checklist would be helpful along with a brief guide for applications timeline/process

Item 20

- Appraiser 2: They were considered. It is uncertain how much additional money will be required to purchase more warming blankets and maintain or purchase new Forced Air machines.
- Appraiser 4: There are funding/budget concerns for machines/inditherm blankets on the preoperative and inpatient units.

Item 21

- Appraiser 2: Yes

Domain 6. Editorial Independence

Item 22

- Appraiser 2: Yes.

Item 23

- Appraiser 2: Yes.

Overall Assessment

- Appraiser 2: Overall, this is a very worthy CPG to implement

3rd round comments

Domain 1. Scope and Purpose

No comments found for this domain.

Domain 2. Stakeholder Involvement

No comments found for this domain.

Domain 3. Rigour of Development

No comments found for this domain.

Domain 4. Clarity of Presentation

No comments found for this domain.

Domain 5. Applicability

No comments found for this domain.

Domain 6. Editorial Independence

No comments found for this domain.

Overall Assessment

- Appraiser 6: This CPG has evolved tremendously from its initial version. Strong work on incorporating GDT feedback and improving clarity in all aspects.

Appendix K
Qualitative comments from the Modified Acceptability/Applicability tool (AAES)

Communication/Coordination comments:
"There are several variables that delay the OR alerting the ICU of an OR time (OR charge RN workload, variability in previous OR case length, turnover time). [*Applicability of*] this CPG will heavily rely on improved communication between the OR charge RN about the expected time frame of the ICU patient to the OR to begin warming process. The OR charge RN/OR clerk should be involved in CPG education to improve the process of preoperative warming".

"Must have adequate notice from OR to initiate preoperative warming".

"Provide information regarding patient education".

"Education specifying the importance of this EBP guideline to decrease likelihood of post-operative complications could facilitate buy-in by the nursing staff".

Process comments:
"A flow chart (algorithm) may be more user friendly".

"This [*CPG*] would benefit from a flow chart and/or graphic to make implementation easier".

"[*The CPG*] checklist is quite lengthy, unnecessary questions can be eliminated, and instructions should be provided to nurses on what to do with assessment information such as diaphoresis".

"Need to make sure there are enough Bair Huggers".

"Treatment for pre-warming intolerance besides removing heater needs to be described. Consider the addition of a maintenance or sustainability phase, once patient is at [*desired*] temperature, and [*specify*] how to monitor to prevent over-heating".

"[*Specify*] cut off age for adult [*patients targeted in this intervention*]".

"[*Availability of*] resources in terms of equipment (heating units and blankets) may be an issue".

"We need to know how often this [*CPG*] will be used (estimate), to know if we have enough Bair hugger machines".

"This is likely to fall off the radar for all patients who are not 1st case, because the preoperative checklist is done by night shift, yet it is the day shift RN who sends the patient to the OR. For second case OR patients, we would need signage and lots of in-services to help the staff realize how important this is, and to brainstorm a workflow to make the CPG part of the unit culture".

Acceptability/Applicability comments:
"There is consistent applicability of the CPG for use within a perioperative area".

"Based on literature and recommendations from the AORN and AANA, this intervention is possibly beneficial. It appears [*that*] a true consensus to this practice may not have been established. But the CPG is reasonable for the appropriate candidates".

"The CPG requirements for the ICU RN are reasonable in the preoperative preparation of patients for surgery".

Appendix L
Demographic data from the Modified Acceptability/Applicability tool (AAES)

	(N=5) (APRNs) and (n=3) Perioperative S/ICU RNs		
	Mean years	Median years	Mode years
Age range	44	40-49	30-39
Clinical practice	23	21-30	11-20
Employment at institution	19	21-30	21-30

Appendix M
Not Human Subjects Research Determination

Not Human Subjects Research (NHSR) Confirmed

To: Promise Olomo

Link: HP-00070032

Description: An IRB Analyst has reviewed the information provided and has determined that the project meets the definition of *Not Human Subjects Research* (NHSR). IRB oversight is not required and no further actions are required.

Submission Title: Clinical Practice Guideline for Preoperative Warming