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AST Guidelines for Best Practice in Maintaining Normothermia in the Perioperative Patient

Introduction

The following Guidelines for Best Practices were researched and authored by the AST Education and Professional Standards Committee, and are AST approved.

AST developed the guidelines to support healthcare delivery organizations (HDO) reinforce best practices in maintaining *normothermia* in the perioperative patient as related to the role and duties of the Certified Surgical Technologist (CST®), the credential conferred by the National Board of Surgical Technology and Surgical Assisting (NBSTSA). The purpose of the guidelines is to provide information OR supervisors, risk management, and surgical team members can use in the development and implementation of policies and procedures for maintaining normothermia in the perioperative patient in the surgery department. The guidelines are presented with the understanding that it is the responsibility of the HDO to develop, approve, and establish policies and procedures for the surgery department regarding maintaining normothermia in the perioperative patient per HDO protocols.

Rationale

Physiology of Normothermia

The following information provides a review of the physiology of *core body temperature* control to stress the importance of the surgical team being an advocate for the patient by taking proactive, rather than reactive, measures to prevent *inadvertent patient hypothermia* (IPH), also referred to as unintended or unplanned perioperative hypothermia.

Strict core body temperature is critical to normal cellular, enzymatic, and organ function.[1] The control of the temperature is strictly regulated by the body within 0.2° C; this is referred to as the *interthreshold range*.[1,77] Temperature regulation involves both the central and peripheral nervous systems through autonomic and behavioral triggers. Afferent signals for cold and hot sensations are transmitted through A-delta and C nerve fibers.[1] Temperature signals from the skin, spinal cord, abdominal tissue, and thoracic tissue combine in the anterior spinal cord and travel to the primary region of temperature control, the hypothalamus.[1] The hypothalamus triggers autonomic and behavioral responses to the changes in temperature.

The human body closely controls the core body temperature through a variety of physiological responses, including autonomic nervous system stimulation, sweating, and increased heat production via non-shivering and shivering thermogenesis.[1] Autonomic actions, including peripheral vasoconstriction or vasodilation, occur in reaction to controlling core body temperature.[1]

Physiology and Causes of Hypothermia

Heat loss occurs through four mechanisms: *conduction, convection*, *evaporation*, and *radiation*.[1] Conduction is the transfer of heat through physical contact with a colder, solid object, for example, when the patient is positioned on the cold mats of the OR table. Conductive heat loss also occurs when cold IV fluids and blood products are administered; the infusion of a large amount of ambient or cold fluids can quickly decrease the temperature of the circulating blood. Convection is the movement of heat based on air flow, for example, cold winter air blowing over the body. The rate of convective heat loss depends on the velocity of the air currents; additionally, this increases the conductive heat loss.[4,5] Evaporation involves the loss of heat through surface skin sweating or fluid loss from exposure of internal organs and tissues to the atmosphere, that is, open surgical procedures that involve the thoracic and abdominal cavities. Radiation is the infrared transfer of heat that occurs when the skin and viscera are warmer than the environment. Exposed patients can rapidly experience radiant heat loss as compared to the surgical patient that is covered by sterile drapes. However, it is the most significant method of heat loss with approximately 60% occurring by radiation.[1]

Normothermia is defined as a body's core temperature of 36° C, and hypothermia is defined as a core temperature below 36° C.[1,6-9,142] It is estimated that IPH occurs in more than 50% of U.S. surgical patients, including those undergoing a short procedure, defined as 1½ hours or less.[9] The commonly accepted levels of hypothermia are:[5]

- Mild 34° - 36° C
- Moderate 32° - 34° C
- Severe <32° C

Hypothermia with a patient core temperature of <32°C has a mortality rate of 21%.[5,10]

Multiple issues combine to contribute to IPH. OR temperature contributes to IPH through radiant heat loss. The OR's cool environment is maintained for the comfort of the members of the sterile surgical team who are working under warm surgical lights while wearing a hair cover, mask, gown, double gloves, and occasionally, a lead apron under the gown, often under stressful conditions for an extended period of time. Therefore, the OR temperature is often kept cool. The Facility Guidelines Institute and American Society for Healthcare Engineer's recommend an OR temperature of 20°C - 23° C.[11] As previously mentioned, conductive heat loss occurs when the patient is positioned on the cold mats of the OR table and convection heat loss occurs by laminar airflow.[1]

However, anesthetic-induced impairment of the thermoregulatory control is the primary cause of IPH in the non-emergent patient. This impairment combined with the exposure of tissues and major organs in body cavities for a length of time in the cool environment of the OR can increase the severity of IPH.[10,12-14] General anesthesia impairs the body's autonomic temperature control and heat-preserving functions of the hypothalamus, effecting the inter-threshold temperature range to vary by 2-6° C.[1,10] During the first 30 – 40 minutes of anesthesia, the patient's temperature can drop to below 35° C.[44,141]

The induction of anesthesia causes a three-phase decrease in body core temperature. Initially, anesthesia produces peripheral vasodilation causing redistribution of the blood flow away from the body's core to the periphery through arteriovenous shunts that are anastomoses linking arterioles and veins.[2-4,9,10] Approximately 90% of this heat loss to the environment through the skin is via convection and radiation.[1] The redistribution can occur for up to three hours, making it the primary contributor to body heat loss during the surgical procedure.[1] After redistribution, the core temperature slowly decreases over the next 2 – 4 hours, assuming the surgical procedure lasts that long, primarily from heat loss that is greater than metabolic heat production.[3] After that period of time, the core temperature plateaus and remains about the same for the duration of the procedure. The plateau phase is thought to represent heat loss that is equal to heat production.[3]

Neuraxial anesthesia is just as much of a risk factor for IPH as general anesthesia.[13,14] Redistribution during neuraxial anesthesia decreases the core temperature approximately half as much as compared to general anesthesia, but is still a primary cause of core heat loss during the first hour of the surgical procedure.[1] The regionally blocked portion of the body is unable to shiver or vasoconstrict.[1,16] Additionally, neuraxial anesthesia changes the patient's behavioral responses to hypothermia.[1] Patients that receive neuraxial anesthesia may report they are warm, when actually they are hypothermic, leading the team to believe no action is necessary.[16] Lastly, core body temperature is often not monitored during procedures with neuraxial anesthesia and therefore, IPH is not detected.[1]

Besides anesthesia, there are several medical conditions and traumatic injuries that predispose the patient to IPH including adrenal insufficiency, basilar skull fractures, brain tumors, hypoglycemia, hypothalamic injuries, hypothyroidism, malnutrition, spinal cord injuries, and subdural hematomas (see Table 1).[4,13,14]

Table 1
Risk Factors for IPH

Patient-Specific Risk Factors	**Factors That Contribute to Body Heat Loss**
• Shock. • Alcohol. • Head injury. • Bacterial toxins. • Extremes of age. • Spinal cord injury. • General anesthesia. • Epidural & spinal anesthesia. • Medical conditions: adrenal diseases, cardiac dysfunctions, diabetes, hepatic diseases, malnutrition, thyroid diseases. • Surgical procedures that have an increased risk for IPH: long, complex invasive procedures including cardiac, thoracic, organ transplant, total hip and knee arthroplasty.[17]	• Burns. • Exposure.

Physiological Outcomes of IPH

Research studies have also linked an association between IPH and multiple perioperative complications including:[12,13,16,18-21]

- cardiac abnormalities and complications,[22]
- impaired wound healing and susceptibility to surgical site infection (SSI),[5,13,23,61]
- coagulopathies that are associated with an increase in blood loss leading to transfusion requirements,
- slowed drug metabolism that causes prolonged drug action that delays recovery and other metabolic disorders, and
- post-anesthetic shivering that can increase pain and considerably increases oxygen consumption by the muscle cells.[4,24]

Hypothermia affects the myocardium, including a decrease in the strength of left ventricular contractions with a reduction in cardiac output, and atrial and ventricular arrhythmias.[10] The initial arrhythmia that will be recognized on the electrocardiograph is sinus tachycardia.[4] As the core body temperature decreases a co-related progressive bradycardia occurs.[4] Furthermore, hypothermia decreases the release of oxygen from hemoglobin to the tissues, further impairing the delivery of oxygen that can result in a life-threatening complication, particularly for the patient with multiple traumatic injuries who is already experiencing a lowered circulating oxygen level.[5]

Hypothermia has been linked with increased risk of SSI due to vasoconstriction and decrease in delivery of oxygen to tissues.[1,140] IPH causes thermoregulatory vasoconstriction that decreases the level of oxygen. When this occurs, oxygen delivery to subcutaneous tissues decreases, thus impairing the strength of the collagen matrix that supports the healing tissues and scar, and delaying wound healing.[1,23] Studies have shown that following surgery IPH can significantly increase the risk for bacterial SSI.[2,10] Other complications include impaired functions of neutrophils and macrophages, chemotaxis, and phagocytosis.[1,3-5] One study showed that the incidence of SSI in patients that had experienced mild IPH was three times higher as compared to the normothermic perioperative patients.[25] A reduction in core temperature of 1.9° C has been shown to triple the occurrence of SSI after colon resection and increase the hospital stay by 20%.[4,23] The Association for Professionals in Infection Control and Epidemiology (APIC) has consistently referred to the Centers for Disease Control and Prevention's (CDC) *Guideline for the Prevention of Surgical Site Infection* that states excellent surgical technique contributes to a reduction in SSI, and these techniques include the prevention of IPH.[26] The National Institute for Health and Care Excellence (NICE) states that maintaining normothermia will reduce the risk of infection at the surgical site and ensure that patients feel comfortably warm at all times.[140] Additionally, the avoidance of tissue ischemia by the use of intraoperative warming has been shown to significantly reduce the risk of pressure sores.[10] By reducing the risk of SSI, surgical patients can decrease their intake of antibiotics.

One of the most researched and documented effects of hypothermia is coagulopathy and blood loss. However, the research has provided inconsistent results.[16] Hypothermia effects hemostasis through three factors: impaired platelet function, coagulation cascade enzyme dysfunction, and initiation of fibrinolysis.[1,3,5] In one study, life-threatening coagulopathy occurred in trauma patients who required a massive transfusion with a temperature below 34° C along with a co-morbid increase in metabolic acidosis.[4,27] Prothrombin time is significantly increased at a core body temperature of <35° C that implies the primary mechanism of hypothermia-induced coagulopathy is due to altered enzymatic activity.[5] Lastly, hypothermia increases blood viscosity creating the risk for the development of blood clots and emboli with diminished blood flow.

Hypothermia has been estimated to increase blood loss by up to 30%, and up to a 70% probability of the need for transfusion during surgery.[10,16,141] Even a core body temperature reduction of 0.5° C has been shown to have a physiologic effect on blood loss.[30] In one study, 150 patients undergoing a total hip arthroplasty were randomly assigned to be either warmed to 36.5°C or 36°C. Several outcomes were better in the group warmed to 36.5°C, including the amount of blood loss.[29] The authors concluded that aggressive intraoperative warming can reduce blood loss in total hip arthroplasty patients. This was further supported by another study in which FAW was applied for total hip arthroplasty patients.[8,29] A metanalysis reported that a median patient temperature of 35.6° C resulted in an increased blood loss and risk of transfusion.[11] A retrospective study of noncardiac surgeries published in 2015 reported transfusion requirements increased in proportion to the decrease in body core temperature, as well as the length of time that hypothermia occurred.[31]

Drug metabolism and elimination is affected by core body temperature. Drugs can remain in the circulatory system longer than usual in the hypothermic patient.[5] Hypothermia decreases the abilities of temperature-sensitive enzymes that metabolize and clear anesthetic drugs from the body, thus increasing the drugs duration of action. However, the hypothermic effect on the potency of drugs differs depending on the type of drug.[1] The duration and increased action of drugs, such as benzodiazepines, morphine, propofol, and several nondepolarizing neuromuscular blockers, for example, atracurium, rocuronium, and vecuronium, can be extended by 40% – 50% by the pharmacokinetic effect of hypothermia.[1,3,9,5,32-36] Hypothermia increases the solubility of inhaled anesthetics.[37] The combination of increased duration of muscle relaxants and solubility of inhaled anesthetics explains how hypothermia may be a contributing factor for the delay of emergence and recovery from general anesthesia.[37,38] Additionally, hypothermia can cause a decrease in the twitch response, even when neuromuscular blocking drugs have not been administered.[39]

Rewarming a hypothermic patient can cause additional serious metabolic complications due to blood that was pooled in the peripheral vascular beds of the body that now returns to the body's core.[19-21] Along with the transport of the blood, acid metabolites are also released resulting in cardiac instability.[4] The signs and symptoms of hemodynamic instability include hypotension, myocardial depression, and release of metabolic acids.[4]

Moderate to severe shivering can occur between 34° C - 36° C core body temperature that results in an increase in oxygen demand by as much as 400%, and an increase in myocardial work load and blood pressure.[4,5,10] During shivering, all patients are vasoconstricted.[40] In the postoperative patient, shivering can increase the level of pain due to the overall body movement. Postoperatively, cutaneous warming decreases the patient's level of thermal discomfort, oxygen consumption, and shivering intensity; however, it does not stop the duration of shivering.[40]

These complications can cause prolonged recovery and hospital stay that contributes to loss of work and wages, increased treatment costs for the patient, and an increase in the risk of healthcare acquired infection (HAI).[10,24,41,42] Studies have shown that hospital stays can be 20% - 65% longer for the IPH patient.[10]

Time spent in the PACU is also affected by hypothermia. Studies have reported an increase in 40 minutes to two hours in hypothermic patients, particularly if the discharge criteria include that the patient must be normothermic.[43] In positive terms, the prevention of IPH clearly benefits the patient through reduced morbidity and mortality that is correlated to reduced hospitalization costs and faster recovery (see Table 2).

Table 2
Effects of IPH on Body Systems

Body System	Effects of IPH
Cardiovascular Disorders.	• Bradycardia. • Arrhythmias. • Metabolic acidosis. • Myocardial ischemia. • Blood viscosity increased. • Peripheral vasoconstriction. • Impaired tissue oxygen delivery.
Coagulopathy.	• Impaired platelet function. • Impaired coagulation factors. • Impaired clotting enzyme function.
Decreased Metabolism of Drugs.	• Decreased renal circulation. • Decreased hepatic functions.
Gastrointestinal.	• Decreased motility.
General Metabolic Disorders.	• Shivering. • Acidosis.
Increased Risk of SSI.	• Sepsis. • Decrease of WBC. • Impaired immune response. • Impaired function of neutrophils.
Neurological.	• Confusion.

Evidence-based Research and Key Terms

The research of articles and randomized controlled trials is conducted using the Cochrane Database of Systematic Reviews and MEDLINE®, the U.S. National Library of Medicine® database of indexed citations and abstracts to medical and healthcare journal articles.

The key terms used for research include: active warming, ambient temperature, conduction, convection, core body temperature, evaporation, inadvertent patient hypothermia, inter-threshold range, lethal triad, meperidine, and neuraxial anesthesia. Key terms used in the guidelines are italicized and included in the glossary.

Guideline I

The patient, and patient's family, should be provided preoperative education on maintaining the warmth of the patient.

1. Maintaining normothermia begins in the home. The night before surgery, and the morning of surgery when travelling to the HDO, the patient should be kept warm.[15]
   A. During the preoperative interview, the patient and family should receive verbal and written instructions for maintaining normal body temperature at home, particularly during the winter months.[15]
      (1) The patient and family should be informed that staying warm before surgery will lower the risk of postoperative complications.[15]

   (2) The patient and family should be advised to bring extra clothing, such as slippers and nightwear, because the HDO environment may be colder as compared to home.[143]

B. It is recommended the patient take his or her temperature before going to bed the night before surgery and the morning of surgery.[15]

   (1) The patient should try to maintain a normal body temperature as close to 37° C as possible.[15]

2. The patient and family should be provided discharge teaching and instructions regarding methods to maintain normothermia at home, such as the use of blankets, increased clothing and socks, and increased room temperature.[143]

Guideline II
The anesthesia provider is ultimately responsible for assessing the patient for the risk of IPH.

1. The American Society of Anesthesiologists (ASA) considers the use of aggressive perioperative thermal management to maintain normothermia in the surgical patient is imperative to positive surgical outcomes.[12,25] The optimal approach to hypothermia is to prevent it from occurring, starting in the preoperative phase of care.
2. All non-emergent surgical patients should have their risk for IPH assessed and documented preoperatively by the anesthesia provider.
   A. Patients should be considered as having a higher risk for developing IPH if two of the following apply.[139]
      (1) An ASA grade of 2-5.
      (2) The patient is undergoing a major surgical procedure.
      (3) The patient is at risk for cardiovascular complications.
      (4) The patient is undergoing combined general and regional anesthesia.
      (5) The preoperative core body temperature is below 36°C and preoperative warming cannot be accomplished due to urgency of surgical procedure.
   B. The preoperative assessment should include the following because they can be a part of the cause of IPH.[13-15,24,44-51]
      (1) OR temperature is below 20° C.
      (2) The risk for cardiovascular complications.
      (3) Type and length of the surgical procedure.
      (4) The extremes of age – very young or elderly.
      (5) The patient is diagnosed with chronic hypotension.
      (6) The patient has had previous cardiovascular or organ transplant surgery.
      (7) Devices that need to be used for the procedure, for example, tourniquets.
      (8) The ASA patient grade is 2-5, and the higher the grade, the greater the risk.
      (9) The patient is diagnosed with congestive heart failure or other cardiac diseases.
      (10) The type and length of anesthesia, for example, general anesthesia or combined neuraxial and general anesthesia.
   C. The risk assessment should include reviewing the patient's medical chart, interviewing and physical examination of the patient, and discussing the anesthesia plan and surgical procedure with the patient.[9]

(1) The patient should be assessed for the risk of shivering.
(2) The patient's preoperative baseline temperature should be measured and documented.[52]
(3) The risk assessment should consider the age of the patient.
    (a) Neonates and infants are more susceptible to IPH than adults due to a high ratio of body surface area to weight that causes more heat loss.[13,14] Neonates are also at an increased risk because of disproportionately larger heads, and thinner skulls and scalps, allowing a greater heat loss from the brain as compared to adults.[14]
    The anesthesia plan for pediatric patients should include the use of equipment to humidify warm anesthetic gases as an adjunct to other warming methods, such as FAW.
    The OR should be prewarmed above 26° C and maintained at that temperature.[53] One study of pediatric patients reported an increased risk of IPH by 1.96 times in an OR temperature of less than 23° C.[53] Warm IV fluids and irrigation fluids at body temperature (37° C) should be used.
    (b) The thermoregulatory mechanisms of the elderly are often not optimal requiring the surgical team to be diligent in the provision of warming methods.[19-21] Elderly patients often have less subcutaneous tissue, and the thermoregulatory mechanisms of vasoconstriction and shivering are less effective.[9]
(4) Patients that have suffered extensive burns must be carefully assessed.
    (a) Patients with burns easily lose body heat by radiation and convection, and have lost the insulation of the skin placing them at a higher than normal risk for IPH.
    (b) Warm IV fluids and irrigation fluids at body temperature (37° C) should be used.
    (c) If possible, FAW should be used. If the patient suffered burns over a large portion of the body it may not be possible to use any type of active warming method and as much of the body surface should be covered as possible.
    (d) The OR should be prewarmed above 26° C and maintained at that temperature.
(5) If a patient is on an antipsychotic drug therapy plan, it should be assessed and documented. Antipsychotics impair the thermoregulatory functions of the hypothalamus.[7]
(6) The assessment should include evaluating and documenting the patient's body weight. Low body weight is a risk factor for IPH.[27] Slender patients have less insulation and a larger body-surface-area-to-weight ratio. Whereas, bariatric patients have a high weight-to-body-surface ratio and the peripheral adipose tissue is maintained at a normal to high temperature.
(7) Patients should be assessed for metabolic disorders that can interfere with normal thermoregulation. Studies have shown patients with diabetic neuropathies tend to have a low core body temperature when under

anesthesia for two hours when compared to non-diabetic surgical patients.[54]

(8) The plan and risk assessment documentation should include anesthesia diagnosis, anesthesia plan and method(s) of anesthesia to be used, surgical procedure to be performed, patient assessment risk for IPH, and planned interventions for preoperative, intraoperative and postoperative warming to prevent IPH.
   (a) The plan should be developed based upon the specific, documented risk factors that have been identified for the patient.
   (b) If the plan includes the use of a pneumatic tourniquet, such as for a Bier block, it should be documented. Pneumatic tourniquets lessen hypothermia by blocking the exchange of blood and heat between the extremity and rest of the body.[30,28] However, the risk factor is when the tourniquet is released. Redistribution of the blood flow and heat from the core to the extremity occurs resulting in a sharp decrease in core temperature.[28,30]

(9) The risk factor assessment findings and plan should be shared with all members of the surgical team to allow the team the ability to plan ahead of time to make sure devices and equipment are in working order and available for the procedure.[52] Abreu developed a personalized Hypothermia Risk Index (pHRI) as a tool to identify, in advance, patients that are at risk for hypothermia. However, he acknowledges further studies are needed to confirm its usefulness (see Table 3).[55]

Table 3
Personalized Hypothermia Risk Index

Parameter	**Y/N**	**Value**	**Insert Value of Y Responses**
Autonomic Responses			
Piloerection		1	
Shivering – mild or cold hands/feet (pallor)		2	
Shivering – pronounced		3	
Behavioral response			
Cold?		1	
Hot?		0	
Neutral?		0	
Unresponsive/unable to communicate		1	
Core/brain temperature			
<34.5°C		4	
≥34.5°C to <35.5°C		3	
≥35.5°C to <36°C		2	
≥36°C to <36.5°C		1	
≥36.5°C		0	

Total:

Patients with a score of ≥4 are at an increased risk for developing complications from hypothermia and should be closely monitored during and after surgery.
Abreu M. New Concepts in Perioperative Normothermia: From Monitoring to Management. Anesthesiology News. 2011; 37(10); 39-48.

3. Patient's that have sustained one or more traumatic injuries are susceptible to IPH. The "*lethal triad*" of hypothermia, impaired coagulation, and metabolic acidosis significantly decreases the patient's ability to recover from traumatic injuries.[19-21] Trauma patients are unintentionally hypothermic before they reach the HDO.[19-21] Hypothermic trauma patients are less likely to survive their injuries when compared to trauma patients who are normothermic.[4,19-21,56,43] Up to 50% of trauma patients that are particularly at risk for IPH are neonates/infants, elderly, and homeless.[4]

   Factors that can contribute to the high incidence of IPH in the trauma patient include prolonged exposure to the weather elements, alcohol intoxication, head injury, and shock.[4] A French study, conducted in 2012, confirmed that the three most significant risk factors for IPH are severity of injury, temperature of IV fluids, and temperature inside the ambulance.[57] The study reported that the level of hypothermia is linked to the severity of the injury, such as blood loss, and spine or head injuries that impair the body's internal temperature regulating mechanisms.[57]

   As with all patients, cross-departmental teamwork is essential. Emergency first-responders, Emergency Medical Technicians and Paramedics, and the surgery team must take under consideration the factors that contribute to IPH tend to be exaggerated in the trauma patient.

A. Emergency first-responders must be aware that the infusion of cool isotonic solutions, such as normal saline, contributes to IPH and complicates the ability of the surgical team to achieve normothermia.[19-21,57] Additionally, when the trauma patient is in shock, hypoperfusion can further exacerbate IPH.[24,58,59]
   (1) Warming trays should be used in the ambulance to keep IV fluids warm.[19-21]
   (2) It is recommended that only enough IV fluids should be administered to maintain the systolic blood pressure at 85-90 mm Hg.[21,57]
   (3) Emergency first-responders and the surgery team must be aware of the signs and symptoms of metabolic acidosis, and be prepared to treat the condition.

B. Other risk factors that should be addressed and treated in the trauma patient are shivering and coagulopathy.
   (1) Trauma patients should be covered as best as possible, and as soon as possible, at the scene and when being transported. Emergency foil blankets are effective in retaining body heat. Wet clothing should be removed. However, if the clothing is not wet, as little should be removed as possible that still allows access to the traumatic injuries. The compartment heater of the ambulance should be turned on to make the patient area warm.[56,57]
   (2) The challenge for the surgery team is the trauma patient's coagulation laboratory test results may be reported as normal because the blood sample(s) are heated to 37° C before being tested.[5]

C. If the trauma patient is hypothermic and all other immediate measures have been completed such as covering the patient, the next step is to verify the core body temperature. See Standard of Practice IV for sites where the temperature is taken and recorded.

Guideline III

100% of patients should be adequately covered on the ward and during transfer to the preoperative holding area.

1. The patient should be adequately covered on the ward or any other units, such as the ICU before and after surgery.[24]
   A. The patient should be encouraged to communicate to healthcare providers and/or family if he/she is not warm enough.
2. During transfer from the ward or other unit such as the ICU, the patient should be adequately covered to prevent IPH.
   A. It is recommended that the patient be covered with one sheet and at least two warm blankets prior to transfer.[24]
      (1) If a CST is responsible for transporting the patient, he/she should visually confirm that as much of the surface area of the patient is covered including arms.
      (2) The CST should verbally confirm with the patient that he/she is warm and provide additional blankets if the patient expresses being cold.

3. While waiting in preoperative holding, the patient must be kept warm by providing additional warm blankets, particularly if the patient has been administered premedications.[15] Shivering by the patient should be prevented.
4. 100% of non-emergent patients should have a temperature of 36°C or above prior to transport into the OR and before the start of anesthesia.[24]
   A. The core body temperature should be taken and documented at least one hour before the patient is transported from the ward or other units, such as the ICU, to preoperative holding.[140] If the patient's temperature is 36°C or above, active warming should begin a minimum of 30 minutes before induction of anesthesia, unless it would delay emergency surgery.[139]
      (1) If a CST is responsible for transporting the patient to the preoperative holding area, he/she should confirm the body temperature has been recorded in the patient's hospital chart.
   B. If a patient has been preoperatively assessed for being at-risk for IPH it is recommended that FAW is implemented in preoperative holding.[15,139]

Guideline IV
The body temperature of the patient should be recorded throughout the perioperative period.

1. Body temperature is just as important of a vital sign as the blood pressure or pulse.[24]
   A. Research does not provide a definitive recommendation as to the best or preferred method for monitoring patient temperature, but the method should be selected based upon the clinical situation including:[61-65]
      (1) length of the surgical procedure and anesthesia,
      (2) type of anesthesia, that is, general versus neuraxial,
      (3) ease of access to the site or route for obtaining the body temperature, and
      (4) how anesthesia will be delivered, for example, intravenous (IV), mask, or endotracheal tube.
   B. Studies recommend that the temperature should be recorded every 15 minutes for general anesthesia patients.[67] However, NICE recommends measuring and recording the core body temperature every 30 minutes until the end of the surgical procedure.[140] Additionally, the temperature should be recorded on admission to PACU and every 15 minutes for up to a minimum of 24 hours postoperatively.[24, 140]
      (1) The patient's temperature should be measured and documented before the induction of general or neuraxial anesthesia.[15]
      (2) Adult patients receiving FAW are unlikely to become hyperthermal due to sweating that cools the body. However, neonates, infants, and adolescents quickly become warm and require close monitoring.[3]
   C. Temperature measurement is divided into two categories, core temperature and near-core.[52] NICE recommends to measure the patient's temperature using a site that produces either a direct measurement of core body temperature or a direct estimate of core body temperature that is accurate to within 0.5° C of direct measurement.[139] An indirect estimate of core body temperature should not be used in surgical patients.[139] Clinical studies report the sites that most accurately provide core temperature readings are the cutaneous via zero-heat-flux thermometry, distal

esophagus, nasopharynx, pulmonary artery, and tympanic membrane via thermocouple.[3,5,17,52] Near-core sites include the axilla, bladder, oral chemical dot thermometers, rectum, skin, temporal artery, and tympanic membrane with infrared sensor.[52] However, whichever method and site is chosen, a consistent measuring site and technique should be used throughout the perioperative period to detect changes in temperature from the baseline and obtain comparative results.[52,61,68,69]

(1) Bladder temperature can be measured with a urinary catheter that contains a temperature transducer.[70] Bladder temperatures provide a good calculation of the core temperature as long as the urine flow is good; if the urine flow is low the accuracy of the bladder temperature monitoring decreases.[3,70,71] Therefore, obtaining an accurate bladder temperature relies on a third factor, urine flow, making the bladder a less than optimal site.

(2) Distal esophageal temperature accurately reflects core temperature, but the reading is affected by the use of humidified gases if the probe is not positioned far enough, and may be affected during open cardiothoracic procedures because the cavity is exposed to ambient air.[70,71] However, the site is easy to use and minimally invasive.[17]

(3) Nasopharyngeal temperature is measured by placing the esophageal probe superior to the soft palate; this positions the probe close to the brain to obtain an accurate core temperature.[9] But the temperature measurement can be affected by inspired gases.[70,71]

(4) Pulmonary artery catheters measure the central blood temperature that directly measures the core temperature.[70] However, pulmonary artery catheter use is usually for patients that require close hemodynamic monitoring due to their invasiveness and high cost of the catheters.[70,71]

(5) Studies have indicated tympanic membrane via thermocouple, also called thermistor, measurements are highly reliable and consistent, and are the preferred perioperative method.[3,5,9,17,50] The tympanic membrane is close to the carotid artery and hypothalamus allowing for an accurate measure of core body temperature, and taking the measurement is noninvasive.[70,71]

However, infrared tympanic thermometry and temporal artery thermometers do not provide an accurate temperature measurement during the perianesthesia period.[17,52]

D. CSTs should complete training in the use, care, and handling of temperature recording devices to include applying infection control policies of the surgery department.[139]

(1) On the day of the surgical procedure, the CST should collaborate with the anesthesia provider and other members of the surgical team confirming the availability of the temperature recording device that has been documented to be used in the patient's anesthesia plan.

(2) The CST should complete training on how to test the temperature recording device prior to use on the patient. The CST should test and use the temperature recording device according to the manufacturer's instructions for use (IFU). Additionally, the temperature recording device should be calibrated according to the manufacturer's IFU.[66]

(3) The training should include how to clean and store the devices according to manufacturer's IFU.

Guideline V

FAW, circulating-water device, conductive/resistive devices, for example, electric heating pads and conductive warming mattresses, and energy transfer pads are recommended methods for perioperative warming of the surgical patient and preventing IPH.

1. The method(s) of warming should be selected by the surgical team after discussing all the patient factors including the planned surgical procedure, preventing access to the surgical site, preventing access to IV sites, and patient position.[72]
   A. A combination of active and passive warming methods should be used based on the evidence provided in studies.[73-76]
      (1) Methods for maintaining normothermia are categorized as passive or active. Active warming requires the use of a device, such as a FAW device. It is recommended the surgical team employ both methods to prevent IPH.[17] Research has established the importance of preventing IPH, particularly as a component of the lethal triad; however, the research has not definitively established what is the best warming method.[45,48,49,62,72,77-85]
   B. Passive warming refers to decreasing heat loss by insulation, for example, covering exposed skin surfaces to the extent possible. This is accomplished through the use of warm blankets, foil blankets, sterile drapes, and plastic bags, for example, anesthesia provider covers the head of the patient with a plastic bag.
      (1) Rubber warming bottles or warm IV fluid bags should never be used to warm patients, in particular pediatric patients. The temperature of the bags cannot be controlled and can result in patient burns.
   C. FAW is an effective method of active warming.[6,86] FAW utilizes the mechanisms of convection and radiation.[23] The movement of the warm air transfers heat to the surface of the patient's skin; this allows FAW blankets to transfer more heat at a lower temperature.[23,86] However, in hypothermic patients, particularly trauma patients, peripheral vasoconstriction can limit the efficacy of FAW, and other methods, such as the heated water blanket, may be more effective.[5,87] For a summary of the available methods see Tables 4 and 5.
   D. Circulating-water devices use convective heating to warm the patient.[88] Several studies have confirmed the effectiveness of circulating-water devices with a focus on its use during pediatric and adult cardiac surgery, and major open surgery, such as liver transplant. Research consistently shows that circulating-water devices are more effective than FAW during cardiac and major open surgery.[3,23,28,52,42,89]
      (1) Due to a decrease in the surface area for effective cutaneous heat transfer, FAW has been shown to be insufficient during cardiac surgery and major open surgery.[90] However, the circulating-water garment allows the surgical team to cover a much larger surface area with the ability to position it under the patient and wrap around the anterior surface to cover the torso, legs, and upper arms.[90] Three studies showed that the mean core temperature of patients was significantly higher with the use of the

circulating-water garment as compared to the control group in which FAW was used.[21,23,91] In a study that used nine volunteers, the conclusion is the circulating-water garment transferred more heat than FAW with the difference resulting mainly from posterior heating.[90]

E. The majority of research has established conductive/resistant heating devices as an effective method for preventing IPH.[92-97] Two studies emphasized the effectiveness of the use of an underbody conductive warming mattress for patients undergoing a cesarean section procedure because most other warming methods are either ineffective or cannot be used.[93,94]

F. One of the more recent devices for preventing IPH is the energy transfer pads (ETP). Studies have been performed in the use of ETPs primarily during off-pump coronary artery bypass (OPCAB) surgery and pediatric procedures. The conclusion of the studies is consistently ETP is significantly more effective than FAW and other conventional methods, for example, higher room temperature or heated IV fluids.[58,90,98-101] It is shown to significantly maintain higher core body and skin temperatures, and in some instances even raise the core body temperature when necessary.[58,90,98-101]

F. It is recommended patients should be pre-warmed prior to the administration of general or neuraxial anesthesia. The research has reported an important relationship exists between a low preoperative core body temperature and patients experiencing IPH 60 minutes after the administration of general anesthesia.[52,62,102] When the periphery is pre-warmed, the core to periphery flow of heat can be greatly reduced.[3,87] This is especially important for patients undergoing a complicated procedure. However, research has not provided a definitive recommendation as to the length of pre-warming. Positive results have been reported with patients being pre-warmed 10, 20, 45, and 60 minutes prior to surgery.[103-106]

G. It is recommended that active warming methods be used throughout the intraoperative period to achieve the target temperature of 36° C within 30 minutes immediately before or 15 minutes after the discontinuation of anesthesia.[41,52] The measure applies to all patients, including pediatrics, that undergo a non-emergency surgical procedure in which the patient is under general or neuraxial anesthesia for 60 minutes or longer.[12,24]

H. The OR table mattress and linens should be pre-warmed as an adjunct to preventing conduction heat loss.

I. To assure patient safety, the warming device should be used according to the manufacturer's IFU.

    (1) Only U.S. Food and Drug Administration approved warming devices should be used.
    (2) It is recommended that the temperature setting of the warming device is set as high as possible according to the manufacturer's IFU, and adjusted to the level at which the patient's core body temperature is maintained at 36°C.[15,107]
    (3) Only the blanket and hose that were shipped from the manufacturer with a FAW device should be used. The items should not be replaced by a blanket or hose from another device, even if it is the same model.[108-110]

(4) The FAW hose should never be disconnected from the warming blanket when in use. The hose alone should not be used to deliver the warm air; using just the hose has resulted in patient injuries.[38,39] The temperature at the hose ranges from 41.5° C to 47.7° C, which can burn the patient.[111] The temperature of the air exiting the blanket is 2.5° C to 16.9° C lower.[111]

Table 4
Methods to Maintain Normothermia in the Surgical Patient

External Methods	Internal Methods
• Foil blanket. • Fluid warmer. • Warm blankets. • Forced-air warming. • Heated water blanket. • Heated water mattress. • Increased temperature in OR. • Heated humidified anesthetic gases. • Remove patient from cold environment.	• Cardiopulmonary bypass. • Hemodialysis with warm fluids. • Peritoneal lavage with warm fluids. • Continuous arteriovenous warming (CAVR).[112]

Guideline VI
The pharmacologic agent of choice for the treatment of shivering is meperidine.

1. Based upon clinical studies, the ASA recommends that meperidine should be used for the treatment of patient shivering during emergence and postoperatively.[113]
   A. Clinical research supports the effectiveness of meperidine when compared to other opioid agonists or agonist-antagonists for reducing shivering.[113]
   B. The CST in the assistant circulator role should be familiar with meperidine, including actions, side-effects, and uses.

Table 5

Advantages and Disadvantages of Specific Methods of Patient Warming

Method of Warming	Advantages	Disadvantages
Forced-air warming	• Low risk of patient burns. • Immediately produces warm air and quickly warms the patient.	• Disposables increase the cost of use. • No cooling option except to turn off the unit. • Patient must be padded to prevent pressure sores. • Warms the OR making it uncomfortable for the surgical team.
Water mattress	• Can cool and heat. • Does not warm the OR. • Low risk of patient burns. • Risk of pressure sores alleviated.	• High-use of electrical power. • Water leakage if mattress is damaged. • Transporting, handling, and positioning mattress is difficult due to weight of device.
Fluid Warmer	• Easy and fast to set-up the portable fluid-warming unit. • Direct warming of IV fluids and blood products before they are infused.	• Only use is for warming IV fluids and blood products.

Guideline VII
Intravenous (IV) fluids and blood products should be warmed prior to transfusion to aid in preventing IPH.[61,62,79,93,97,102,114-120]

1. It is recommended that IV fluids should only be warmed when it is anticipated that more than two liters per hour will be administered in adults.[44,48] When less than two liters per hour will be administered warm IV fluids have little effect on the patient's core body temperature.[9,15]
    A. Studies support warming IV fluids as an adjunct to FAW to decrease the risk for IPH.[37,70,121]
    B. The IV bags should be warmed according to manufacturer's IFU.
        (1) The bags should be warmed using either a warming cabinet that is usually located in the sub-sterile room or a fluid-warming device.[122,143]
        (2) The CST should collaborate with the anesthesia provider and other members of the surgical team confirming there is an adequate number of

warm IV bags available in the warming cabinet prior to the start of the surgical procedure.

(3) Research does not provide a definitive temperature as to the optimal temperature to be obtained. However, the majority of research reported warming bags or fluids between 37° C to 45° C.[93,121-123, 139]

2. Blood products must be warmed prior to transfusion.[27,139]
   A. The CST in the assistant circulating role can collaborate with the anesthesia provider in obtaining the portable blood-warming unit and preparing it for use, for example, attaching it to the IV pole, plugging the electrical cord into outlet, starting and testing the unit, and assisting the anesthesia provider with placing the tubing inside the unit.[27]

Guideline VIII
Warm skin preparation antiseptics should be used when performing the patient skin prep.

1. Warm antiseptic solutions will help to prevent cooling the surface of the skin. However, the manufacturer's IFU should be consulted to confirm if it is safe to warm the antiseptic solution, what temperature the solution can be warmed, and the storage temperature.[124]
   A. Some antiseptic solutions are flammable; heating the solution can be a fire hazard.
2. To the extent possible, expose only the skin necessary for the patient skin prep to prevent convection heat loss.
3. The sterile drapes should be placed as soon as possible after the patient skin prep is completed to prevent evaporation heat loss.

Guideline IX
OR ambient temperature may be increased, but should be used in combination with other patient-warming methods to prevent IPH.

1. The majority of research supports increasing OR temperature in conjunction with other warming methods. However, the surgical team should consider the clinical situation for when it would be most effective.[62,114,115,125-128]
   A. Increasing the OR temperature is likely most effective when the surgical procedure involves a pediatric patient.[125] However, additional research is needed in this area.
   B. When increasing the OR temperature, the comfort level of the sterile surgical team members should be taken under consideration.[129]
      (1) NICE recommends that the OR ambient temperature should be a minimum of 21° C when the patient is exposed, such as when performing the patient skin prep.[139] When active warming has begun, the ambient temperature may be decreased to improve the working conditions for the surgical team.[139]

Guideline X
The CST in the first scrub role must provide warm irrigating fluids for use by the surgeon to aid in preventing IPH in the surgical patient.[129]

1. Research confirms that warm irrigation fluids should be used to support the use of other warming methods to prevent IPH.[61,62,102,115,130,131-134]

A. Based upon the warming temperature reported in studies, the irrigation fluids should be warmed to a temperature between 33° C and 40° C.[130,139] However, the irrigation fluids should be warmed according to the manufacturer's IFU.
B. The CST should confirm there is an adequate number of warm containers of irrigation fluids available prior to the start of the surgical procedure.

Guideline XI
The patient's perioperative record should include documentation of the measures taken by the surgical team to prevent IPH and maintain normothermia in the patient.

1. The documentation should include the type of temperature recording device used and settings, temperature measurements recorded during the surgical procedure, type of active warming device(s) used and settings, use of warming device for blood and blood products, if infused, and any other warming methods or devices.[66]

Guideline XII
Incidences of IPH and device malfunctions should be documented and reviewed to identify measures that can be taken to improve surgical outcomes.

1. An incidence of IPH that occurs during the perioperative period should be documented and assessed by the surgical team.
    A. The surgical team should evaluate, to the extent possible, the reason(s) for the occurrence of IPH, including if there was a lapse in applying the policies and procedures, and make the necessary adjustments to prevent further incidences.
    B. The surgery department should review the policies and procedures (P&P) regarding normothermia on an annual basis.
        (1) The surgery department should include members of the surgical team and administration when reviewing the P&Ps, including CSTs, surgeons, RNs, risk management, and infection control officer.
        (2) The surgery department should document when the P&Ps were reviewed, revision completed, and who participated in the review process.
        (3) CSTs should be familiar with the P&Ps for normothermia. The orientation of new employees should include reviewing the P&Ps.
        (4) The P&Ps should be available in the surgery department for the surgical personnel.
2. Incidences involving warming and temperature monitoring devices should be documented according to the HDO's adverse event reporting P&Ps, and in compliance with the Safe Medical Devices Act of 1990.[135]
    A. A patient device injury is required to be reported to the FDA and device manufacturer within 10 days; the report should include the type of device, identifying information such as the serial number and date of manufacture, inspection dates performed by biomedical equipment technicians, and description of the adverse event.[135]

Guideline XIII

CSTs should be familiar with the clinical subject of normothermia and IPH by completing continuing education on the adverse effects of IPH, and methods for preventing and treating IPH.

1. Given its critical importance to positive surgical outcomes, literature has recognized that regulation of normothermia has been inconsistent and often ignored.
   A. The following have been identified as barriers for establishing a national standard of care for normothermia.[3]
      (1) The lack of clear, evidence-based guidelines on warming techniques that are most successful. It has been identified that an evidence-based approach to thermoregulation is needed for HDOs to use as guidance in developing policies.
      (2) Inconsistent practices within HDOs. Some patients are monitored and others are not monitored.
      (3) Inconsistent practices from one HDO to another. An HDO may report 100% of patients monitored and hypothermia prevented, whereas, another HDO may report hypothermia in the PACU as being common.
      (4) Staff turnover can contribute to inconsistent practices. One or more advocates for preventing IPH leave and efforts to monitor patients decreases.
      (5) The benefits of warming the patient are not immediately noticeable. Surgery personnel are more accustomed to seeing immediate results, such as a drug taking effect or stopping bleeding with electrocautery. Surgery personnel may not be aware of the long-term benefits to the patient of maintaining normothermia and preventing IPH. OR staff that do not follow patients postoperatively will not have the experience of observing the benefits and positive outcomes of warming. Continuing education that stresses the evidence-based benefits of patient thermoregulation is important for communicating the message to surgery personnel.
      (6) The warming methods used by the surgery department may be ineffective causing the surgery personnel to disregard the effects of IPH. The department may only be relying upon passive warming methods combined with a lack of awareness of other available technologies.
      (7) The increased focus and pressure by surgery department administration on fast OR turnovers can contribute to ignoring the use of warming measures and monitoring the patient's temperature. A FAW device takes time to set-up and position on the patient, as well as, transportation issues when the patient is transported from preoperative holding to the OR and then the PACU. Additionally, the anesthesia provider may feel the pressure to not take the time to establish a base core body temperature prior to the administration of anesthesia, as well as, upon emergence in the OR.
2. Continuing education and training on patient warming and IPH should be provided to all surgery team members to better understand the correlation between hypothermia and adverse outcomes.[3]

A. The continuing education should include up-to-date, outcomes-based information on the ways IPH can be prevented and treated.
B. CSTs that perform the assistant circulator role should complete training on the use of the warming device(s) that are used in the surgery department.
    (1) When a new device is purchased, surgical personnel should complete training on the use of the device.
C. The CST should periodically complete continuing education on normothermia, IPH, temperature measurement technology up-dates, and methods for preventing IPH.[136]
    (1) The continuing education should be based upon the concepts of adult learning, referred to as andragogy. Adults learn best when the information is relevant to their work experience, the information is practical, rather than academic, and the learner is actively involved in the learning process.[137]
    (2) It is recommended surgery departments use various methods of instruction to facilitate the learning process of CSTs.
        a. If the education is primarily lecture, methods to engage learners include presentation of case studies for discussion, and audience discussion providing suggestions for reinforcing normothermia in the perioperative patient.
        b. Other proven educational methods include interactive training videos, computerized training modules, and teleconferences.
        c. The continuing education should be delivered over short periods of time, such as in modules, and not in a one-time lengthy educational session.
    (3) Continuing education programs should be periodically evaluated for effectiveness, including receiving feedback from surgery department personnel.
    (4) The surgery department should maintain education records for a minimum of three years that include the dates of the education, names and job titles of employees that completed the continuing education, synopsis of each continuing education session provided, and the names, credentials, and experience of instructors.

Competency Statements

Competency Statements	Measurable Criteria
1. CSTs have the knowledge and skills to provide patient care by reviewing the anesthesiologist's risk factors assessment to participate with the surgical team in implementing the thermoregulatory plan for the surgical patient. 2. CSTs have the knowledge and skills to perform patient care by participating in assembling, testing, and applying thermoregulatory devices in the perioperative setting. 3. CSTs have the knowledge and skills to perform patient care by applying passive methods of warming for patients in the perioperative setting. 4. CSTs can serve on, as well as participate, in the work of a committee assigned to assess incidences of IPH and adverse events related to device malfunction.	1. Educational standards as established by the *Core Curriculum for Surgical Technology*.[138] 2. The didactic subject of thermoregulatory care of the patient is included in a CAAHEP accredited surgical technology program. 3. Students demonstrate knowledge of thermoregulatory care of the patient in the lab/mock OR setting and during clinical rotation. 4. CSTs perform patient care by implementing the thermoregulatory plan in coordination with the surgical team members. 5. CSTs participate on the HDO's patient normothermia committee. 6. CSTs complete continuing education to remain current in their knowledge of normothermia, preventing IPH, and safe use of temperature monitoring and warming devices.[136]

Glossary

Active warming: Process that transfers heat to the patient.

Ambient temperature: Air temperature of an environment or object where furniture or equipment is located.

Conduction: Transfer of heat through physical contact with a colder, solid object, or when cold IV fluids and blood products are administered causing a decrease in the circulating blood temperature.

Convection: Movement of heat based on air flow.

Core body temperature: The temperature of the internal environment of the body that includes the internal organs such as the heart, kidneys, liver, and blood.

Evaporation: Loss of heat through surface skin sweating or fluid loss from exposure of internal organs and tissues to the atmosphere, such as during an open surgical procedure.

Inadvertent patient hypothermia: Hypothermia that is unexpected and unplanned.

Interthreshold range: The temperature range between sweating and vasoconstriction thresholds.
.
Lethal triad: Combination of hypothermia, impaired coagulation, and metabolic acidosis.

Meperidine: Opioid pain medication.

Neuraxial anesthesia: Caudal, epidural, or spinal regional anesthesia.

Normothermia: Normal body temperature.

Radiation: Infrared transfer of heat that occurs when the skin and viscera are warmer than the environment.

References

1. McSwain JR, Yared M, Doty JW, Wilson SH. Perioperative hypothermia: causes, consequences and treatment. *World Journal of Anesthesiology*,2015; 4(3): 58-65.
2. Feinstein L, Miskiewicz M. Perioperative hypothermia: review for the anesthesia provider. 2010. https://ispub.com/IJA/27/2/10779. Accessed October 14, 2019.
3. Roundtable summary: perioperative temperature management. 2005. http://www.anesthesiologynews.com/download/544Kimberly-ClarkeSR.pdf. Accessed October 7, 2019.
4. Smith CE. Prevention and treatment of hypothermia in trauma patients. *Trauma Care*. 2004; 14(2):68-79.
5. Tsuei BJ, Kearney PA. Hypothermia in the trauma patient. *Injury*. 2004; 35(1):7-15.
6. American Society of Anesthesiologists. An updated report by the American Society of Anesthesiologist Task Force on Postanesthesia Care. *Anesthesiology*. 2013; 118(2): 1-17.
7. Kudoh A, Takase H, Takazawa T. Chronic treatment with antipsychotics enhances intraoperative core hypothermia. *Anesthesia & Analgesia*. 2004; 98(1):111-115.
8. Memarzadeh F. Active warming systems to maintain perioperative normothermia in hip replacement surgery. *The Journal of Hospital Infection*. 2010; 75(4):332-333.
9. Prevention of inadvertent perioperative hypothermia. *Pennsylvania Patient Safety Advisory*. 2008; 5(2):44-52.
10. Leaper D, Kumar S, Bettles N. Maintaining normothermia during surgery. 2010. http://www.hospital-int.net/article/maintaining-normothermia-during-surgery.html. Accessed October 3, 2019.
11. Facility Guidelines Institute, American Society for Healthcare Engineer. *Guidelines for design and construction of hospitals and outpatient facilities*. Chicago, IL: American Hospital Association; 2014.

12. American Society of Anesthesiologists. Perioperative normothermia: quality incentives in anesthesiology perioperative normothermia. 2013. http://www.asahq.org/For-Members/Advocacy/Advocacy-Division/Perioperative-Normothermia.aspx. Accessed October 1, 2019.
13. Macario A, Dexter F. What are the most important risk factors for a patient's developing intraoperative hypothermia? *Anesthesia & Analgesia*. 2002; 94(1):215-220.
14. Tander B, Baris S, Karakaya D, Ariturk E, Rizalar R, Bernay F. Risk factors influencing inadvertent hypothermia in infants and neonates during anesthesia. *Paediatric Anaesthesia*. 2005; 15(7):574-579.
15. National Institute for Health and Care Excellence. Inadvertent perioperative hypothermia: the management of inadvertent perioperative hypothermia in adults. 2008. https://www.nice.org.uk/guidance/cg65/chapter/introduction. Accessed September 16, 2019.
16. Rajagopalan S, Mascha E, Na J, Sessler DI. The effects of mild perioperative hypothermia on blood loss and transfusion requirements. *Anesthesiology*. 2008; 108(1):71-77.
17. Hannenberg AA, Sessler DI. Improving perioperative temperature management. *Anesthesia & Analgesia*. 2008; 107(5):1454-1457.
18. Fleisher LA, Fleischmann KE, Auerbach AD, Barnason SA, Beckman JA, Bozkurt B, Davila-Roman VG, Gerhard-Herman MD, Holly TA, Kane GC, Marine JE, Nelson MT, Spencer CC, Thompson A, Ting HH, Uretsky BF, Wijeysundera DN. 2014. ACC/AHA guideline on perioperative cardiovascular evaluation and management of patients undergoing noncardiac surgery: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines. *Journal of the American College of Cardiology*. 2014; 64(22): e77-137.
19. Helm M, Lampl L, Hauke J, Bock KH. 1995. Accidental hypothermia in trauma patients: It is relevant to preclinical emergency treatment? *Anaesthesist*. 1995; 44(2): 101-107.
20. Hsieh A. The chilling effect of hypothermia on trauma patients. 2012. http://www.boundtreeuniversity.com/print.asp?act=print&vid=1263681. Accessed October 1, 2015.
21. National Association of Emergency Medical Technicians. *PHTLS: Prehospital trauma life support*, 8th ed. Burlington, MA: Jones & Bartlett Learning; 2014.
22. Hannan EL, Samadashvili Z, Wechsler A, Jordan D, Lahey SJ, Culliford AT, Gold JP, Higgins RS, Smith CR. The relationship between perioperative temperature and adverse outcomes after off-pump coronary artery bypass graft surgery. *The Journal of Thoracic & Cardiovascular Surgery*. 2010; 139(6):1568-1575.e1.
23. Stevens MH. Forced-Air warming: an effective tool in fighting SSI. 2013. http://www.infectioncontroltoday.com/articles/2011/03/forced-air-warming-an-effective-tool-in-fighting-ssi.aspx. Accessed September 23, 2019.
24. Harper M. Peri-operative temperature management. In: Colvin JR, Peden CJ, eds. *Raising the Standard: A Compendium of Audit Recipes*. 3rd ed. London, England: The Royal College of Anaesthetists; 2012:104-105.
25. Kurz A, Sessler DI, Lenhardt R. Perioperative normothermia to reduce the incidence of surgical wound infection and shorten hospitalization. *New England Journal of Medicine*. 1996; 334(19):1209-1215

26. Mangram AJ, Horan TC, Pearson ML, Silver LC, Jarvis WR. Centers for Disease Control and Prevention guideline for the prevention of surgical site infection. *Infection Control and Hospital Epidemiology*. 1999; 20(4):247-278.
27. Association of Surgical Technologists. Guidelines for best practices for massive transfusion of the surgical patient. 2018. https://www.ast.org/uploadedFiles/Main_Site/Content/About_Us/Guideline_Massive_Transfusion.pdf. Accessed September 30, 2019.
28. Murphy CG, Winter DC; Bouchier-Hayes DJ. Tourniquet injuries: pathogenesis and modalities for attenuation. *Acta Orthopaedica Belgica*. 2005; 71(6):635-645.
29. Winkler M, Akca O, Birkenberg B, Hetz H, Scheck T, Arkilic CF, Kabon B, Marker E, Grübl A, Czepan R, Greher M, Goll V, Gottsauner-Wolf F, Kurz A, Sessler DI. Aggressive warming reduces blood loss during hip arthroplasty. *Anesthesia & Analgesia*. 2000; 91(4):978-984.
30. Kim YS, Jeon YS, Lee JA, Park WK, Koh HS, Joo JD, In JH, Seo KW. Intra-operative warming with a forced-air warmer in preventing hypothermia after tourniquet deflation in elderly patients. *The Journal of International Medical Research*. 2009; 37:1457-1464.
31. Sun Z, Honar H, Sessler DI, Dalton JE, Yang D, Panjasawatwong K, Doroee AF, Salmasi V, Saager L, Kurz A. Intraoperative core temperature patterns, transfusion requirement, and hospital duration in patients warmed with forced air. *Anesthesiology*. 2015; 122:276-285.
32. Hostler D, Zhou J, Tortorici MA, Bies RR, Rittenberger JC, Empey PE, Kochanek PM, Callaway CW, Poloyac SM, Mild hypothermia adhers to midazolam pharmacokinetics in normal healthy volunteers. *Drug Metabolism & Disposition*. 2010;. 38: 781-788.
33. Caldwell JE, Heier T, Wright PM, Lin S, McCarthy G, Szenohradszky J, Sharma ML, Hing JP, Schroeder M, Sessler DI. Temperature-dependent pharmacokinetics and pharmacodynamics of vecuronium. *Anesthesiology*. 2000; 92: 84-93.
34. Heier T, Caldwell JE, Sessler DI, Miller RD. Mild intraoperative hypothermia increases duration of action and spontaneous recovery of vecuronium blockade during nitrous oxide-isoflurane anesthesia in humans. *Anesthesiology*. 1991; 74: 815-819.
35. Heier T, Caldwell JE, Sharma ML, Gruenke LD, Miller RD. Mild intraoperative hypothermia does not change the pharmacodynamis (concentration-effect relationship) of vecuronium in humans. *Anesthesia & Analgesia*. 1994; 78: 973-977.
36. Leslie K, Sessler DI, Bjorksten AR, Moayeri A. Mild hypothermia alters propofol pharmacokinetics and increases the duration of action of atracurium. *Anesthesia & Analgesia*. 1995; 80: 1007-1014.
37. Sessler DI. Complications and treatment of mild hypothermia. *Anesthesiology*. 2001; 95(2):531-543.
38. Frank SM. Pathophysiology and consequences of hypothermia. *Trauma Care*. 2004; 14(2):64-67.
39. Heier T, Caldwell JE, Sessler DI, Kitts JB, Miller RD. The relationship between adductor pollicis twitch tension and core, skin, and muscle temperature during nitrous oxide-isoflurane anesthesia in humans. *Anesthesiology*. 1989; 71: 381-384.
40. Alfonsi P, Nourredine KE, Adam F, Chauvin M, Sessler DI. Effect of postoperative skin-surface warming on oxygen consumption and the shivering threshold. *Anaesthesia*. 2003; 58: 1228-1234.

41. Alderson P, Campbell G, Smith AF, Warttig S, Nicholson A, Lewis SR. Thermal insulation for preventing inadvertent perioperative hypothermia. *Cochrane Database of Systematic Review*. 2014; 6, Article No. CD009908.
42. John M, Ford J, Harper M. Peri-operative warming devices: performance and clinical application. *Anaesthesia*. 2014; 69(6):623-638.
43. Lenhardt R, Marker E, Goll V, Tschernich H, Jurz A, Sessler DI, Narzt E. Lackner F. Mild intraoperative hypothermia prolongs postanesthetic recovery. *Anesthesiology*. 1997; 87: 1318-1323.
44. Chon JY, Lee JY. The effects of surgery type and duration of tourniquet inflation on body temperature. *Journal of International Medical Research*. 2012; 40(1): 358-365.
45. Holtzclaw BJ. Managing inadvertent and accidental hypothermia. *The Online Journal of Clinical Innovations*. 2008; 10(2): 1-58.
46. Khan SA, Aurangzeb M, Zarin M, Khurshid M. Temperature monitoring and perioperative heat loss. *Journal of Postgraduate Medical Institute*. 2010: 24(2): 85-90.
47. de Brito, Poveda V, Galvao CM, dos Santos CB. Factors associated to the development of hypothermia in the intraoperative period. *Revista Latino-Americana de Enfermagem*. 2009; 17(2): 228-233.
48. Hernandez M, Cutter TW, Apfelbaum JL. Hypothermia and hyperthermia in the ambulatory surgical patient. *Clinics in Plastic Surgery*. 2013: 40(3): 429-438.
49. Huh J, Cho YB, Yang MK, Yoo YK, Kim DK. What influence does intermittent pneumatic compression of the lower limbs intraoperatively have on core hypothermia? *Surgical Endoscopy*. 2013: 27(6): 2087-2093.
50. Han SB, Gwak MS, Choi SJ, et. al. Risk factors for inadvertent hypothermia during adult living-donor liver transplantation. *Transplantation Proceedings*. 2014: 46(3): 705-708.
51. Billeter AT, Hohmann SF, Druen D, Cannon R, Polk HC Jr. Unintentional perioperative hypothermia is associated with severe complication and high mortality in elective operations. *Surgery*. 2014; 156(5): 1245-1252.
52. Hooper VD, Chard R, Clifford T, Fetzer S, Fossum S, Godden B, Martinez EA, Noble KA, O'Brien D, Odom-Forren J, Peterson C, Ross J, Wilson L. ASPAN's evidence-based clinical practice guideline for the promotion of perioperative normothermia: Second edition. *Journal of PeriAnesthesia Nursing*. 2010; 25(6):346-365.
53. Sessler DI. Temperature Regulation and Monitoring. In: Miller RD, ed. *Miller's Anesthesia*. 8th ed. Philadelphia, PA: Elsevier; 2015:1571-1597.
54. Kitamura A, Hoshino T, Kon T, Ogawa R. Patients with diabetic neuropathy are at risk of a greater intraoperative reduction in core temperature. *Anesthesiology*. 2000; 92(5):1311-1318.
55. Abreu NM, New concepts in perioperative normothermia: from monitoring to management. *Anesthesiology News*. 2011; 37(10: 39-48.
56. Dallas ME. Trauma patients at higher risk of dying of hypothermia: study. 2012. http://www.medicinenet.com/script/main/art.asp?articlekey=161043. Accessed October 1, 2015.
57. Lapostolle F, Sebbah JL, Couvreur J, Koch FX, Savary D, Tazarourte K, Egman G, Mzabi L, Galinski M, Adnet F. Risk factors for onset of hypothermia in trauma victims: the HypoTraum Study. 2012. http://ccforum.com/content/16/4/R142. Accessed September 16, 2019.

58. Hofer CK, Worn M, Tavakoli R, Sander L, Maloigne M, Klaghofer R, Zollinger A. Influence of body core temperature on blood loss and transfusion requirements during off-pump coronary artery bypass grafting: a comparison of 3 warming systems. *Journal of Thoracic and Cardiovascular Surgery*. 2005: 129(4): 838-843.
59. Mehta SP. Burn injuries from warming devices in the operating room. *Anesthesiologist*. 2013; 77(2):16-17.
60. Flaifel HA, Ayoub F. Esophageal temperature monitoring. *Middle East Journal of Anesthesiology*. 2007: 19(1): 123-147.
61. Torossian A, Brauer A, Hocker J, Bein B, Wulf H, Horn EP. Preventing inadvertent perioperative hypothermia. *Deutsches Arzteblatt International*. 2015; 112(10): 166-172.
62. Torrossian A. Thermal management during anaesthesia and thermoregulation standards for the prevention of inadvertent perioperative hypothermia. *Best Practices & Research: Clinical Anaesthesiology*. 2008; 22(4): 659-668.
63. Sessler DI. Temperature monitoring: the consequences and prevention of mild perioperative hypothermia. *Southern Africa Journal of Anaesthesia & Analgesia*. 2014: 20(1): 25-31.
64. Eshraghi Y, Nasr V, Parra-Sanchez I, et al. An evaluation of zero-heat-flux cutaneous thermometer in cardiac surgical patients. *Anesthesia & Analgesia*. 2014: 119(3): 543-549.
65. Sato H, Yamakage M, Okiuyama K, et al. Urinary bladder and oesophageal temperatures correlate better in patients with high rather than low urinary flow rates during noncardiac surgery. *European Journal of Anaesthesiology*. 2008; 25(10): 805-809.
66. O'Grady NP, Barie PS, Bartlett JG, et al. Guidelines for evaluation of new fever in critically ill adult patients: 2008 update from the American College of Critical Care Medicine and the Infectious Diseases Society of America. *Critical Care Medicine*. 2008: 36(4): 1330-1349.
67. Arshad M, Qureshi WA, Ali A, Haider Z. Frequency of hypothermia during general anaesthesia. *Pakistan Journal of Medical Health Sciences*. 2011: 5(3): 549-552.
68. Washington GT, Matney JL, Comparison of temperature measurement devices in post anesthesia patients. *Journal of PeriAnesthesia Nursing*. 2008; 23(1): 36-48.
69. American Society of PeriAnesthesia Nurses. ASPAN's evidence-based clinical practice guideline for the promotion of perioperative normothermia, 2nd edition. 2010. https://www.aspan.org/Portals/6/docs/ClinicalPractice/Guidelines/Normothermia_Guideline_12-10_JoPAN.pdf. Accessed September 16, 2019.
70. Leslie K, Sessler DI. Perioperative hypothermia in the high-risk surgical patient. *Best Practice & Research Clinical Anesthesiology*. 2003; 17(4): 485-498.
71. Lenhardt R. Monitoring and thermal management. *Best Practice & Research Clinical Anesthesiology*. 2003; 17(4):569-581.
72. John M, Ford J, Harper M. Peri-operative warming devices: performance and clinical application. *Anaesthesia*. 2014; 69(6): 623-638.
73. Smith CE, Sidhu RS, Lucas L, Mehta D, Pinchak AC. Should patients undergoing ambulatory surgery with general anesthesia be actively warmed? *The Internet Journal of Anesthesiology*. 2007: 12(1): 18.
74. Shao L, Zheng H, Jia FJ, et al. Methods of patient warming during abdominal surgery. *PLOS One*. 2012: 7(7): e39622.

75. Pagnocca ML, Tai EJ, Dwan JL. Temperature control in conventional abdominal surgery: comparison between conductive and the association of conductive and convective warming. *Revista Brasileira de Anestesiologia*. 2009; 59(1): 56-66.
76. Kim P, Taghon T, Fetzer M, Tobias JD. Perioperative hypothermia in the pediatric population: a quality improvement project. *American Journal of Medical Quality*. 2013: 28(5): 400-406.
77. Kurz A. Physiology of thermoregulation. *Best Practice & Research Clinical Anesthesiology*. 2008; 22(4): 627-644.
78. Rozentsveig V, Neulander EZ, Roussabrov E, et al. Anesthetic considerations during percutaneous nephrolithotomy. *Journal of Clinical Anesthesia*. 2007; 19(5): 351-355.
79. Forbes SS, Eskicioglu C, Nathens AB, et al. Best Practice in General Surgery Committee, University of Toronto. Evidence-based guidelines for prevention of perioperative hypothermia. *Journal of the American College of Surgeons*. 2009; 209(4): 492-503.
80. Lassen K, Soop M, Nygren J, et al. Consensus review of optimal perioperative care in colorectal surgery: Enhanced Recovery After Surgery (ERAS®) Group recommendations. *The Archives of Surgery*. 2009; 144(10): 961-969.
81. Lassen K, Coolsen MM, Slim K, et al. ERAS® Society; European Society for Clinical Nutrition and Metabolism; International Association for Surgical Metabolism and Nutrition. Guidelines for perioperative care for pancreaticoduodenectomy: Enhanced Recovery After Surgery (ERAS®) Society recommendations. *Clinical Nutrition*. 2012; 31(6): 817-830.
82. Winslow EH, Cooper SK, Haws DM, et al. Unplanned perioperative hypothermia and agreement between oral, temporal artery, and bladder temperatures in adult major surgery patients. *Journal of PeriAnesthesia Nursing*. 2012: 27(3) 165-180.
83. Araz C, Pirat A, Unlukaplan A, et al. Incidence and risk factors of intraoperative adverse events during donor lobectomy for living-donor liver transplantation: a retrospective analysis. *Experimental and Clinical Transplantation*. 2012: 10(2): 125-131.
84. Esnaola NF, Cole DJ. Perioperative normothermia during major surgery; is it important? *Advances in Surgery*. 2011; 45: 249-263.
85. Fleisher LA, Fleischmann KE, Auerbach AD, et al. 2014 ACC/AHA guideline on perioperative cardiovascular evaluation and management of patients undergoing noncardiac surgery: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines. *Circulation*. 2014; 130(24): 2215-2245.
86. Young VL, Watson ME. Prevention of perioperative hypothermia in plastic surgery. *Aesthetic Surgery Journal*. 2006; 26(5):551-571.
87. Sessler DI. Perioperative heat balance. *Anesthesiology*. 2000; 92(2):578-596.
88. ECRI Institute. Healthcare product comparison system. Warming units, patients, forced air. Plymouth Meeting, PA: ECRI Institute; 2007.
89. Taguchi A, Ratnaraj J, Kabon B, Sharma N, Lenhardt R, Sessler DI, Kurz A. Effects of a circulating-water garment and forced-air warming on body heat content and core temperature. *Anesthesiology*. 2004; 100(5):1058-1064.
90. Sellke FW, Ruel M. (Eds.). *Atlas of cardiac surgical techniques*. Philadelphia, PA: Saunders; 2009.
91. Marders J. FDA encourages the reporting of medical device adverse events: free-hosing hazards. *APSF Newsletter*. 2002; 17:42.

92. Tanaka N, Ohno Y, Hori M, Utada M, Ito K, Suzuki T. A randomised controlled trial of the resistive heating blanket versus the convective warming system for preventing hypothermia during major abdominal surgery. *Journal of Perioperative Practice*. 2013; 23(4): 82-86.
93. Paris LG, Seitz M, McElroy KG, Regan M. A randomized controlled trial to improve outcomes utilizing various warming techniques during cesarean birth. *Journal of Obstetric, Gynecological, and Neonatal Nursing*. 2014; 43(6): 719-728.
94. Chakladar A, Dixon MJ, Crook D, Harper CM. The effects of a resistive warming mattress during caesarean section: a randomised controlled trial. *International Journal of Obstetric Anesthesia*. 2014; 23(4): 309-316.
95. Perl T, Rhenius A, Eich CB, Quintel M, Heise D, Brauer A., Conductive warming and insulation reduces perioperative hypothermia. *Central European Journal of Medicine*. 2012; 7(3): 284-289.
96. Sharma M, Dixon M, Eljelani F, Crook D, Harper M. A randomised controlled trial to determine the influence of carbon-polymer warming blankets on the incidence of perioperative hypothermia during and after short, day-case operations. *Journal of One Day Surgery*. 2014; 24(4): 92-99.
97. Munday J, Hines S, Wallace K, Chang AM Gibbons K, Yates PA. A systematic review of the effectiveness of warming interventions for women undergoing cesarean section. *Worldview on Evidence-Based Nursing*. 2014; 11(6): 383-393.
98. Grocott HP, Mathew JP, Carver EH, Phillips-Bute B, Landolfo KP, Newman MF. A randomized controlled trial of the Artic Sun Temperature Management System versus conventional methods for preventing hypothermia during off-pump cardiac surgery. *Anesthesia & Analgesia*. 2004; 98(2): 298-302.
99. Nesher N, Wolf T, Uretzky G, Oppenheim-Eden A, Yussim E, Kushnir I, Shoshany G, Rosenberg B, Berant M. A novel thermoregulatory system maintains perioperative normothermia in children undergoing elective surgery. *Paediatric Anaesthesia*. 2001; 11(5): 555-560.
100. Nesher N, Insler SR, Shenberg N, Bolotin G, Kramer A, Sharony R, Paz Y, Pevni D, Loberman D, Uretzky G. A new thermoregulation system for maintaining perioperative normothermia and attenuating myocardial injury in off-pump coronary artery bypass surgery. *The Heart Surgery Forum #2002-26052*. 2002; 5(4): 1-8.
101. Vassillades, Jr. TA, Nielsen JL, Lonquist JL. Evaluation of a new temperature management system during off-pump coronary artery bypass. *Interactive CardioVascular and Thoracic Surgery*. 2003; 2(4): 454-457.
102. Hart SR, Bordes B, Hart J, Corsino D, Harmon D. Unintended perioperative hypothermia. *Ochsner Journal*. 2011; 11(3): 259-270.
103. Andrzejowski J, Hoyle J, Eapen G, Turnbull D. Effect of prewarming on post-induction core temperature and the incidence of inadvertent perioperative hypothermia in patients undergoing general anesthesia. *British Journal of Anaesthesia*. 2008; 101(5): 627-631.
104. De Witts JL, Demeyer C, Vandemaele E. Resistive-heating or forced-air warming for the prevention of redistribution hypothermia. *Anesthesia & Analgesia*. 2010: 110(3): 829-833.

105. Horn EP, Bein B, Bohm R, Steinfath M, Sahili N, Hocker J. The effect of short time periods of pre-operative warming in the prevention of peri-operative hypothermia. *Anaesthesia*. 2012; 67(6): 612-617.
106. Vanni SMD, Castiglia YMM, Ganem EM, et al. Preoperative warming combined with intraoperative skin-surface warming does not avoid hypothermia caused by spinal anesthesia in patients with midazolam premedication. *Sao Paulo Medical Journal*. 2007; 125(3): 144-149.
107. ECRI Institute. Hazard report update: ECRI Institute revises its recommendations for temperature limits on blanket warmers. *Health Devices*. 2009; 38(7):230-231.
108. Wu X. The safe and efficient use of forced-air warming systems. *AORN Journal*. 2013; 97(3): 302-308.
109. Chung K, Lee S, Oh SC, Choi J, Cho HS. Thermal burn injury associated with a forced-air warming device. *Korean Journal of Anesthesiology*. 2012; 62(4): 391-392.
110. Sikka RS, Prielipp RC. Forced air warming devices in orthopaedics: a focused review of the literature. *Journal of Bone and Joint Surgery. American Volume*. 2014; 96(24): e200.
111. Association of periOperative Registered Nurses. *Guidelines for Perioperative Practice*. 2019 ed. Parker, CO: Authors; 2019.
112. Nesher N, Uretzky G, Insler, S, Nataf P, Frolkis I, Pineau E, Cantoni E, Bolotin G, Vardi M, Pevni D, Lev-Ran O, Sharony R, Weinbroum AA. Thermo-wrap technology preserves normothermia better than routine thermal care in patients undergoing off-pump coronary artery bypass and is associated with lower immune response and lesser myocardial damage. *Journal of Thoracic and Cardiovascular Surgery*. 2005; 129(6): 1371-1378.
113. Mitchell JC, D'Angelo M. Implications of hypothermia in procedural areas. *Journal of Radiology Nursing*. 2008; 27(2): 70-73.
114. Kurz A. Thermal care in the perioperative period. *Best Practice & Research Clinical Anesthesiology*. 2008; 22(1): 39-62.
115. Nygren J, Thacker J, Carli F, et al., Enhanced Recovery After Surgery Society. Guidelines for perioperative care in elective rectal/pelvic surgery; Enhanced Recovery After Surgery (ERAS®) Society recommendations. *Clinical Nutrition*. 2012; 31(6): 801-816.
116. Yang R, Wolfson M, Lewis MC. Unique aspects of the elderly surgical population: an anesthesiologist's perspective. *Geriatric Orthopaedic Surgery and Rehabilitation*. 2011; 2(2): 56064.
117. Gustafsson UO, Scott MJ, Schwenk W, et al. Guidelines for perioperative care in elective colonic surgery: Enhanced Recovery After Surgery (ERAS®) Society recommendations. *Clinical Nutrition*. 2012; 31(6): 783-800.
118. Carpenter L, Baysinger CL. Maintaining perioperative normothermia in the patient undergoing cesarean delivery. *Obstetrical & Gynecological Survey*. 2012; 67(7): 436-446.
119. Kim G, Kim MH, Lee SM, Choi SJ, Shin YH, Jeong HJ. Effect of pre-warmed intravenous fluids on perioperative hypothermia and shivering after ambulatory surgery under monitored anesthesia care. *Journal of Anesthesia*. 2014; 28(6): 880-885.

120. Andrzejowski JC, Turnbull D, Nandakumar A, Gowthaman S, Eapen G. A randomised single blinded study of the administration of pre-warmed fluid vs active fluid warming on the incidence of peri-operative hypothermia in short surgical procedures. *Anaesthesia*. 2010; 65(9): 942-945.
121. De Mattia AL, Barbosa MH, de Freitas Filho JP, Rocha Ade M, Pereira NH. Warmed intravenous infusion for controlling intraoperative hypothermia. *Revista Latino-Americana de Enfermagem*. 2013; 21(3): 803-810.
122. Woolnough M, Allam J, Hemingway C, Cox M. Yentis SM. Intra-operative fluid warming in elective caesarean section: a blinded randomised controlled trial. *International Journal of Obstetric Anesthesia*. 2009; 18(4): 346-351.
123. Yokoyama K, Suzuki M, Shimada Y, Matsushima T, Bito H, Sakamoto A. Effect of administration of pre-warmed intravenous fluids on the frequency of hypothermia following spinal anesthesia for cesarean delivery. *Journal of Clinical Anesthesiology*. 2009; 21(4): 242-248.
124. Association of Surgical Technologists. Standards of practice for skin prep of the surgical patient. 2008. https://www.ast.org/uploadedFiles/Main_Site/Content/About_Us/Standard_Skin_Prep.pdf. Accessed September 16, 2019.
125. Cassey JF, King RA, Armstrong P. Is there thermal benefit from preoperative warming in children? *Paediatric Anaesthesiology*. 2010; 20(1): 63-71.
126. Deren ME, Machan JT, DiGiovanni CW, Ehrlich MG, Gillerman RG. Prewarming operating rooms for prevention of intraoperative hypothermia during total knee and hip arthroplasties. *The Journal of Arthroplasty*. 2011; 26(8): 1380-1386.
127. Ozer AB, Tosun F, Demirel I, Unlu S, Bayar MK, Erhan OL. The effects of anesthetic technique and ambient temperature on thermoregulation in lower extremity surgery. *Journal of Anesthesia*. 2013; 27(4): 528-534.
128. Cheng KW, Wang CH, Chen CL, et al. Decreased fresh gas flow cannot compensate for an increased operating room temperature in maintaining body temperature during donor hepatectomy for living liver donor hepatectomy. *Transplantation Proceedings*. 2010; 42(3); 703-704.
129. Frey K. (ed.). *Surgical technology for the surgical technologist: a positive care approach*. 5th ed. Boston, MA: Cengage Learning, 2018.
130. Board TN, Svrinivasan MS. The effect of irrigation fluid temperature on core body temperature in arthroscopic shoulder surgery. *Archives of Orthopaedic & Trauma Surgery*. 2008; 128(5): 531-533.
131. Parodi D, Tobar C, Valderrama J, et al. Hip arthroscopy and hypothermia. *Arthroscopy*. 2012; 28(7): 924-928.
132. Fekgul ZT, Pektas S, Yildirim U, et al. A prospective randomized double-blind study on the effects of the temperature of irrigation solutions on thermoregulation and postoperative complications in percutaneous nephrolithotomy. *Journal of Anesthesiology*. 2014; 29(2): 165-169.
133. Kim YS, Lee JY, Yang SC, Song JH, Koh HS, Park WK. Comparative study of the influence of room-temperature and warmed fluid irrigation on body temperature in arthroscopic shoulder surgery. *Arthroscopy*. 2009; 25(1): 24-29.

134. Parodi D, Valderrama J, Tobar C, et al. Effect of warmed irrigation solution on core body temperature during hip arthroscopy for femoroacetabular impingement. *Arthroscopy*. 2014; 30(1): 36-41.
135. Summary: H.R.3095 Safe medical devices act of 1990. 1990. https://www.congress.gov/bill/101st-congress/house-bill/3095. Accessed October 1, 2019.
136. Association of Surgical Technologists. AST continuing education policies for the CST and CSFA. 2005. http://www.ast.org/webdocuments/CEPoliciesCSTCSFA/. Accessed October 14, 2019.
137. Pappas C. The adult learning theory-andragogy-of Malcolm Knowles. 2013. https://www.elearningindustry.com/the-adult-learning-theory-andragogy-of -malcolm-knowles. Accessed October 14, 2019.
138. Association of Surgical Technologists. Core curriculum for surgical technology. 2011. https://www.ast.org/uploadedFiles/Main_Site/Content/Educators/Core%20Curriculum%20v2.pdf. Accessed October 14, 2019.
139. National Institute for Health and Care Excellence. Hypothermia: prevention and management in adults having surgery. 2008. www.nice.org.uk/guidance/cg65. Accessed September 9, 2019.
140. National Institute for Health and Care Excellence. Surgical site infection. 2013. www.nice.org.uk/guideance/qs49. Accessed September 9, 2019.
141. Infection Control Today. Patients actively warmed during surgery still experience hypothermia, study finds. 2015. https://www.infectioncontroltoday.com/ssi/patients-actively-warmed-during-surgery-still-experience-hypothermia-study-finds. Accessed October 1, 2019.
142. Lista F, Doherty CD, Backstein RM, Ahmad J. The impact of perioperative warming in an outpatient aesthetic surgery setting. *Aesthetic Surgery Journal*. 2012; 32(5): 613-620.
143. National Institute for Health and Care Excellence. Inadvertent perioperative hypothermia implementation advice. 2008. https://www.nice.org.uk/guidance/cg65/resources/implementation-advice-pdf-485694109. Accessed September 9, 2019.