Evidence-based Approach To Perioperative Normothermia: Brief Review For Anesthesia Residents

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Review

The purpose of this brief review is twofold: to provide a concise and practical resident-level guide to the evidence underlying this aspect of anesthetic care, and to identify key publications in the field (offset and cited in bold). More expansive reviews are readily available.1

I. Perioperative Temperature Monitoring

a. Thermal Disturbances and Their Mechanisms

Human body temperature is normally regulated in a very tight range of 0.2-0.4°C. Our use of 37°C or 98.6°F as “normal” body temperature historically derives primarily from the work of a German physician, Carl Wunderlich, in the 1860s. This standard has been revisited and revised to a mean normal oral temperature of 36.8°C.2

Temperature monitoring during the perioperative period is necessary to detect and treat two general types of thermal disturbance. Perioperative hyperthermia is uncommon, but can be quite severe, resulting from iatrogenic overheating, fever, or malignant hyperthermia (MH). A classic paper on MH, which was first described in Australia in the 1960s, was recently revisited in Anesthesiology.3

Perioperative hypothermia, defined as a core temperature < 36°C, is usually inadvertent, and historically was so common as to be an accepted consequence of general anesthesia. Earnest investigation into the causes and consequences of intraoperative hypothermia developed during the 1980s, when the primary concerns were cardiovascular depression, shivering, and delayed metabolism. By the 1990s, a more complete understanding had emerged.

Hypothermia during general anesthesia occurs in a characteristic three-stage pattern:4

(1) Heat is initially redistributed from the core to the periphery as a result of anesthetic-induced peripheral vasodilation, causing a temperature drop of 1 to 1.5°C.

(2) Heat is then lost primarily by radiation to the cold operating-room environment, and less so by evaporation, while anesthetic action on the hypothalamus prevents thermoregulatory vasoconstriction and shivering is impaired. The result is a drop of another 1 to 2°C over the next few hours.

(3) At around 34°C, shivering and vasoconstriction responses return and balance heat losses, maintaining a stable temperature until anesthesia is concluded.


b. Adverse Consequences

The important adverse consequences of perioperative hypothermia were detailed in a series of randomized trials in the mid-1990s; the three most prominent are summarized here.

Frank et al. studied 300 patients with known or suspected coronary artery disease undergoing major surgery and randomized them to warming or no warming. Maintenance of normothermia reduced morbid cardiac events (unstable angina/ischemia, arrest, MI) by 55% and reduced the incidence of postoperative ventricular tachycardia.

Frank SM et al. Perioperative maintenance of normothermia reduces the incidence of morbid cardiac events. JAMA 1997;277:1127-34.

Kurz et al. studied 200 patients undergoing colorectal surgery and randomized them to warming or no warming. Hypothermic patients were three times as likely (19% vs. 6%) to develop a surgical-site infection as patients who were kept normothermic.


Schmied et al. studied 60 patients undergoing total hip arthroplasty and randomized them to warming or no warming. Hypothermic patients had greater blood losses and required more red blood cell transfusions than normothermic patients.


c. Temperature Monitoring Sites

ASA guidelines for basic anesthetic monitoring require temperature monitoring for all patients in whom thermal disturbances are intended, anticipated, or suspected. In practice this applies to all general anesthetics lasting longer than 30-45 minutes.

Because monitoring “true” core temperature (at the...
hypothalamus) is impractical, anesthesiologists can use four sites that are considered equivalent to core temperature: pulmonary artery, esophagus, nasopharynx, and tympanic membrane. Temperatures from the rectum or urinary bladder correspond to core temperature well enough to substitute during most anesthetics, with the exception of high heat-flux states (e.g. CPB). Axillary temperature can be sufficiently accurate if the arm is tucked to the side and the sensor is positioned over the axillary artery. An oral temperature taken carefully in a sublingual pocket is acceptable for patients who are not mouth-breathing or drinking cold fluids. Forehead-skin temperatures, which run 1-3°C below core temperature, should be avoided unless no other sites are available.

It is important to note that the thermometers commonly used in PACUs, ICUs, EDs, and hospital wards are actually quite inaccurate. Axillary and oral temperatures can be extremely inaccurate if taken incorrectly. Anesthesiologists should be particularly wary of the quick “forehead” and “ear” infrared thermometers used in PACUs, as they are probably the most inaccurate in current clinical use.

II. Perioperative Thermal Management

A number of strategies to prevent hypothermia have been devised; these strategies vary considerably in efficacy, cost, and mechanism.

The most common active thermal intervention is the forced-air warming blanket, such as the Bair Hugger brand. These blankets have become popular due to their effectiveness of heat transfer (about 30W), price (about $20), and safety profile. They are effective both at preventing and treating hypothermia, and should be activated soon after induction of anesthesia and continued throughout the case unless hyperthermia results. Heat transfer with these blankets is directly proportional to the body-surface area covered, according to the “rule of nines.”

Passive insulation with blankets or surgical drapes is effective and reduces heat loss by about 30%. Unwarmed blankets are just as good as warmed ones or a layer or two of standard paper surgical drapes.

Warming of IV fluids is effective at limiting the heat loss due to infusion of room-temperature fluids (loss of 0.25°C per liter). However, this effect is only pronounced with high infusion rates, and fluid warming cannot add much excess heat to the patient due to safety concerns.

The humidifier element of the breathing circuit (“HME”) is cheap and effective at limiting heat loss via the airway. However, heat loss via this route normally contributes only 10% of total loss, and the heat-conserving effect of the HME is quite small in comparison to that of active warming.

Circulating-water mattresses, though effective, have largely been replaced by forced-air devices because they are cumbersome and can cause burns. However, circulating-water adhesive pads are available for cases in which little of the body surface is available for warming. These pads are effective, warming patients twice as quickly as forced-air blankets.

Further detail on thermal interventions can be found in the following article.


References

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