enFlow* IV Fluid/Blood Warming System

Education

Learn how temperature management and fluid warming can help you attain desired patient outcomes.

Patient Warming Overview

Although largely preventable, hypothermia affects many patients' hospital stays. Here you'll learn:

1. What is hypothermia?
2. How and why do patients lose heat?
3. What are the costs associated with hypothermia?
4. How can active warming positively impact patient outcomes? And what are the benefits of fluid warming?

1. What is hypothermia?

In humans, a core temperature of 36.5-37.5°C is normally maintained by behavioral and physiological responses-- regardless of changes in the environment. Hypothermia is defined as a core body temperature for humans greater than one standard deviation below their mean core temperature under resting conditions in a thermo neutral environment.\(^1,2\) While there is no universally-accepted definition of mild hypothermia in the industry, by this approach it would commence at 36.4°C. Most consider mild hypothermia in the range of 33-36.4°C. This is also the approximate range at which organ dysfunction may begin, and before moderate to severe hypothermia begins.\(^3\)

2. How and why do patients lose heat?

In the hospital setting, there are many ways for the body to lose heat including radiation (from tissues- 60% of heat loss), conduction (contact with cool surfaces-5% of heat loss), evaporation (respiration- 20% of heat loss), and convection (exposure to the environment- 15% of heat loss).\(^5,6\) Approximately 50% of surgical patients will develop hypothermia to a core temperature of less than 36.0°C, and 33% develop hypothermia to a temperature of less than 35°C during surgery.\(^7\)

The propensity to lose heat is especially high when anesthetics are being administered. All general anesthetics impair normal thermoregulatory control to some extent, resulting in the escalation of warm-response thresholds and the reduction of cold response thresholds. The result is an interthreshold range that is increased to approximately 2°C to 4°C.\(^8\)

Heat loss starts when anesthetics cause vasodilation through a direct peripheral action and inhibit vasoconstriction which causes arteriovenous shunt dilation. This vasodilation initiates a reaction where core heat flows peripherally, warming extremities at the expense of the core.\(^8\)

Redistribution decreases the core temperature 1°C to 1.5°C during the first hour of general anesthesia.\(^8\) Research has shown that redistribution remains the major cause of hypothermia even after 3 hours of anesthesia.\(^9\) Additionally, anesthesia often stimulates heat loss from the lungs via inhaled gases, medication-induced vasodilation, decreased metabolic rate, and decreased tissue perfusion.\(^10\)

But anesthetics are not the only cause. Anesthetics in combination with cold operating rooms, open body cavities, and the administration of cold intravenous (IV) fluids and blood, result in a high proportion of surgical
patients becoming hypothermic. In addition, patient characteristics can also have an impact on heat loss. Traits that may influence and increase the likelihood of hypothermia include:

- preoperative thermal status
- body morphology
- patient age
- electrolyte status
- oxygen saturation
- preexisting medical conditions, such as hypothyroidism, hypoglycemia, malnourishment, burns and trauma

3. What are the costs associated with hypothermia?

A groundbreaking meta-analysis of costs associated with hypothermia concluded that the cost of preventing intraoperative hypothermia is much less than the cost of treating the adverse outcomes associated with it. The study found that body temperature averaging only 1.5°C below normal caused cumulative adverse outcomes -- which added $2,500 to $7,000 per surgical patient to hospitalization costs.

Costs linked to hypothermia are not isolated to the operating room. Rather, hypothermia impacts a spectrum of patients, outcomes, and departments. The information below highlights some of the primary results associated with patient hypothermia.

- **Increased Hospitalization**: On average, hypothermic patients require approximately 40 minutes longer to reach fitness for discharge, even when return to normothermia is not a criterion. Duration of recovery in normothermia and hypothermia groups differ by approximately 90 minutes when a core temperature >36 degrees C is required.

- **Wound Infections**: Core temperatures approximately 2°C below normal can triple the incidence of wound infection and prolong hospitalization by about 20%. Maintaining intraoperative normothermia may thus decrease infectious complications and potentially shorten hospitalization in patients.

- **Significant Patient Discomfort**: Even mild hypothermia can produce postoperative thermal discomfort. Patients often indicate that feeling cold in the immediate postoperative period is the worst part of their hospitalization, sometimes rating it worse than surgical pain.

- **Cardiac Morbidity**: The physiologic response to hypothermia may lead to increased blood pressure, heart rate and/or the secretion of plasma catecholamines. As a result, myocardial morbidity is threefold higher in mildly hypothermic patients. In patients with cardiac risk factors who are undergoing noncardiac surgery, the perioperative maintenance of normothermia is also associated with a reduced incidence of morbid cardiac events and ventricular tachycardia.

- **Blood Loss/Transfusions**: Hypothermia can also have a deleterious effect on coagulation by decreasing platelet function and the activity of coagulation factors and other important enzymes -- leading to potentially increased bleeding and blood loss during surgical procedures. In one study, even mild perioperative hypothermia (median temperature of 35.6°C) led to a 16% increase in blood loss and a 22% increase in transfusion requirements compared to patients whose temperatures were maintained at normothermia.
4. How can active warming positively impact patient outcomes? And what are the benefits of fluid warming?

When it comes to continuous warming, earlier is better. Preanesthetic warming reduces initial postinduction hypothermia in surgical patients -- preventing intraoperative hypothermia and postoperative shivering even for procedures lasting 3 hours or longer. Pre-warming has also been shown to decrease blood pressure, which has significant implications for high risk cardiac patients.

In addition to continuous warming from pre-op to the PACU, choosing IV fluid/blood warming systems to maintain normothermia has proven to be beneficial for patient outcomes. Infusing cold fluids can produce hypothermia in surgical patients. Specifically, infusing one liter of room temperature fluid (21°C) has been shown to decrease a patient's mean body temperature by 0.25°C. The infusion of refrigerated fluids (4°C) has an even greater effect. Those effects are additive, too, so the higher the infusion volume the higher the drop in mean body temperature.

Fluid administration does not need to equal patient hypothermia. One study found that patients who received IV fluid at body temperature had significantly higher core temperatures during and after surgery compared with patients who received IV fluids at the temperature of the operating room. Additionally, warming of intraoperative IV fluids has been found to reduce perioperative changes in hemodynamic parameters. And when it comes to patient warming, less is not always more: research has found that the combination of convective and fluid warming is associated with a decreased likelihood of patients leaving the operating room hypothermic, when compared to convective warming alone.
References

9. Matsukawa, Takashi MD; Sessler, Daniel I. MD; Sessler, Andrew M. PhD; Schroeder, Marc BA; Ozaki, Makoto MD; Kurz, Andrea MD; Cheng, Christi MD. Heat Flow and Distribution during Induction of General Anesthesia. Anesthesiology; Volume 82(3)March 1995pp 662-673.