3M

Bair Hugger™

Normothermia System

Advance Quality of Care and Improve Patient Outcomes with Proactive Temperature Management

Introduction

Maintaining normothermia – defined as core body temperature 36°C-37.5°C[1,2] – before, during, and after surgery matters. Clinical practice guidelines across the world recognize the critical nature of temperature management in improving patient outcomes. Yet, perioperative hypothermia remains a common, but preventable, surgical complication that can lead to several adverse – sometimes deadly – consequences.

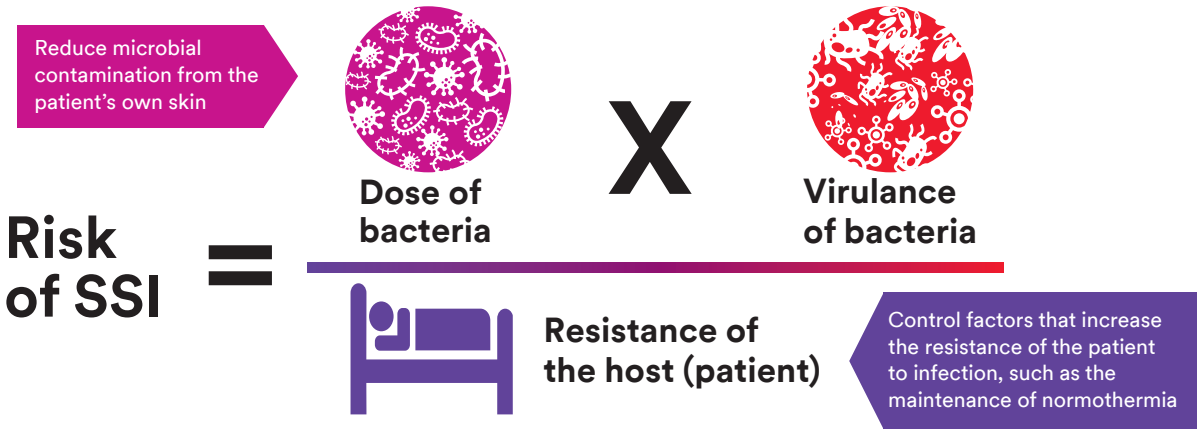
How do we solve for this? Data show it's critical for surgical care teams to manage patient's core body temperature proactively throughout the perioperative journey – and beyond.

The importance of maintaining normothermia

The difference between a positive patient outcome and a complicated recovery can be a matter of degrees. Numerous studies have demonstrated that even mild hypothermia can result in significant complications, including: increased rate of wound infection,[3,4] increased mortality rates,[5] coagulopathy,[5-7] prolonged and altered drug effect,[8] myocardial ischemia and cardiac disturbance,[9,10] shivering and thermal discomfort,[3, 11-14] and delayed emergence from anesthesia.[14]

Unintended hypothermia can increase the incidence of surgical site infections.[3,4] Surgical site infections have been shown to:

The Centers for Disease Control (CDC) has a category I-A (strongest) recommendation for the prevention of surgical site infections that recommends the maintenance of perioperative normothermia.[19]



Aside from the risk of surgical site infection, consider a few of the other potential consequences of unintended hypothermia:

- **Prolonged recovery:** Drug metabolism is decreased in a hypothermic patient, which can prolong the duration of post-operative recovery by approximately 40 minutes.[20]
- **Post-operative pain and shivering:** Post-op shivering occurs in 40% of unwarmed patients, increases oxygen consumption, and exacerbates post-operative pain.[12,21]
- **Thermal discomfort:** Patients often report shivering as the worst part of their hospitalization, sometimes rating it worse than surgical pain.[12]

A hypothermic patient's duration of hospitalization is 20% longer (2.6 days) than a typical patient's stay.[22] The table below demonstrates potential additional costs associated with a hypothermic patient's longer length of stay.[22]

Potential cost of a hypothermic patient	
Blood products	$227 - $334
Hospital stay	$1,534 - $4,602
ICU time	$105 - $314
Wound infections	$549 - $1,697
Myocardial infarctions	$68 - $90
Mechanical ventilation	$16 - $26
Mortality	Undefined
Increase cost/patient	$2,495 - $7,073

Before discussing the importance of proactive temperature management, we must understand how a patient becomes hypothermic and how to help prevent this from happening.

The thermoregulation system

The body's ideal temperature is approximately 37.0°C in the patient's core, which encompasses the brain and the body cavity containing the vital organs.[11,12] This thermal state, the state of homeostasis, is aggressively maintained at a set point determined by the central nervous system. The body's autonomic thermoregulation system is so reliable that the core body temperature seldom varies more than ±0.2°C above or below the ideal state.[12,23]

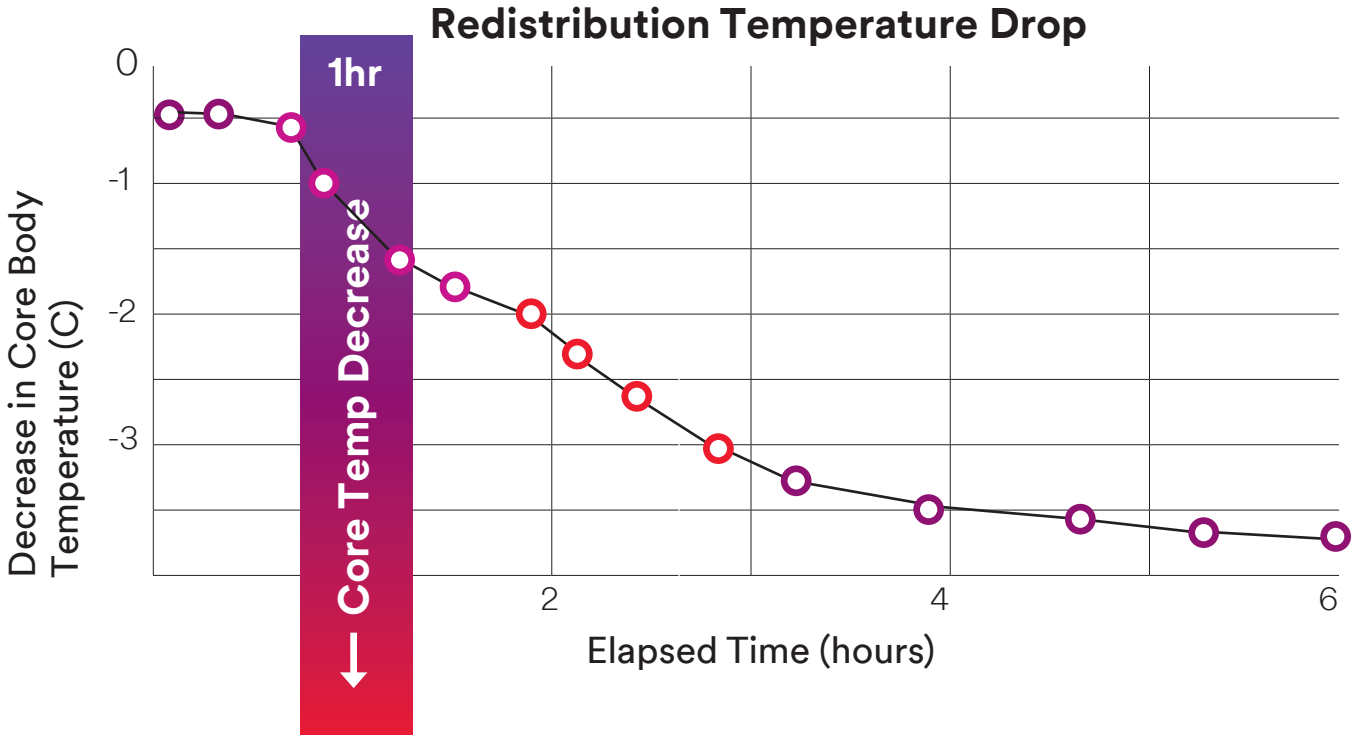
Body heat is distributed unevenly. Under normal conditions, the body's core temperature is 2.0-4.0°C warmer than the temperature of the body's periphery.[23] The core temperature generally remains relatively unaffected by lower temperatures in peripheral areas.[12]

The hypothalamus receives and integrates information from thermoreceptors located in the skin, spinal cord, various parts of the brain, and deep central tissues. If external factors push the core temperature outside the ideal range, the hypothalamus triggers the appropriate thermoregulatory response. The response may include vasoconstriction and shivering when the temperature is too low, or vasodilation and sweating when the temperature is too high.

Anesthesia's impact on thermoregulation

The major cause of intraoperative hypothermia is not heat loss to the environment or cold operating room temperature, but instead a phenomenon commonly referred to as redistribution temperature drop (RTD). RTD is caused by the action of anesthetic medications on the body's ability to properly thermoregulate.

Under anesthesia, the ability of the hypothalamus to regulate temperature is diminished as the anesthetic agents reduce metabolism and depress the thermoregulatory response, triggering vasodilation—or an opening of the shunts used to retain warmer blood in the core. Anesthetic-induced vasodilation allows heat in the warm core tissue to mix with cooler peripheral tissue, which warms the periphery at the expense of the core temperature.[12,23] When warmer blood in the core mixes freely with cooler blood in the periphery, this causes a dramatic drop in core body temperature – up to 1.6°C within the first hour of surgery.[22] This means that a patient who has a normal pre-induction core temperature of 36.2°C may be hypothermic approximately 7.5 minutes following induction.



Inadvertent perioperative hypothermia remains a common, yet preventable complication of surgery. The solution: proactive perioperative temperature management to help maintain normothermia across the continuum of care.

Proactive temperature management

Proactive temperature management has three distinct goals:

1) Increase preoperative mean body temperature (Pre-op)

Hypothermia caused by RTD is exceedingly difficult to reverse in adults, but it can be minimized by prewarming patients with convective air technology for at least 10 minutes before anesthesia induction. It is not possible to prewarm patients solely by minimizing heat loss from the skin; prewarming requires the transfer of heat into the body by an active warming device. Prewarming with convective air adds energy (heat) to the peripheral thermal compartment of the body before induction of anesthesia[23] and has been shown to mitigate the effects of heat redistribution and prevent unintended hypothermia when combined with intraoperative warming.[24] Increasingly, active prewarming is being recommended in clinical practice guidelines and quality improvement initiatives across the globe.[25-29]

Prewarming works by increasing the temperature of the peripheral tissue, reducing or eliminating the temperature gradient within the body's core.[15] When vasodilation occurs following anesthesia induction, blood temperature in the core and periphery are similar, thereby minimizing redistribution temperature drop and mitigating the risk of inadvertent perioperative hypothermia.[30]

2) Maintenance or restoration of intraoperative core body temperature (OR)

After a patient has been prewarmed with convective air blankets or gowns for at least 10 minutes, it is critical to reduce the gap between the end of prewarming and the induction of anesthesia. This time-period should preferably be less than 10 minutes to help achieve the desired normothermic outcome. For cases with anticipated anesthesia greater than 30 minutes, active warming with convective air blankets or gowns should be used. One of the current challenges associated with proactive temperature management is inaccurate, inconsistent methods to monitor patient's core temperature; thus, when possible, a single, accurate, non-invasive core temperature monitoring modality should be used throughout the perioperative journey.

3) Post-operative thermal comfort and normothermia (PACU)

Upon arrival in the PACU after surgery, active warming should continue with a convective air blanket or gown until the patient is normothermic and thermally comfortable. Ideally, the same thermometry method of measuring core body temperature should be used when the patient arrives in the PACU to ensure consistency and accuracy of the data.

Implement an evidence-based temperature management protocol

Enhanced Recovery After Surgery (ERAS) protocols, developed by the ERAS® Society, can help staff drive collaboration, reduce postoperative complications, and ultimately improve patient outcomes. In fact, data suggest that these ERAS pathways not only improve clinical outcomes and quality of care, but also come with significant cost savings.[31] Though these protocols are most common in colorectal, gynecology, orthopedics, surgical oncology, and urology, new guidelines continue to emerge for other surgical specialties such as cardiac, breast, cesarean delivery, and more.

One critical aspect of an effective ERAS protocol is the maintenance of normothermia. Implementation of an ERAS-Compliant Perioperative Normothermia Protocol using convective warming, that is based on published clinical guidelines of ERAS, WHO, ASA, ACS, ASPAN, AORN, CDC, and NICE, includes the following:[32]

- All surgical patients, especially infants and children, should have their core temperature monitored continuously during the entire perioperative period.
- Prior to surgery, all adult patients scheduled for neuraxial, general, or combined anesthesia should be prewarmed with a convective air warming device on its high-temperature setting for at least 10 minutes. Longer periods of prewarming can be accomplished by adjusting the warming unit setpoint temperature to the highest setting that does not cause sweating or excessive thermal discomfort. Prewarming should be considered for children who weigh more than 15 kg.
- The amount of time between the end of prewarming and induction of anesthesia should be as brief as possible, but ideally fewer than 10 minutes.[33]
- If more than 1L of intravenous fluid will be administered during the procedure, a fluid warmer should be used.
- During surgery, all patients with anticipated anesthesia durations 30 minutes or longer should receive intraoperative convective air warming with a blanket or a gown that can cover the largest possible amount of skin surface. The warming unit should be operated on the lowest temperature and blower settings that maintain the core temperature within the normothermic range. Infants and children should be warmed unless contraindicated.
- After surgery, all patients should be warmed until they are thermally comfortable and have a core temperature within the normal range.

Conclusion

Keeping patients normothermic is important to help lower the risk of negative surgical outcomes associated with unintended hypothermia.

To be successful, facilities should supply clinicians with the temperature management systems they need to warm and monitor patients in any type of procedure, under any type of anesthesia—throughout the perioperative journey.

When selecting a partner to support your temperature management efforts, it is important to consider that partner's ability to meet your facility's unique needs. Ultimately, the chosen solution should provide broad clinical flexibility and proven efficacy. Ask about the system's history, its track record of safety and efficacy, and review the available research. Take the input of a product's end user into account – no one knows more about a system's performance than those who use it every day. The importance of clinician confidence in a product cannot be overlooked.

Perioperative temperature management interventions can bring new value to facilities today and in the future. Temperature management can help clinicians reduce the risk of complications and improve patient outcomes.

3M is committed to helping clinicians

3M is committed to helping you advance quality of care, improve product utilization, optimize workflow, and strengthen patient satisfaction. Through the 3M™ PEAK™ Clinical Outcomes Program, we will partner with you to provide insights that will help you achieve better outcomes for your patients. This program consists of:

- **Temperature Management Assessment:** Before taking action, it is important to gather a baseline. Through this assessment program, we will partner with you to assess current practice and protocol as it relates to temperature management. In addition to observations on current patient warming practices in pre-op, OR, and PACU, a non-invasive core temperature monitoring solution is used to gain insight into the current hypothermia rate. 3M will then provide an executive summary to leadership based on the findings of the assessment, providing you with actionable data and evidence-based recommendations for process improvement to help achieve desired outcomes.
- **Perioperative Temperature Management Program:** 3M offers a comprehensive temperature management education program, endorsed by the American Nurses Credentialing Center (ANCC) as a nursing skills checklist program and prior approved by the American Association of Nurse Anesthetists (AANA) for 6.00 Class A CE credits. The program consists of:
    - Two online modules via 3M℠ Health Care Academy (*Unintended Perioperative Hypothermia* and *Getting to the Core*)
    - Key normothermia recommendations and protocols with a focus on ERAS®
    - Prewarming article review and small group discussion
    - Perioperative temperature management case scenarios and simulation (live, hands-on exercises)
- **Clinical Evidence:** As a global technology and science company, 3M is committed to bringing forward evidence to demonstrate the safety and efficacy of our solutions. With more than 170 studies and 9 of the top 10 U.S. hospitals using the 3M™ Bair Hugger™ brand, the 3M™ Bair Hugger™ Temperature Management System is the most widely studied and utilized temperature management solution on the market, having benefited more than 300 million humans and animals globally.[34]
- **3M℠ Health Care Academy:** Live webinars, online CE modules, and curated learning pathways.
- **3M Clinical Specialists:** Live in-servicing, CE education, and PEAK™ Program assessments conducted by registered nurses.
- **ERAS®-Compliant Perioperative Normothermia Protocol Implementation:** 3M partners with you to help you implement an evidence-based temperature management protocol, based on published guidelines from ERAS, WHO, ASA, ACS, ASPAN, AORN, CDC, and NICE.

To learn more about the 3M™ PEAK™ Clinical Outcomes Program and how 3M can partner with you to help you achieve your desired clinical goals and patient outcomes, get in touch with your local 3M Account Manager, call 3M Health Care Customer Service at **1-800-327-5380,** or visit us online at **bairhugger.com** or **3M.com/PEAK.**

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