

The Importance of Avoiding Perioperative Hypothermia in Surgery Patients

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Cosmetic dermatologic surgery is routinely performed in an ambulatory surgery center or office setting. Liposuction surgery and similar sophisticated procedures may bring hypothermia to light as a potential risk for our patients. Hypothermia is defined as a drop in core body temperature by 2°C or more. Caring for and re-warming a hypothermic patient has many known challenges and potential dangers. Problems encountered in the mildly hypothermic patient include patient discomfort, shivering, and increased respiration and oxygen consumption. More profound hypothermia may occur when surgical duration exceeds 2 hours. Symptoms of profound hypothermia can include: muscle breakdown, nitrogen loss/imbalance, induction of metabolic rate, altered pharmacokinetics slowing drug metabolism with risk of toxicity, modified platelet activity with increased risk of deep vein thrombosis, altered immune system function with impaired wound healing, transient hyperphosphatemia, inhibition of antidiuretic hormone induces cold diuresis and dehydration, activation of autonomic nervous system, peripheral vasoconstriction, elevation of blood pressure and heart rate, increase in cardiac output by up to 500%, and cardiac arrhythmias. Inadvertent cooling clearly has no benefit and is desirably avoided in the elective cosmetic dermatologic surgery patient. Various heat preservation and warming methods for patients will be discussed. Many of these techniques are simple and may easily be incorporated into the protocol of the office or ambulatory surgery center by the cosmetic dermatologic surgeon to maximize safety, comfort, and positive experience for our patients.

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Background

Normothermia is defined as a core body temperature of 37°C, plus or minus 1°C. Hypothermia is classified as mild (32°C to 35°C), moderate (30°C to 32°C), and severe (below 30°C) by American College of Surgeons 1989 criteria. Body heat is lost through convection, conduction, radiation, and evaporation. Hospital operating rooms routinely use many warming techniques to prevent hypothermia intraoperatively and in surgical recovery. These include preoperative passive heat preservation with cotton or reflective blankets, intraoperative active warming with air or water pads or mattresses under the patient, use of thermally insulated esophageal tubes, warming and humidifying oxygen and other gases delivered to the lungs for general anesthesia, passively wrapping or applying active warming devices to body parts not involved in the actual surgery including the patient's head, warming of IV fluids prior to infusion, and limited use of anesthesia.

During induction of general anesthesia, use of muscle paralytics is accompanied by an initial rapid decrease in core body temperature of 0.6°C to 1.0°C, followed by a slow linear decrease in body core temperature for the duration of the procedure. After 3 to 4 hours of general anesthesia, the decrease tends to plateau at 34°C to 35°C, where the body heat production balances the heat loss.¹ Regional, epidural, or spinal anesthesia has a lower degree of loss of body temperature proportional to the decrease in body paralysis induced. Conscious sedation induces partial relaxation, but not paralysis of musculature, thus preserving some body heat. Shivering is inhibited intraoperatively by anesthetics and resumes as the patient emerges from sedation. Shivering is a physiological compensatory mechanism by which the body attempts to raise core temperature by burning calories in muscles to generate heat. It is a clinical marker for a patient experiencing lowered body temperature. Preserved normothermia prevents shivering and other problems associated with hypothermia. In elective

cosmetic dermatologic surgery, there is clearly no desire or benefit in having a hypothermic patient. Prevention of hypothermia will avoid the above undesirable and unnecessary problems.

Inadvertent Perioperative Heat Loss

Unwanted cooling of the human body, or perioperative heat loss, occurs due to many interwoven factors. Thermal physics and geometry theories teach us that thinner objects resembling tall thin cylinders lose heat faster than wide, round objects like spheres. It follows that passive convective heat loss is greatest in humans with high body surface area-to-mass ratio. Classically, infants and children are most vulnerable to intraoperative hypothermia. However, any patient with high body surface area—relative to their mass dependent metabolic rate—may become rapidly hypothermic intraoperatively. Rewarming rate is a function of cutaneous heat transfer plus metabolic heat production divided by body mass. The rate of rewarming is inversely proportional to body size.² The smaller the person, the faster they cool intraoperatively and the faster they rewarm postoperatively. The larger the person, the slower they cool intraoperatively, but the slower they can be rewarmed postoperatively.

Perioperative heat loss is predominantly due to radiation of body heat from the surface of the skin to the cool air of the operative suite, and convection of body heat to the cold surface of the operating table. Conduction and evaporation contribute little to heat loss during operation. Between 50% to 60% of the body surface area must be covered to adequately protect against conductive heat loss. Cutaneous convective heat loss in an undressed adult at the 20°C ambient operating room temperature is a linear function of body surface area, ranging from 80 to 100 W. Measurable skin temperature is normally 2°C to 4°C below core temperature, and depends on the ambient temperature of the operating room, the patient's core body temperature, the patient's vasomotor status, and the patient's preoperative thermal environment. The patient's ability for tonic vasoconstriction is primarily responsible for maintaining the core body temperature at 2°C to 4°C higher than the skin temperature.

Volatile inhaled general anesthetics inhibit nonshivering thermogenesis, whereas conscious sedation with propofol and fentanyl do not inhibit nonshivering thermogenesis.² Resting energy expenditure has been experimentally increased by 20% in healthy and septic patients by infusing amino acids. Amino acids equivalent to 28 g of dietary protein during general anesthesia and surgery can counteract the perioperative loss of body heat and maintain the patient normothermic.¹ Peripheral vasoconstriction is the body's mechanism to try to conserve core body heat in a cold environment. The induction of general anesthesia is associated with redistribution hypothermia. General anesthesia causes a counterproductive delay in re-warming postoperatively

due to the block of peripheral-to-core thermoregulatory control by general anesthetics. Vasoconstriction occurs during general anesthesia-induced hypothermia. Clonidine, commonly given orally as premedication prior to general anesthesia, impairs normal thermoregulatory responses to warm and cold stimuli and depresses sympathetic tone, protecting the patient from intraoperative hypertension. Premedicating with clonidine did not worsen the redistribution hypothermia after induction of anesthesia with thiopental, fentanyl, and vecuronium and maintenance with 0.6% isoflurane.³ Postoperative use of pharmacologic vasodilators such as opioids by anesthesiologists in the recovery room after general anesthesia can hasten rewarming. Rewarming patients before anesthesia⁴ and limited use of anesthesia (using spinal, epidural, or conscious sedation instead of general anesthesia) may speed postop rewarming and recovery. Minimizing the time the patient is under anesthesia without being warmed helps prevent hypothermia.⁵ Keeping patients warm during conscious sedation with propofol is advisable because propofol blood concentrations average 28% more in patients with mild hypothermia (34°C) compared to normothermic patients (37°C).⁶

Preventing Perioperative Hypothermia

In the dermatologic surgeon's ambulatory surgical center, steps are taken to keep patients safely warm and comfortable. Using conscious sedation, the core body temperature drop of 1°C seen during induction and in the first hour of general anesthesia using paralytic agents is eliminated. The patient is ambulatory into the ACS, using large muscle groups to heat themselves until they enter the ACS suite. The ambient heat in the ACS suite can easily be adjusted to the recommended minimum 20°C (70°C).

Operating room temperature is important in determining the patient's heat loss by convection. It is recommended that the operating room temperature be kept at 21°C to 24°C for adults and at 24°C to 26°C for children and elderly patients.⁷ Kamitani et al⁸ showed that in a 25°C operating room, covering the head and face of patients with towels and sheets immediately after induction of anesthesia with thiopental and isoflurane delivered with a heat and moisture exchanger in the anesthesia circuit for elective abdominal surgery, patients maintained a statistically greater tympanic membrane body temperature with head and face covered by warmed towels and sheets compared to those patients in the control group with towels and sheets covering trunk and limbs. Although insufficient as a monotherapy to prevent hypothermia during general anesthesia, passive heat retention with diligent use of warmed sterile cotton towels, sheets, and blankets—especially applied to the head region—may be enough to maintain normothermia during conscious sedation, although no published study is available to date specifically for conscious sedation.

Active warming with water mattresses, forced warm air convection blankets, and electric blankets are very effective at maintaining normothermia intraoperatively. Water mattresses are labor intensive to re-establish and maintain sterility between cases. There have been reports of burns to patients with active warming devices as well. Forced warm air convection blankets have been widely studied as effective, but are associated with increased wound infection due to the non-sterile airflow blowing dust into and contaminating the sterile field. One study by Kemper⁹ found that economically-warmed 38°C air delivery under standard bed sheets (\$0.70) was twice as effective as commercially available full body forced hot air blankets (\$180 Bair Hugger model 315, Augustine Medical, Eden Prairie, Minnesota). Electric blankets have traditionally been used with fear of malfunction and shortage, and electrocution or burn of patient, surgeon, and staff. Reflective aluminum space blankets are used in recovery rooms, but are considered a fire hazard to be avoided in the operating room. Warming blankets alone did not keep the patient's temperature above 36°C unless the operating room temperature was above 21°C.

Leg warming with either electric blanket or forced warm air convection blanket provided sufficient heat to counter-balance heat losses during abdominal surgery, preventing shivering in 10 out of 11 warmed patients.¹⁰

Infusion of 53 ml/kg of intravenous crystalloid fluid at room temperature (20°C) leads to a mean body temperature loss of 1°C. Warming intravenous fluids can also help prevent hypothermia, and various devices are available for warming IV fluids to 35°C. Ideally, to avoid cooling of the warmed IV fluid prior to infusion, only 40 cm of IV tubing should lie between the warming device and the patient's IV site. The Hotline HL-90 and System H-250/ heat exchanger D-50 (SIMS Level 1 Inc., Rockland, Massachusetts) outperformed other models from USA, Germany, and France in one study. The cases with higher volume crystalloid solution infused and the faster the infusion rate used, the more efficient the heating of the patient with IV fluids.¹¹

Summary

Keeping cosmetic surgery patients warm is important. It is not a new discovery that hypothermia represents an unwanted surgical complication that leads to further problems for patients. Hypothermia is something to be aware of, so that reasonable steps can be taken to prevent inadvertent cooling in cosmetic surgery patients. Simply adjusting the room temperature to 21°C and teaching staff to use sterile drape sheets, sterile towels, or sterile cotton blankets to cover any unnecessarily exposed parts of the patient intraoperatively will help to resolve postoperative shivering and mild hypothermia.

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