Some Like it Hot: Peri-operative Thermal Care

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Body temperature is normally tightly regulated. Perioperative hypothermia is common, nonetheless, because anesthetics impair thermoregulatory control. Even mild hypothermia is associated with severe complications and thus should be avoided in most patients.

Thermoregulation

Nearly all autonomic responses result from thermal input from core structures to the hypothalamus. In contrast, most of the input controlling behavioural responses is derived from the skin surface. The inter-threshold range (core temperatures not triggering autonomic thermoregulatory responses) is only 0.2° to 0.4°C.

Thermoregulatory defensive responses to core hypothermia range from cutaneous vasoconstriction to the extreme response of sustained shivering . Sweating is the only mechanism by which the body can dissipate heat in an environment exceeding core temperature and is remarkably effective.

General anaesthesia impairs normal autonomic thermoregulatory control. Warm-response thresholds are elevated slightly, whereas cold-response thresholds are markedly reduced. Consequently, the inter-threshold range increases tenfold.

Epidural and spinal anesthesia each decrease the thresholds triggering vasoconstriction and shivering (above the level of the block) Interestingly, core hypothermia during regional anesthesia may not trigger a perception of cold.

Intraoperative Hypothermia

Inadvertent hypothermia under GA is common, resulting from impaired thermoregulation and exposure to a cold environment. Intraoperative hypothermia develops with a characteristic pattern; an initial rapid decrease followed by a slow, linear reduction in core temperature with a final plateau.

Volatile anesthetics cause vasodilation, inhibit thermoregulatory vasoconstriction and allow core heat to flow peripherally (‘rapid phase’). The subsequent ‘slow phase’ is the result of heat loss exceeding metabolic heat production. The ‘plateau phase’ may either represent a thermal steady state or be the consequence of vasoconstriction triggered by core temperatures of 33° to 35°C.

Consequences of Mild Hypothermia

Animal models have demonstrated that a 1° to 3°C decrease in body temperature affords substantial protection against cerebral ischemia, hypoxia and myocardial infarction (presumably due to decreased excitatory amino acids rather than from the modest reduction in the tissue metabolic rate) .

Human trials have failed to demonstrate the benefit of mild hypothermia in patients; with severe brain trauma, undergoing aneurysm surgery or having an acute myocardial infarction.

Blood Loss

Coagulation is impaired by mild hypothermia causing decreased platelet function and directly impairing enzymes of the coagulation cascade (not apparent during routine coagulation screening - performed at 37°C). Consistent with these findings, prospective RCTs indicate that mild hypothermia significantly increases blood loss during hip arthroplasty.

Wound Infection

Wound infections are one of the most common serious perioperative complications (and may have higher morbidity than all other anaesthetic complications combined). Hypothermia contributes to wound infections both by directly impairing immune function and by triggering thermoregulatory vasoconstriction (decreased oxygen delivery to the wound). Mild intraoperative hypothermia triples the risk for surgical wound infection in patients undergoing colon surgery.

Patient Discomfort

Hypothermia causes subjective discomfort, which is physiologically stressful (elevating the blood pressure, heart rate, and plasma catecholamine concentrations). These factors presumably contribute to what is possibly the most important consequence of mild peri-operative hypothermia: a 3-fold increase in morbid myocardial outcomes.

Reductions in Drug Metabolism

Drug metabolism is reduced by hypothermia. The duration of action of vecuronium, for example, is more than doubled by a 2°C reduction in the core temperature. During a constant infusion of propofol, the plasma concentration is approximately 30% greater than normal when individuals are hypothermic by 3°C. Post-anesthetic recovery may be significantly prolonged.

Shivering

Shivering is a potentially serious complication of hypothermia. Shivering can double oxygen consumption. However, the typical increase is much less and myocardial ischemia is poorly correlated with shivering. It can be treated with a variety of drugs, including clonidine (75 mcg, I.V.) and tramadol (1 mg/kg), but the most popular treatment for shivering in the United States is Meperidine (Pethidine) (25 mg, I.V.).

Perioperative Thermal Manipulation

Redistribution hypothermia can be prevented by warming the skin surface (for as little as 30 minutes) before the induction of anesthesia. If this is done, the anesthetic-induced inhibition of normal thermoregulatory vasoconstriction produces little “heat loss” because heat can flow only down a temperature gradient.

Because little heat is lost through respiration, even active airway heating and humidification only minimally influence the core temperature.

It is not possible to warm patients by administering heated fluids because the fluids cannot exceed body temperature by much. However, heat loss due to cold I.V. fluids becomes significant when large amounts are administered. One unit of refrigerated blood or 1 L of crystalloid solution administered at room temperature decreases the mean body temperature approximately 0.25°C.

The operating room temperature determines the rate at which metabolic heat is lost by radiation and convection from the skin and by evaporation from within surgical incisions. However, room temperatures exceeding 23°C generally are required to maintain normothermia in patients. Increasing the ambient temperature is thus usually impractical .

A single layer of cotton blanket, reflective “space” blanket or surgical drapes reduces heat loss approximately 30%, but adding more layers does not help much.

Passive insulation alone rarely is sufficient to maintain normothermia in patients undergoing in such cases. Because about 90% of metabolic heat is lost through the skin surface, only cutaneous warming will transfer sufficient heat to prevent hypothermia. Metabolic heat production will increase the mean body temperature approximately 1°C per hour when cutaneous heat loss is eliminated.

Cutaneous Warming devices:

Circulating Water Devices:

Circulating-water mattresses are nearly ineffective - the combination of heat and decreased local capillary blood flow (caused by patient’s weight) increases the risk of pressure and heat necrosis. Circulating water is safer and more effective when placed **over** patients rather than under them (this approach can almost completely eliminate metabolic heat loss).

Forced Air Warmers:

Forced air usually maintains normothermia even during the largest operations and is superior to circulating water mattresses. The best forced-air systems eliminate the loss of metabolic heat and even transfer some heat across the skin surface.

Conclusion: Temperature Monitoring And Thermal Management Guidelines

The objective of temperature monitoring and perioperative thermal management is to detect thermal disturbances and maintain appropriate body temperature during anesthesia. Available data suggest the following guidelines:

1. The core body temperature should be measured in most patients kept under general anesthesia for longer than 30 minutes.

2. The temperature should also be measured during regional anesthesia when changes in the body temperature are intended, anticipated, or suspected.

3. Unless hypothermia is specifically indicated (eg, for protection against ischemia), efforts should be made to maintain the intraoperative core temperature above 36°C.

Reference:

Sessler DI , Kurz A . **Mild Perioperative Hypothermia** . *Anesthesiology News Special Edition* 2005; 45-51