Artigo de revisão

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Instruções Brasileiras sobre Intervenções para Prevenção e Treinamento a Respeito de Hipotermia Perioperatória Inadvertida em Adultos – Produzida pela Sociedade de Anestesiologia do estado de São Paulo

Brazilian guidelines on interventions for preventing and treating inadvertent perioperative hypothermia in adults – produced by the São Paulo State Society of Anesthesiology

Consenso brasileño sobre intervenciones para la prevención y tratamiento de la hipotermia perioperatoria inadvertida en adultos - elaborado por la Sociedad Estatal de Anestesiología de São Paulo

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BACKGROUND

Perioperative hypothermia is defined as a core body temperature below 36°C (96.8°F) at any moment during the perioperative period. After induction of anesthesia, the most important cause of perioperative hypothermia is core-to-peripheral redistribution of body heat, an effect that accounts for most of the core temperature reduction during the first hour of anesthesia. In clinical doses, anesthetic drugs markedly impair thermoregulatory defenses against hypothermia. Additionally, they produce vasodilatation and impair vasoconstrictor responses. The combination of an impaired thermoregulation and cool operating room environment renders nearly all non-warmed surgical patients hypothermic.

Hypothermia increases blood loss and surgical site infections and prolongs postoperative recovery. Therefore, inadvertent non-therapeutic hypothermia is considered an adverse effect of general and regional anesthesia, which means that understanding hypothermia and its complications and effective strategies for its prevention in the perioperative period is fundamental for health care providers. It is also essential to plan effective interventions that minimize or that facilitate the prevention of complications arising from anesthesia.

The São Paulo State Society of Anesthesiology (SAESP) thus invited a task force of multidisciplinary health professionals to establish Brazilian guidelines on interventions for preventing and treating inadvertent perioperative hypothermia in adults. The following clinical questions were addressed:

1. Is hypothermia a risk factor for morbidity and/or mortality?
2. Are active warming systems effective?
3. Does pre-warming (i.e., before anesthesia) help prevent intraoperative hypothermia?
4. Which is the best and most precise location to measure core body temperature? Which device is the best to measure core body temperature during the perioperative period?

STATEMENTS

I. Since the 1990s, inadvertent perioperative hypothermia has been recognized as a source of perioperative complications, and in many surveys, patients respond about postoperative shivering and prefer to feel pain than this discomfort.

Currently, patient-centered care means that healthcare professionals can inform patients about their surgery, anesthesia and all aspects of their care and treatment, , allowing patients to define their needs and preferences.

Good communication between healthcare professionals and patients is essential and should be supported by evidence-based written information tailored to the patient's needs. Treatment and care and the information patients are given about it should be culturally appropriate. It should also be accessible to people with additional needs such as physical, sensory or learning disabilities and to people who do not speak or read Portuguese.

If healthcare professionals understand the patient's need and the patient and his family understand the medical complications associated with inadvertent perioperative hypothermia, they will be ready to work together to achieve better results.

Action Plan

Perioperative Care

- Patients (and their families and caregivers) should be informed of the following:
  - They should try to stay warm before surgery because if will lower the risk of postoperative complications.
  - They should be aware that the hospital environment might be colder than their own home.
  - They should bring additional clothing, such as a dressing gown, a vest, warm clothing and slippers, to help them keep comfortably warm.
  - They should tell staff if they feel cold at any time during their hospital stay.
- When using any device to measure patient temperature, healthcare professionals should consider the following:
  - Be aware of and perform any adjustments that need to be made in order to obtain an estimate of core temperature from that recorded at the site of measurement.

- Be aware of any such adjustments that are made automatically by the device that is being used.

II. In this guideline, hypothermia is defined as a patient core temperature below 36°C (96.8°F). During the first 30 to 40 minutes of anesthesia, a patient's temperature can drop to below 35°C (95.0°F), but the risk of developing hypothermia occurs at any stage of the perioperative period. There are three main phases: the preoperative phase is defined as the 1 hour before induction of anesthesia (when the patient is prepared for surgery on the ward or in the emergency department), the intraoperative phase is defined as total anesthesia time, and the postoperative phase is defined as the 24 hours after entry into the recovery area from the surgical suite (which includes transfer to and time spent on the ward).

Action Plan

Preoperative phase

- Each patient should be assessed for his/her risk of inadvertent perioperative hypothermia and potential adverse consequences before transfer to the surgical suite. Patients should be managed as being at a higher risk for hypothermia if any two of the following apply:
  - ASA grade II to V (the higher the grade is, the greater the risk is). [1]
  - Preoperative temperature below 36.0°C (96.8°F) (please note that preoperative warming is not possible because of clinical urgency).
  - Undergoing combined general and regional anesthesia.
  - Undergoing major or intermediate surgery.
  - At risk of cardiovascular complications.
- If the patient's temperature is below 36.0°C (96.8°F), the following should be performed:
  - Forced air warming should be started preoperatively on the ward or in the emergency department (unless there is a need to expedite surgery because of clinical urgency, for example, if bleeding or critical limb ischemia present).
  - Forced air warming should be maintained throughout the intraoperative phase.
  - Pre-warming is possible with a sufficient duration in the preoperative or holding area.
  - Pre-warming is highly efficient, even when performed over a short duration before surgery.

III. It is thus the standard of care to monitor temperature and avoid inadvertent perioperative hypothermia. The choice of device or probe to measure temperature and specific body location, such as the distal esophagus, rectum, pulmonary artery, nasopharynx, skin surface, or to measure central temperature on the lateral forehead and lateral neck is currently a challenge.

It is also important to check and document the temperature measured at intervals every 10 to 15 minutes, to create the opportunity to make an active intervention if needed.

Action Plan

Intraoperative phase

- The patient's temperature should be measured and documented before induction of anesthesia and then every 30 minutes until the end of surgery.
- Induction of anesthesia should not begin unless the patient's temperature is 36.0°C (96.8°F) or above (unless there is a need to expedite surgery because of clinical urgency, for example bleeding or critical limb ischemia present).
- Intravenous fluids (500 mL or more) and blood products should be warmed to 37°C (98.6°F) using a fluid-warming device.
- Patients who are at a higher risk of inadvertent perioperative hypothermia (see section 1.2.1) and who are having anesthesia for less than 30 minutes should be warmed intraoperatively from induction of anesthesia using a forced air warming device.
- All patients who undergo anesthesia for longer than 30 minutes should be warmed intraoperatively from induction of anesthesia using a forced air warming device.
- In the surgical suite, the following parameters should be maintained:
    - The ambient temperature should be at least 21°C (69.8°F) while the patient is exposed.
    - Once forced air warming is established, the ambient temperature can be reduced to allow better working conditions.
    - Using equipment to cool the surgical team should also be considered.
- The patient should be adequately covered throughout the intraoperative phase to conserve heat and exposed only during surgical preparation.

- Intravenous fluids (500 mL or more) and blood products should be warmed to 37°C (98.6°F) using a fluid warming device.
- Patients who are at a higher risk of inadvertent perioperative hypothermia (see section 1.2.1) and who are having anesthesia for less than 30 minutes should be warmed intraoperatively from induction of anesthesia using a forced air warming device.
- All patients who undergo anesthesia for longer than 30 minutes should be warmed intraoperatively from induction of anesthesia using a forced air warming device.
- The temperature setting on forced air warming devices should be set at maximum and then adjusted to maintain the patient's temperature of at least 36.5°C (97.7°F).
- All irrigation fluids used intraoperatively should be warmed in a thermostatically controlled cabinet to a temperature of 38–40°C (100.4 – 104.0°F).

In Brazil, in 2006, the Federal Council of Medicine (FCM) published a resolution, number 1802/2006 II - Basic Equipment for Anesthesia Support and Cardiorespiratory – "…3. The monitoring of the temperature and the use of the active equipment to transfer heat for pediatric and geriatric patient is recommended during the intraoperative period and in surgical procedures during more than two hours".

IV. We suggest that clinicians observe and document the occurrence of inadvertent perioperative hypothermia of patients in the postoperative recovery room (PACU). We also suggest using the incidence of inadvertent perioperative hypothermia in the PACU as a quality indicator of anesthetic care.

Another important topic is associated with the real incidence of the hypothermia in the PACU because these are associated with device for measurement, calibration and local.

Action Plan

Postoperative phase

- The patient's temperature should be measured and documented on admission to the recovery room and then every 15 minutes.
  - Ward transfer should not be arranged unless the patient's temperature is 36.0°C (96.8°F) or above.

- If the patient's temperature is below 36.0°C **(**96.8°F**),** he/she should be actively warmed using forced air warming until he/she is discharged from the recovery room or he/she is comfortably warm.

MATERIALS AND METHODS

Types of included studies

We included only systematic reviews and randomized controlled trials (RCTs) or quasi-randomized controlled trials (quasi-RCTs).

Types of participants

We included all adult patients (over 17 years old) undergoing elective or non-elective interventions (including surgery for trauma) or any medical procedures under general or regional (central neuraxial block) anesthesia. We considered only inadvertent hypothermia, and we defined this as body temperature below 36°C (96.8°F).

The exclusion criteria included the following: induced hypothermia, studies that did not specify the type of surgery, all causes of hypothermia unrelated to surgery and outpatient surgeries defined as those lasting less than 90 min. We also excluded systematic reviews without quantitative analysis.

Type of intervention and control group

We considered any intervention applied preoperatively, intraoperatively, or postoperatively aimed at restoring normal body temperature. Interventions were compared against each other, usual care or no intervention. In addition, we defined the control group as no intervention.

We defined passive warming systems strategies to reduce heat loss and prevent hypothermia as changes to environmental temperature, passive insulation by covering exposed body surface, closed or semi-closed anesthesia circuits with low flow and heat and moisture exchangers.

We defined active warming strategies as those that aimed to transfer heat to the patient, such as infrared lights, electric blankets, mattresses or blankets with warm water circulation, forced-air warming or convective air warming transfer, warming of intravenous and irrigation

fluids, and warming and humidifying of medical gases. We also considered pharmacological agents.

We excluded intermittent pneumatic compression interventions, which are not primarily designed for patient warming.

Type of outcomes evaluated

We analyzed the following outcomes: incidence of hypothermia, time taken to achieve normothermia, mean temperature after induction, rate of rewarming, rate of shivering, morbidities and mortality (until the period evaluated by the included studies).

The question "*Is hypothermia a risk factor for morbidity and/or mortality?"* was answered according to the studies identified in the literature that reported complications related to hypothermia regardless of the study design.

Search strategy

We searched the Cochrane Central Register of Controlled Trials (CENTRAL); The Cochrane Library (2015, issue 5), PubMed (1966 to February 2015), EMBASE (1980 to February 2015), Web of Science (1864 to February 2015) and Literatura Latino-Americana e do Caribe em Ciências da Saúde (LILACS, 1982 to February 2015). There was no language restriction. The date of the last search was February 28, 2015.

Table 1 shows the electronic databases from which the articles were obtained and the total number of references retrieved by them. Because we searched with both subject headings and free text words, it was expected that all studies of interventions in hypothermia patients would be identified. Table 2 shows our bibliographic search strategy, which was adapted for each electronic database.

Table 1 - Electronic databases, date of last search and number of reference retrieved.

Electronic databases	Date of last search	Number of reference retrieved
PubMed	1966 to February 2015	13.012
EMBASE	1980 to February 2015	5.832
CENTRAL	issue 2, 2015	1.995
Web of Science	1864 to February 2015	81
LILACS	1982 to February 2015	54

Table 2 – Search strategy.

(Hypothermia OR Hypothermias OR Accidental Hypothermia OR Accidental Hypothermias OR

Inadvertent Hypothermia OR Inadvertent Postoperative Hypothermia OR inadvertent perioperative hypothermia OR intraoperative hypothermia OR perioperative hypothermia OR postoperative hypothermia OR Inadvertent intraoperative hypothermia OR Transient hypothermia OR persistent hypothermia OR Incidental intraoperative hypothermia OR Incidental hypothermia OR deep hypothermia OR non intentional hypothermia OR non-intentional hypothermia OR Shivering OR low temperature) AND (Rewarming OR Rewarmings OR Heating OR Thermal insulation OR warming OR Warming system OR Warming systems OR Active warming system OR Active warming systems OR passive warming systems OR passive warming system OR warming device OR warming devices OR Radiant warmers OR Infant Radiant Warmers OR Infant Radiant Warmer OR vasodilator OR vasodilators OR Vasorelaxants OR Vasodilator Drugs OR Vasoactive Antagonists OR infrared light OR intravenous nutrient OR intravenous nutrients OR Mattress OR Mattresses OR blanket OR warm water OR fluid OR fluids OR pharmacological agent OR pharmacological agents OR thermal insulation OR pre-warming OR pre-operative warming OR pre warming OR pre operative warming OR fluid warming OR fluids warming OR temperature monitoring)

Selection of studies and data abstraction

Two authors independently selected potential studies, assessed trial quality and extracted data. Disagreements were resolved by consulting with a third review author.

Strength of evidence and recommended grading system

For this guideline, the studies cited from the literature were rated according to the strength of evidence and recommended grading scheme of the GRADE system (Appendix A).[1-3]

The grading scheme classifies recommendations as strong (Grade 1) or weak (Grade 2), according to the balance between the benefits, risks, burden, and cost, and degree of confidence in estimates of benefits, risks, and burden. The system classifies quality of evidence (as reflected in confidence in estimates of effects) as high (Grade A), moderate (Grade B), or low (Grade C) according to factors that include the risk of bias, precision of estimates, consistency of the results, and directness of the evidence[1-3] (Appendix A).

To assist readers, we expressed the results of the GRADE evidence using a color system in which green represents a strong recommendation (i.e., 1), red color represents a weak recommendation (i.e., 2) and yellow represents all the studies that the evidence was very likely to be recommended but that were downgraded due to some issues with either he internal and/or external validities (i.e., either 1 B/C or 2 regardless if A, B or C).

Methods used to analyze the evidence

We developed an evidence table for hypothermia based on the analysis of current literature and expert panel consensus (Appendices B to G). When possible, we performed

relative risk (RR) analysis for dichotomous data as well as mean difference (MD) analysis for continuous data with confidence intervals (CIs) of 95%. Additionally, the number of patients needed to be treated (NNT) to prevent one additional bad outcome (e.g., the number of patients who need to be treated for one to benefit compared with a control in a clinical trial) was calculated for significant dichotomous results.

When there were insufficient data to allow for a statistical analysis, we excluded the study.

RESULTS

See Appendices A to G.

Selection of studies

After duplicates were removed, we identified a total of 20.974 citations through database searches for the original review (Figura 1). After screening by title and then by abstract, we obtained full-paper copies for 551 citations that were potentially eligible for inclusion in the guideline. We excluded 535 studies for the following reasons: off-topic, editorial letters, narrative reviews, case reports, duplicates, published protocols, cohort and case-control studies. Therefore, 28 studies (six systematic reviews and 22 RCTs or quasi-RCTs) met the inclusion criteria of this guideline.

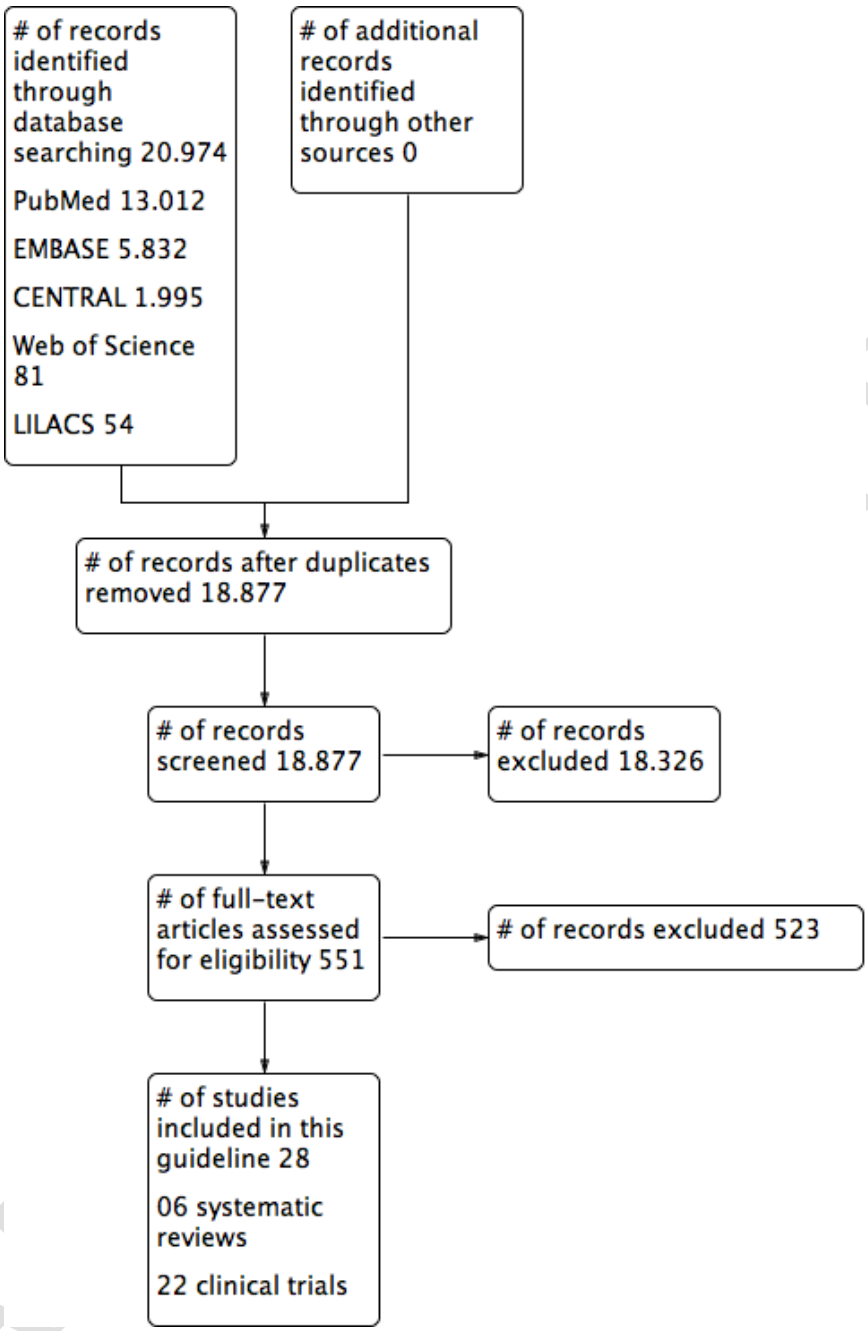

Figura 1. Flowchart of the studies evaluated for this guideline.

1. Is hypothermia a risk factor for morbidity and/or mortality?

GRADE: 1B

Answer: Six RCTs[28-33] evaluated hypothermia as a risk factor for morbidity and/or mortality. Hypothermia predisposes patients to wound infections and prolongs the hospital stay. In patients undergoing colorectal surgery, surgical-wound infections were found in 18 of 96

patients with hypothermia (19 percent) but in only 6 of 104 patients with normothermia (6 percent, P = 0.009). The length of hospital stay increased two days.[30] Another study conducted in patients undergoing elective major abdominal surgery showed that by extending the warming period to 2 h before and after surgery, the incidence of surgical-site infection can be further reduced from 27 to 13 per cent.[33] In these studies, 421 patients underwent surgery clean (breast, varicose, or hernia). The group of patients who were not heated had a 14% infection rate compared to 5% in the group that received heating, P = 0.0001.[32]

Hypothermia is a risk factor for cardiac events. One hundred patients who underwent lower extremity vascular reconstruction received continuous Holter monitoring throughout the first 24 h postoperatively. Myocardial ischemia was determined by a cardiologist masked to the clinical variables. The patient's sublingual temperature on arrival at the intensive care unit immediately after the surgical procedure was used to divide the patients into two groups: hypothermic (temperature < 35 degrees C; n = 33) and normothermic (temperature ≥ 35 degrees C; n = 67). The relationship between intentional hypothermia and myocardial ischemia occurring during the first postoperative day was evaluated by univariate and multivariate analyses.

A greater percentage of patients had electrocardiographic changes consistent with myocardial ischemia in the hypothermic group (36%, 12 of 33) compared with those in the normothermic group (13%, 9 of 67, P = 0.008). The reoperative risk factors for perioperative cardiac morbidity were similar between the two groups, except for patient age. The mean age was 70 +/- 2 yr and 62 +/- 1 yr in the hypothermic and normothermic groups, respectively (P = 0.001). When subgroup and multivariate analyses were used to adjust for differences in age, temperature remained an independent predictor of ischemia (odds ratio, 1.82 per degree Celsius; 95% confidence interval, 1.09-3.02). The incidence of postoperative angina was greater in the hypothermic group (18%, 6 of 33) than in the normothermic group (1.5%, 1 of 67, P = 0.002). The incidence of PaO_2 < 80 mmHg in the arterial blood was greater in the hypothermic group (52%, 17 of 33) than in the normothermic group (30%, 20 of 67, P = 0.03).[28]

In patients undergoing abdominal, thoracic, or vascular surgical procedures that either had documented coronary artery disease or who were at high risk for coronary disease, the perioperative maintenance of normothermia is associated with a reduced incidence of morbid cardiac events (relative risk, 2.2; 95% confidence interval (CI), 1.1-4.7; P = 0.04) and ventricular tachycardia (2.4% vs. 7.9%; P = 0.04).[29]

Mild intraoperative hypothermia prolongs post-anesthetic recovery. Patients undergoing elective major abdominal surgery were randomly assigned to routine thermal treatment (hypothermia) or additional heating (normothermia). Hypothermic patients required approximately 40 min longer (94 +/- 65 vs. 53 +/- 36 min) to reach fitness for discharge, even when return to normothermia was not a criterion ($P < 0.001$). Duration of recovery in the two groups differed by approximately 90 min when a core temperature >36 degrees C was also required ($P < 0.001$).[31]

Two trials assessed mortality, and no significant differences were found between active warming and control (hypothermic).[29,30]

Hypothermia is associated with a minor bleeding rate and transfusion. Normothermic versus hypothermic patients are associated with a 16% (95% CI 4%, 26%) lower average blood loss ($P = 0.009$) and a 22% lower risk of transfusion than hypothermia (95% CI 3%, 37%), $P = 0.027$.[34]

A systematic review examined whether preventing hypothermia during surgery prevents postoperative complications and improves outcomes for patients. Twenty-six randomized controlled trials were identified, and data extraction and assessment of study quality were performed by two researchers independently. The results of studies with similar patients, surgical procedures, and outcomes were pooled. The outcomes that were measured included postoperative pain levels, thermal comfort, and treatment costs. The postoperative complications that were identified were shivering (seventeen studies), cardiac events (two studies), need for blood transfusion (four studies), wound infections (two studies), and pressure ulcers (one study). The majority of studies favored treatment.[35]

2. Are active warming systems effective (active body surface warming systems versus control - generally involving a passive system, warmed cotton blankets or thermal insulation)?

GRADE: 1B

Answer: Forty-five RCTs evaluated the use of warming systems in the prevention of preoperative hypothermia.[9,18,22,25,29,30,32,36-72] The most studied warming system was large, forced-air warming in 38 RCTs, electric blankets in three, and resistive warming mattress, water garment, warmed foam pad, warming pad, and heated circulating water system in one. Most of the included studies reported only one comparison (two arm RCTs), but 14 trials reported two or

more comparisons in the same article.[32,36,40,43,44,47,58,60,61,64,70,73-75] The vast majority of the included studies showed that the use of any active warming system is definitely more efficacious than no intervention or than a passive warming system to prevent hypothermia.

3. Is pre-warming (i.e., before anesthesia) an effective strategy to prevent hypothermia?

GRADE: 1B

Answer: Three RCTs evaluated pre-warming; two of them were conducted in an orthopedic population and one study in colorectal patients.[11,16,47] Andrzejowski's study compared a pre-warming strategy versus no intervention (i.e., no pre-warming) for 60 min before surgery and concluded that patients had higher temperatures than the control group at the end of surgery.[11] The Horn study compared different times of pre-heating (10, 20 and 30 minutes) and discontinued the heating system during surgery until the temperature reached less than 36 °C.[47] de Witte's study compared two heating systems for 30 min concluded that both worked in the prevention of intraoperative hypothermia.[16] Other studies on this topic do not specify the pre-heating time and do not clarify how the pre-heating was performed, which invalidates conclusions concerning this topic.[9,13,14]

Although existing studies indicate a trend that pre-heating is effective in preventing intraoperative hypothermia, the forced-air warming system was also effective to reduce perioperative hypothermia.[76]

To evaluate the efficacy of the pre-warming program in the preoperative holding area, the authors started a 3-month pre-warming program and evaluated 127 patients with assessment using a quality assurance check sheet. The average duration of pre-warming was 46 ± 38 minutes. During the pre-warming, the core temperature increased by 0.3 ± 0.4 degrees Celsius (core temperature 37.1 ± 0.5 degrees Celsius), and after induction of anesthesia, the temperature decreased to 36.3 ± 0.5 degrees Celsius. At the end of the operation, the authors found that 14% of the patients were hypothermic, and the core temperature was 36.4 ± 0.5 degrees Celsius. The authors concluded: 1. Pre-warming is possible with a sufficient duration in the preoperative or holding areas and 2. Pre-warming is highly efficient, even when performed over a short duration before surgery.

4. Which is the best and most precise location to measure core body temperature? Which device is the best to measure core body temperature during the perioperative period?

Answer: The ideal core body temperature thermometer (probe or disposable) should be noninvasive, easy to use, accurate in non-physiological conditions, and independent of operator and technique and should provide continuous measurements.

The skin surface is rapidly influenced by the environment, and local temperature decreases mainly by radiation, convection and conduction (physical ways of losing heat). This is the peripheral compartment, and blood flux to the skin decreases significantly; therefore, if temperature is measured in the axillary region, it will be underestimated in relation to the core. In addition, skin surface temperature varies among individuals, as well as over time within individuals.[77]

The esophagus and nasopharynx are the most widely used core body locations in patients who are intubated or under general anesthesia. Well-perfused and deeper parts of the body (central compartment) better approximate central body temperature.

During mechanical ventilation (cold air) or during warming and rewarming in cardiopulmonary bypass, the core body temperature of the patient is affected by external influences, and the temperature measurement might not be accurate.

Other core body locations, such as the tympanic membrane, pulmonary artery and more recently, a precise and totally noninvasive probe that measures central temperature, are located in the lateral forehead and lateral neck. For example, one author showed that “deep-forehead” temperature correlated well with pulmonary artery temperature, and the bias for the deep-forehead temperature was 0.0^{o}C.[78]

During the perioperative period, the temperature probes used for long-term monitoring comprise sensors that are enclosed in a rigid metal or flexible plastic reusable housing. In addition, healthcare professional should be complying with local infection control policies. The same probe is used for measuring the core body location, such as the nasopharynx, esophagus or rectum. When measuring rectal temperature, a plastic cover must be used. Careful placement is necessary, mainly in the nasopharynx and esophagus, due to complications such as bleeding, laceration and esophageal perforation.

DISCUSSION

In Brazil, approximately 11.000.000 surgeries and invasive and diagnostic procedures are performed per year under any type of anesthesia, and it is estimated that 26%-90% of these

patients are exposed to the potential risk of perioperative hypothermia. Most of these procedures are carried out in public hospitals, where financial resources are scarce. Considering the disparity of resources among public and private hospitals in the country and the non-uniformity of anesthetic routines, a consensus guideline could contribute to ameliorating this problem.

The findings are positive and suggest a benefit of the systematic incorporation of heating methods in the perioperative period. Economic and cost-effectiveness studies should be initiated to demonstrate whether the cost of implementing these procedures and equipment is justified by the lower incidence of complications; however, it is also costly.

The included guidelines are consistent with guidelines that stress the importance of warming patients during the perioperative period, including those guidelines of the National Institute for Health and Care Excellence (NICE), which were published in April 2008, entitled "Hypothermia prevention and management in adults having surgery" for the UK. Another clinical practice guideline is "Preventing Inadvertent Perioperative Hypothermia", published in 2015 by the German Society of Anesthesiology and Intensive Care, German Surgical Society, German Society of Pediatric Surgery, German Society for Specialist Nursing and Ancillary Medical Staff, Austrian Society of Anesthesiology and Intensive Care and Swiss Society of Anesthesiology and Resuscitation. Both of these guidelines and our Brazilian Guideline on interventions for preventing and treating inadvertent perioperative hypothermia in adults ─ produced by the São Paulo State Society of Anesthesiology ─ clearly define the morbimortality associated with inadvertent perioperative hypothermia; we are very compromised in create national conditions to all healthcare centers and that healthcare professionals understand these practice as bad medicine.[79]

The Centers for Disease Control and Prevention (CDC) published preoperative measures associated with prevention strategies to reduce infection in the perioperative period and noted that maintaining postoperative normothermia is an important target.[80]

We could begin with pre-warming, maintain warming during and after surgeries, and address the gaps in the scientific literature regarding the amount of time necessary to pre-warm a patient before surgery.[76] Clinicians should also evaluate new technologies, which are continually being applied in the operating room and follow the possible post-procedure adverse events related to warming methods.

This places a demand on the ability of surgical staff to evaluate new devices, and efforts will be necessary to educate them about the importance of preventing hypothermia, which aspects should be observed, and the best evidence produced by the scientific literature.

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APPENDICES

Appendix A - Grading recommendations (GRADE system).[22-24]

Grade of Recommendation	Clarity of risk/benefit	Quality of supporting evidence	Implications
1A. Strong recommendation, high-quality evidence	Benefits clearly outweigh risk and burdens, or vice versa.	Consistent evidence from well-performed randomized controlled trials or overwhelming evidence of some other form. Further research is unlikely to change our confidence in the estimate of benefits and risks.	Strong recommendations, can apply to most patients in most circumstances without reservation. Clinicians should follow a strong recommendation unless a clear and compelling rationale for an alternative approach is present.
1B. Strong recommendation, moderate-quality evidence	Benefits clearly outweigh risk and burdens, or vice versa.	Evidence from randomized controlled trials with important limitations (inconsistent results, methodologic flaws, indirect or imprecise), or very strong evidence of some other research design. Further research (if performed) is likely to have an impact on the confidence in the estimate of benefits and risks and might change the estimate.	Strong recommendation and applies to most patients. Clinicians should follow a strong recommendation unless a clear and compelling rationale for an alternative approach is present.
1C. Strong recommendation, low-quality evidence	Benefits appear to outweigh risk and burdens, or vice versa.	Evidence from observational studies, unsystematic clinical experience, or from randomized controlled trials with serious flaws. Any estimate of effect is uncertain.	Strong recommendation, and applies to most patients. Some of the evidence base supporting the recommendation is, however, of low quality.
2A. Weak recommendation, high-quality evidence	Benefits closely balanced with risks and burdens.	Consistent evidence from well-performed randomized controlled trials or overwhelming evidence of some other form. Further research is unlikely to change the confidence in the estimate of benefits and risks.	Weak recommendation, best action might differ depending on circumstances or patients or societal values.
2B. Weak recommendation, moderate-quality evidence	Benefits closely balanced with risks and burdens, some uncertainly in the estimates of	Evidence from randomized controlled trials with important limitations (inconsistent results, methodologic flaws, indirect or imprecise), or very strong evidence of some other research	Weak recommendation, alternative approaches likely to be better for some patients under some circumstances.

	benefits, risks and burdens.	design. Further research (if performed) is likely to have an impact on the confidence in the estimate of benefits and risks and might change the estimate.	
2C. Weak recommendation, low-quality evidence	Uncertainty in the estimates of benefits, risks, and burdens; benefits might be closely balanced with risks and burdens.	Evidence from observational studies, unsystematic clinical experience, or from randomized controlled trials with serious flaws. Any estimate of effect is uncertain.	Very weak recommendation; other alternatives might be equally reasonable.

Appendix B – Preventing and treating hypothermia according to level of evidence and grade of recommendation.

Intervention	Control group	Period	Purpose	GRADE	Type of surgery	Age	Reference
Warmed intravenous fluids[1]	Room temperature intravenous fluids	Preoperative and/or intraoperative	Prevention	1A	Abdominal, gynecologic, urologic and orthopedic, transurethral resection of the prostate, off-pump cardiac, repair of abdominal aortic aneurysm, general surgery longer than 90 min, urological[2]	Adults (over 18 years of age)	Campbell2015[4]
Warmed irrigation fluids	Room temperature irrigation fluid	Preoperative and/or intraoperative	Prevention	1A	Endoscopic	Adults (not specified)	Jin et al. 162011[5]
Active warming methods[3]	Cotton blankets; unwarmed blankets; warmed blankets	Postoperative	Treatment	1A	Abdominal, orthopedic, thoracic, PACU, OR, SICU, laparotomy, spinal	Adults (over 18 years of age)	Warttig et al. 2014[6]
Thermal insulation	Control[4] or forced air warming	Preoperative and/or intraoperative	Prevention	1B	Abdominal, gynecologic, urologic, orthopedic, thoracic hepatobiliary, resection of the prostate, lumbar laminectomy expected to last at least 90 minutes, craniotomy	Adults (over 18 years of age)	Alderson et al. 2014[7]

Forced-air warming systems	Passive or radiant warming or; circulating water garments	Preoperative	Prevention	1C	Abdominal, gynecologic, urologic, orthopedic, off-pump cardiac, laparoscopic cholecystectomy, surgery > than a two-hour duration, liver transplantation	Adults (over 18 years of age)	Galvão et al. 2010[8]
Warming mattress	No intervention	Preoperative	Prevention	1C	Obstetric	Adults (over 17 years of age)	Chakladar et al. 2014[9]
Forced-air warming systems	Water mattress	Preoperative	Prevention	1C	Infrarenal aortic	Adults (not specified)	Elmore et al. 1998[10]
Forced-air warming systems	No intervention	Preoperative	Prevention	1C	Orthopedic	Adults (not specified)	Andrzejowski et al. 2008[11]
Pre-warming operating rooms	No intervention	Preoperative	Prevention	1C	Orthopedic	Adults (at least 18 years of age)	Deren et al. 2011[12]
Warm air filtered-flow	Forced-air warming systems (Bair Hugger)	Preoperative	Prevention	1C	Abdominal, orthopedic	Adults (18 to 85 years of age)	Wagner et al. 2008[13]
Forced-air warming systems (Bair Hugger)	Electric heating pad	Preoperative	Prevention	1C	Orthopedic	Adults (18 to 80 years of age)	Ng et al. 2006[14]
Warming blood transfusion and infusion	No intervention	Preoperative	Prevention Prevention	1C	Orthopedic	Adults (60 to 75 years of age)	Wei et al. 2014[15]
Carbon fiber total body cover	No pre-warming	Preoperative	Prevention	1C	Laparoscopic colorectal	Adults (older than 80 years of age)	de Witte et al. 2010[16]
Carbon fiber total body cover	Forced-air warming systems	Preoperative	Prevention	1C	Laparoscopic colorectal	Adults (older than 80 years of age)	de Witte et al. 2010[16]
Forced-air warming systems	No pre-warming	Preoperative	Prevention	1C	Laparoscopic colorectal	Adults (older than 80 years of age)	de Witte et al. 2010[16]

Resistive heating warmed (Hot Dog)	Forced-air warming systems (Bair Hugger)	Intraoperative	Treatment	1C	Head and neck	Adults (not specified)	Röder et al. 2011[17]
Forced-air warming systems	Wool blanket only	Preoperative	Prevention	1C	Cholecystectomy	Adults (not specified)	Camus et al. 1995[18]
Forced-air warming systems (Bair Hugger)	Resistive heating warmed (Hot Dog)	Preoperative	Prevention	1C	Orthopedic	Adults (not specified)	Brandt et al. 2010[19]
Forced-air warming systems	Intravenous fluids and blood warmed with a heat moisture exchanger plus paper drapes and warmed cotton blankets	Preoperative and Postoperative	Prevention	1C	Abdominal, thoracic, or lower extremity vascular surgical procedures	Adults (not specified)	Frank et al. 1995[20]
Fluid warming via the Hotline	Fluid warming via the Flotem IIe	Preoperative	Prevention Prevention	1C	Orthopedic and gynecologic	Adults (not specified)	Patel et al. 1996[21]
Forced-air warming systems	Cotton blanket	Preoperative	Prevention	1C	Orthopedic, urologic and gynecologic	Adults (over 18 years of age)	Fossum et al. 2001[22]

Thermal blanket	Thermal mattress	Preoperative	Prevention	1C	Gastrointestinal	Adults (not specified)	Moyses et al. 2014[23]
Thermostat device	Warmed blankets and/or radiant heat	Postoperative	Treatment	2B	Gynecologic, urologic, thoracic, orthopedic scheduled to last ≥ 90 min	Adults (not specified)	Smith et al. 1999[24]
Forced-air warming systems	No intervention	Preoperative	Prevention	2B	Obstetric	Adults (18 to 40 years of age)	Butwick et al. 2007[25]
Heated humidifier	Conventional respiratory circuit	Preoperative	Prevention	2B	Orthopedic	Adults (25 to 75 years of age)	Lee et al. 2011[26]
Heat and moisture exchanger	No intervention	Preoperative	Prevention	2B	Orthopedic	Adults (not specified)	Yam and Carli 1990[27]
Gases humidified and warmed at 40° C by heated humidifier	No intervention	Preoperative	Prevention	2B	Orthopedic	Adults (not specified)	Yam and Carli 1990[27]
Heat and moisture exchanger	Gases humidified and warmed to 40° C by heated humidifier	Preoperative	Prevention	2B	Orthopedic	Adults (not specified)	Yam and Carli 1990[27]

[1]A wide range of methods of warming included pre-warmed fluids and various devices for warming; fluids were warmed to a range of temperatures between 37°C and 41°C.
[2]Most studies excluded patients with medical morbidity, such as thyroid disease, acute illness and central causes for abnormal temperature regulation.
[3]Forced air warming, circulating hot water devices, radiant blankets, radiant warmers, electric blankets. Interventions were commenced in the immediate postoperative period in the PACU or in critical care unit and were applied until normothermia was reached.
[4]Control group was defined as cotton sheets or blankets, wool blankets, and other non-reflective textiles.

Appendix C - Mean difference of temperature after induction in preventing hypothermia according to the grade of recommendation.

Intervention	Control group	Follow-up*	Type of surgery	Mean Difference (MD) [95% CI]	References
Warmed intravenous fluids[1]	Room temperature intravenous fluids	Temperature 30 minutes after induction	Overall	0.41 [0.24, 0.57][2]	Campbell et al. 2015[4]
Warmed intravenous fluids[1]	Room temperature intravenous fluids	Temperature 30 minutes after induction	Elective Caesarean delivery	0.44 [0.12, 0.76][2]	Campbell et al. 2015[4]
Warmed intravenous fluids[1]	Room temperature intravenous fluids	Temperature 30 minutes after induction	All other surgery	0.39 [0.26, 0.51][2]	Campbell et al. 2015[4]
Warmed intravenous fluids[1]	Room temperature intravenous fluids	Temperature 60 minutes after induction	Overall	0.51 [0.33, 0.69][2]	Campbell et al. 2015[4]
Warmed intravenous fluids[1]	Room temperature intravenous fluids	Temperature 60 minutes after induction	Elective Caesarean delivery	0.60 [0.01, 1.19]	Campbell et al. 2015[4]
Warmed intravenous fluids[1]	Room temperature intravenous fluids	Temperature 60 minutes after induction	All other surgery	0.47 [0.30, 0.64][2]	Campbell et al. 2015[4]

Warmed intravenous fluids[1]	Room temperature intravenous fluids	Temperature at 90 minutes after induction	--	0.54 [0.04, 1.04]	Campbell et al. 2015[4]
Warmed intravenous fluids[1]	Room temperature intravenous fluids	Temperature at 120 minutes after induction	--	0.74 [0.31, 1.17]	Campbell et al. 2015[4]
Warmed intravenous fluids[1]	Room temperature intravenous fluids	Temperature at end of procedure/arrival to PACU	Overall	0.63 [0.28, 0.98][2]	Campbell et al. 2015[4]
Warmed intravenous fluids[1]	Room temperature intravenous fluids	Temperature at end of procedure/arrival to PACU	Elective Caesarean delivery	0.56 [0.08, 1.04]	Campbell et al. 2015[4]
Warmed intravenous fluids[1]	Room temperature intravenous fluids	Temperature at end of procedure/arrival to PACU	All other surgery	0.66 [0.19, 1.12]	Campbell et al. 2015[4]
Warmed intravenous fluids[1]	Room temperature intravenous fluids	Temperature at end of procedure/arrival to PACU	--	0.24 [-0.06, 0.55]	Campbell et al. 2015[4]
Additional insulation[3]	Control[4]	Temperature after 30 minutes	--	0.11 [-0.02, 0.23]	Alderson et al. 2014[7]

Additional insulation[3]	Control[4]	Temperature after 1 hour	--	0.02 [-0.13, 0.16]	Alderson et al. 2014[7]
Additional insulation[3]	Control[4]	Temperature after 90 minutes	--	0.20 [-0.07, 0.46]	Alderson et al. 2014[7]
Additional insulation[3]	Control[4]	Temperature after 2 hours	--	0.09 [-0.23, 0.41]	Alderson et al. 2014[7]
Additional insulation[3]	Control[4]	Temperature at end of procedure/arrival to PACU	--	0.12 [-0.07, 0.31]	Alderson et al. 2014[7]
Additional insulation[3]	Control[4]	Estimated blood loss	--	-27.80 [-175.48, 119.87]	Alderson et al. 2014[7]
Additional insulation[3]	Forced air warming	Temperature after 30 minutes	--	-0.15 [-0.31, 0.01]	Alderson et al. 2014[7]
Additional insulation[3]	Forced air warming	Temperature after 1 hour	--	-0.24 [-0.38, -0.10][5]	Alderson et al. 2014[7]

Additional insulation[3]	Forced air warming	Temperature after 90 minutes	--	-0.59 [-0.73, -0.45][5]	Alderson et al. 2014[7]
Additional insulation[3]	Forced air warming	Temperature after 2 hours	--	-0.46 [-0.91, 0.00]	Alderson et al. 2014[7]
Additional insulation[3]	Forced air warming	Temperature at end of procedure/arrival to PACU	--	-0.67 [-0.95, -0.39][5]	Alderson et al. 2014[7]
Additional insulation[3]	Forced air warming	Estimated blood loss	--	15.06 [-67.23, 97. 35]	Alderson et al. 2014[7]
Forced-air warming systems	Passive warming	Temperature control	--	0.29 [-0.02, 0.59]	Galvão et al. 2010[8]
Forced-air warming systems	Radiant warming	Temperature control	--	0.16 [-0.01, 0.33]	Galvão et al. 2010[8]
Forced-air warming systems	Circulating water garments	Temperature control	--	-.073 [-1.51, 0.05]	Galvão et al. 2010[8]

Forced-air warming systems	Circulating water garments	Temperature control	--	-0.09 [-0.28, 0.09]	Galvão et al. 2010[8]
Forced-air warming systems	Circulating water garments	Temperature control	--	-0.03 [-0.24, 0.18]	Galvão et al. 2010[8]
Forced-air warming systems	No intervention	Temperature after 20 minutes	Spinal surgery	0.20 [-0.01, 0.41]	Andrzejowski et al. 2008[11]
Forced-air warming systems	No intervention	Temperature after 60 minutes	Spinal surgery	0.30 [0.04, 0.56]	Andrzejowski et al. 2008[11]
Forced-air warming systems	No intervention	Temperature after 120 minutes	Spinal surgery	0.30 [-0.11, 0.71]	Andrzejowski et al. 2008[11]
Forced-air warming systems	No intervention	Temperature after 160 minutes	Spinal surgery	0.00 [-0.48, 0.48]	Andrzejowski et al. 2008[11]
Pre-warming operating rooms	No intervention	Esophageal core temperature	Knee and hip arthroplasty	-0.04 [-0.09, 0.01]	Deren et al. 2011[12]

Warm air filtered flow	Forced-air warming systems (Bair Hugger)	Temperature after 10 minutes	Abdominal and orthopedic	0.00 [-0.16, 0.16]	Wagner et al. 2008[13]
Warm air filtered flow	Forced-air warming systems (Bair Hugger)	Temperature at end of surgery	Abdominal and orthopedic	-0.10 [-0.29, 0.09]	Wagner et al. 2008[13]
Warm air filtered flow	Forced-air warming systems (Bair Hugger)	PACU	Abdominal and orthopedic	0.00 [-0.16, 0.16]	Wagner et al. 2008[13]
Forced-air warming systems (Bair Hugger)	Electric heating pad	Temperature at end of surgery	Orthopedic	-0.10 [-0.30, 0.10]	Ng et al. 2006[14]
Heated humidifier	Conventional respiratory circuit	Temperature after 30 minutes	Orthopedic	0.30 [0.17, 0.43][6]	Lee et al. 2011[26]
Heated humidifier	Conventional respiratory circuit	Temperature after 60 minutes	Orthopedic	0.40 [0.22, 0.58][6]	Lee et al. 2011[26]
Heated humidifier	Conventional respiratory circuit	Temperature after 90 minutes	Orthopedic	0.50 [0.28, 0.72][6]	Lee et al. 2011[26]

Heated humidifier	Conventional respiratory circuit	Temperature after 120 minutes	Orthopedic	0.40 [0.20, 0.60][6]	Lee et al. 2011[26]
Heated humidifier	Conventional respiratory circuit	Temperature after 150 minutes	Orthopedic	0.40 [0.20, 0.60][6]	Lee et al. 2011[26]
Heated humidifier	Conventional respiratory circuit	Temperature after 180 minutes	Orthopedic	0.50 [0.30, 0.70][6]	Lee et al. 2011[26]
Carbon fiber total body cover	No pre-warming	Temperature after 50 minutes**	Laparoscopic colorectal	0.60 [0.27, 0.93][7]	de Witte et al. 2010[16]
Carbon fiber total body cover	Forced-air warming systems	Temperature after 50 minutes**	Laparoscopic colorectal	0.30 [-0.03, 0.63]	de Witte et al. 2010[16]
Forced-air warming systems	No pre-warming	Temperature after 50 minutes**	Laparoscopic colorectal	0.30 [0.01, 0.59][7]	de Witte et al. 2010[16]
Warming mattress	No intervention	Temperature at recovery admission	Obstetric	0.20 [0.04, 0.36]	Chakladar et al. 2014[9]

Forced-air warming systems	Wool blanket only	Skin temperature	Cholecystectomy	2.30 [2.05, 2.55][8]	Camus et al. 1995[18]
Forced-air warming systems	Wool blanket only	Temperature after 1 hour	Cholecystectomy	0.60 [0.50, 0.70][8]	Camus et al. 1995[18]
Forced-air warming systems	Resistive heating warmed (Hot Dog)	Temperature at end of surgery	Orthopedic	0.20 [0.00, 0.40]	Brandt et al. 2010[19]
Heat and moisture exchanger	No intervention	Temperature at end of surgery	Orthopedic	-0.10 [-0.50, 0.30]	Yam and Carli 1990[27]
Gases humidified and warmed to 40° C by heated humidifier	No intervention	Temperature at end of surgery	Orthopedic	0.90 [0.47, 1.33][9]	Yam and Carli 1990[27]
Gases humidified and warmed to 40° C by heated humidifier	Heat and moisture exchanger	Temperature at end of surgery	Orthopedic	1.00 [0.60, 1.40][10]	Yam and Carli 1990[27]
Forced-air warming systems	Intravenous fluids and blood warmed with a heat moisture exchanger plus paper drapes and	Temperature at admission to PACU	Abdominal, thoracic, or lower extremity vascular surgical procedures	1.40 [1.35, 1.45][11]	Frank et al. 1995[20]

	warmed cotton blankets					
Forced-air warming systems	Cotton blanket	Temperature at discharge	Orthopedic, urologic and, gynecologic	0.30 [0.10, 0.50][12]	Fossum et al. 2001[22]	
Thermal blanket	Thermal mattress	Temperature after 30 min	Gastrointestinal	-0.40 [-0.81, 0.01]		
Thermal blanket	Thermal mattress	Temperature after 60 min	Gastrointestinal	-0.30 [-0.85, 0.25]	Moyses et al. 2014[23]	
Thermal blanket	Thermal mattress	Temperature after 120 min	Gastrointestinal	-0.70 [-1.11, -0.29][13]	Moyses et al. 2014[23]	
Thermal blanket	Thermal mattress	Temperature after 180 min	Gastrointestinal	-0.60 [-1.05, -0.15][13]	Moyses et al. 2014[23]	
Thermal blanket	Thermal mattress	Temperature at the end	Gastrointestinal	-0.90 [-1.41, -0.39][13]	Moyses et al. 2014[23]	

*After induction.
**After anesthesia.

[1]A wide range of methods of warming included pre-warmed fluids and various devices for in-line warming; fluids were warmed to a range of temperatures between 37°C and 41°C.
[2]There was a significant difference favoring patients who received warmed intravenous fluids (who had a higher core temperature) than those who received room-temperature intravenous fluids.
[3]Thermal insulation was defined as interventions deliberately designed to prevent heat loss (reflective blankets or clothing).
[4]Control group was defined as cotton sheets or blankets, wool blankets, and other non-reflective textiles.
[5]There was a significant difference in core temperature favoring patients who received forced air warming compared to those with extra insulation.
[6]There was a significant difference favoring patients who received heated humidified air compared to those with a conventional respiratory circuit.
[7]There was a significant difference favoring patients who received either a carbon fiber total body cover or forced-air warming systems versus no pre-warming.
[8]There was a significant difference favoring patients who received a forced-air warming system compared to those with only wool blanket.
[9]There was a significant difference favoring patients who received gases humidified and warmed to 40° C by a heated humidifier compared to those with no intervention.
[10]There was a significant difference favoring patients who received gases humidified and warmed to 40° C by a heated humidifier compared to those with a heat and moisture exchanger.
[11]There was a significant difference favoring patients who received a forced-air warming system compared to those with intravenous fluids and blood warmed with a heat moisture exchanger plus paper drapes and warmed cotton blankets.
[12]There was a significant difference favoring patients who received a forced-air warming system compared to those with a cotton blanket.
[13]There was a significant difference favoring patients who received a forced-air warming system compared to those with a cotton blanket.
--No subgroup analysis per type of surgery.

Appendix D - Risk relative and number of patients needed to prevent a clinical outcome of hypothermia according to the grade of recommendation.

Intervention	Comparator	Type of surgery	Clinical outcome	Relative risk (RR) [95% CI]	NNT	Reference
Warmed intravenous fluids[1]	Room temperature intravenous fluids	Overall	Rate of shivering	0.39 [0.23, 0.67][2]	3.7	Campbell et al. 2015[4]
Warmed intravenous fluids[1]	Room temperature intravenous fluids	Elective Caesarean delivery	Rate of shivering	0.61 [0.36, 1.02]	***	Campbell et al. 2015[4]
Warmed intravenous fluids[1]	Room temperature intravenous fluids	All other surgery	Rate of shivering	0.29 [0.14, 0.62][2]	3.8	Campbell et al. 2015[4]
Warmed intravenous fluids[1]	Room temperature irrigation fluids	--	Rate of shivering	0.09 [0.01, 1.55]	***	Alderson et al. 2014[7]
Additional insulation	Control	--	Rate of shivering	0.36 [0.12, 1.06]	***	Alderson et al. 2014[7]
Additional insulation	Forced air warming	--	Rate of shivering	3.0 [0.48, 18.69]	***	Alderson et al. 2014[7]
Forced air warming	Water mattress	Infrarenal aortic surgery	Cardiac complications	9.00 [0.50, 162.89]	***	Elmore et al. 1998[10]
Forced air warming	Water mattress	Infrarenal aortic surgery	Mortality	9.00 [0.50, 162.89]	***	Elmore et al. 1998[10]
Forced air warming	Water mattress	Infrarenal aortic surgery	Postoperative median length of stay (days)	1.00 [0.31, 3.24]	***	Elmore et al. 1998[10]
Forced air warming	Water mattress	Infrarenal aortic surgery	Wound infections	3.00 [0.64, 14.16]	***	Elmore et al. 1998[10]
Forced air warming	Water mattress	Infrarenal aortic surgery	APACHE II: recovery room	0.88 [0.34, 2.23]	***	Elmore et al. 1998[10]
Forced air warming	Water mattress	Infrarenal aortic surgery	APACHE II: postoperative day 1	1.00 [0.35, 2.89]	***	Elmore et al. 1998[10]
Forced air warming	No intervention	Spinal surgery	Rate of shivering	0.80 [0.14, 4.46]	***	Andrzejowski et al.

						2008[11]
Warming blood transfusion and infusion	No intervention	Orthopedic	Unrecovered cognitive rate after 3 days postoperative	1.14 [0.65, 2.02]	***	Wei et al. 2014[15]
Forced air warming	No intervention	Obstetric	Shivering score ≥ 1a[3]	0.57 [0.21, 1.55]	***	Butwick et al. 2007[25]
Warming mattress	No intervention	Obstetric	Rate of shivering	1.25 [0.53, 2.94]	***	Chakladar et al. 2014[9]
Heat and moisture exchanger	No intervention	Orthopedic	Rate of shivering	0.67 [0.19, 2.33]	***	Yam and Carli 1990[27]
Gases humidified and warmed at 40° C by heated humidifier	No intervention	Orthopedic	Rate of shivering	0.25 [0.06, 1.02]	***	Yam and Carli 1990[27]
Gases humidified and warmed at 40° C by heated humidifier	Heat and moisture exchanger	Orthopedic	Rate of shivering	0.38 [0.09, 1.54]	***	Yam and Carli 1990[27]
Fluid warming via the Hotline	Fluid warming via the Flotem IIe	Orthopedic and gynecologic	Rate of shivering	0.31 [0.08, 1.22]	***	Patel et al. 1996[21]
Warmed irrigation fluids	Room temperature irrigation fluid	Endoscopic	Rate of shivering	5.13 [2.59, 10.19][4,5]	***[4]	Jin et al. 2011[5]
Warmed irrigation fluids	Room temperature irrigation fluid	Endoscopic	Perioperative hypothermia	20.01 [2.03, 197.08][4,5]	***[4]	Jin et al. 2011[5]

***The NNT was not calculated because there was no significant difference between the groups studied. When there is no treatment effect, the absolute risk reduction is zero and the NNT is infinite.

[1]A wide range of methods of warming included pre-warmed fluids and various devices for in-line warming; fluids were warmed to a range of temperatures between 37°C and 41°C.

[2]There was a significant difference favoring patients who received warmed intravenous fluids, who had a higher core temperature than those who received room-temperature intravenous fluids.

[3]Shivering was graded using the following scale as (9): 0 □ no shivering; 1, one or more of the following: piloerection, peripheral vasoconstriction, peripheral cyanosis without other cause, but without visible muscular activity; 2, visible muscular activity confined to one muscle group; 3, visible muscular activity in more than one muscle group; and 4, gross muscular activity involving the whole body.
[4]The authors presented data as odds ratios.
[5]There was a significant difference favoring patients who received warmed irrigation fluids compared to those who received room-temperature irrigation fluids.
--No subgroup analysis per type of surgery.

Appendix E - Mean difference of continuous outcomes in treating hypothermia patients according to the grade of recommendation.

Intervention	Control group	Outcome	Mean Difference (MD) [95% CI]	References
Active warming methods[1]	Unwarmed blankets	Time to achieve normothermia	-88.86 [-123.49, - 54.23][2]	Warttig et al. 2014[6]
Active warming methods[1]	Warmed blankets	Time to achieve normothermia	-32.13 [-42.55, -21. 71][2]	Warttig et al. 2014[6]
Active warming methods[1]	Cotton blankets; unwarmed blankets; warmed blankets	Mean temperature difference (after 60 minutes of warming)	0.18 [-0.10, 0.46]	Warttig et al. 2014[6]
Active warming methods[1]	Unwarmed blankets	Shivering	0.61 [0.42, 0.86][2]	Warttig et al. 2014[6]

Active warming methods[1]	Warmed blankets		0.95 [0.52, 1.74]	Warttig et al. 2014[6]
Forced air	Hot water	Time to achieve normothermia	-54.21 [-94.95, -13.47][3]	Warttig et al. 2014[6]
Thermostat	Warmed blankets and/or radiant heat	Time to reach 36°C (min)	10.00 [-12.90, 32.90]	Smith et al. 1999[24]
Resistive heating (Hot Dog)	Forced-air warming systems (Bair Hugger)	Core temperature	-0.40 [-0.62, -0.18][4]	Röder et al. 2011[17]
Resistive heating (Hot Dog)	Forced-air warming systems (Bair Hugger)	Rewarming rate	-0.25 [-0.27, -0.23][4]	Röder et al. 2011[17]
Resistive heating (Hot Dog)	Forced-air warming systems (Bair Hugger)	Temperature after 60 minutes	-0.20 [-0.27, -0.13]	Röder et al. 2011[17]
Resistive heating (Hot Dog)	Forced-air warming systems (Bair Hugger)	Temperature after 120 minutes	-0.50 [-0.58, -0.42]	Röder et al. 2011[17]

Resistive heating (Hot Dog)	Forced-air warming systems (Bair Hugger)	Temperature after 180 minutes	-0.90 [-0.98, -0.82]	Röder et al. 2011[17]
Resistive heating (Hot Dog)	Forced-air warming systems (Bair Hugger)	Temperature after 240 minutes	-1.20 [-1.29, -1.11]	Röder et al. 2011[17]

[1]Forced air warming, circulating hot water devices, radiant blankets, radiant warmers, electric blankets. Interventions were commenced in the immediate postoperative period in the PACU or in the critical care unit and were applied until normothermia was reached.
[2]There was a significant difference favoring patients who received active warming methods than those who received unwarmed or warmed blankets.
[3]There was a significant difference favoring patients who received forced air compared to those who recieved hot water.
[4]There was a significant difference favoring patients who received a Hot Dog warmer compared to those who received a Bair Hugger warmer.
--No subgroup analysis per type of surgery.

Appendix F - Risk relative and number needed to treat rate of shivering in hypothermia patients according to the grade of recommendation.

Intervention	Comparator	Type of surgery	Risk Relative (RR) [95% CI]	NNT	Reference
Thermostat	Warmed blankets and/or radiant heat	Gynecologic, urologic, thoracic, orthopedic scheduled to last ≥ 90 min	1.00 [0.43, 2.31]	***	Smith et al. 1999[24]

***The NNT was not calculated because there was no significant difference between the groups studied. When there is no treatment effect, the absolute risk reduction is zero and the NNT is infinite.
--No subgroup analysis per type of surgery.