Unintended Perioperative Hypothermia and Prewarming in the ASC

September 28, 2015
Melissa Bailey MA, RN
Disclosure

Sponsored by: 3M Health Care

3M Health Care is a provider approved by the California Board of Registered Nursing
Registered Nurse participants can receive up to 1.0 contact hour upon course completion

Presented by: Melissa Bailey, MA, RN

Technical Service Specialist
3M Health Care
3M Infection Prevention Division
Introduction

• Perioperative hypothermia is defined as any core temperature less than 36.0°C (96.8°F)^1-3
• Inadvertent (unintended) perioperative hypothermia is considered a frequent, preventable complication of surgery
• Unless preventative measures are taken, unintended hypothermia occurs in 50% to 90% of surgical patients^1
• Research shows that even mild hypothermia can result in significant negative outcomes
Introduction

• The induction of anesthesia can cause a drop in patient core temperature of up to 1.6°C on average within the first hour²

• Even mild hypothermia can lead to adverse outcomes and additional costs³

Adapted from: Sessler, *Anesth*, 2000
Course Objectives

- Explain how the body’s thermoregulation system works
- Define unintended perioperative hypothermia
- Define and explain the principle mechanisms of heat loss in the surgical patient
- Identify adverse patient outcomes associated with unintended perioperative hypothermia
- Identify areas where cost savings can be recognized by maintaining normothermia
- Explain the benefit of prewarming to help prevent unintended perioperative hypothermia
- Discuss unintended hypothermia and how it impacts your facility
The Thermoregulation System
Normothermia

• Normothermia: the body’s ideal thermal state
• Core temperature: 3
  • 37.0°C (98.6°F)
• Temperature gradient:
  • 2-4°C between the core and periphery
Hypothalamus

- The hypothalamus regulates the body’s core temperature\textsuperscript{3,4}
- Thermoreceptors are used by the hypothalamus to respond to temperature\textsuperscript{3,4}
- Thermoreceptors are located in:\textsuperscript{3,4}
  - Skin
  - Spinal cord
  - Brain
  - Deep central tissues
Behavioral Changes to Body Temperature

• Behavioral changes to temperature are prompted by thermal discomfort\(^3\)

• Responses may include:\(^3\)
  • Adding or removing clothing
  • Adjusting ambient temperature
  • Moving to cooler or warmer areas
What are some causes of hypothermia in the ASC patient?

- Cold operating room
- Large areas of skin exposed
- Wearing patient gowns
- Surgical incision
- Wet skin preps
- Laying on cold OR table
- Longer surgeries
- Anesthesia-related Redistribution Temperature Drop
Anesthesia-related Redistribution Temperature Drop
General Anesthesia

• Patients cannot regulate their core temperature to the optimal set point under general anesthesia\(^3\)
  • Inability to rely on behavioral responses
  • Rely on autonomic thermoregulation system to respond

• Anesthetic agents inhibit the autonomic system by:\(^3\)
  • Reducing metabolism
  • Depressing hypothalamus
Surgical Patients’ Response to Body Temperature

• Anesthetized surgical patients:
  • Cannot regulate temperature through behavior changes
  • Rely on body’s thermoregulation system - and clinician intervention - to regulate temperature
Regional (Neuraxial) Anesthesia

- Similar process of hypothermia as compared to general anesthesia\textsuperscript{3}
- Central and peripheral thermoregulatory functions impaired\textsuperscript{3}
- Nerve blocks prevent normal responses and disrupt nerve conduction\textsuperscript{3}
- Skin temperatures in blocked areas misjudged by thermoreceptors\textsuperscript{3}
Regional (Neuraxial) Anesthesia

• Patients often feel warmer due to incorrect perceptions of thermoreceptors in blocked areas\(^3\)

• Hypothermia is frequently undetected in patients under regional anesthesia because:\(^3\)
  • Core temperatures are not monitored as frequently
  • Patients do not typically express feelings of thermal discomfort
Metabolic Heat Production

- 40-year-old (70kg) patient
  - Awake: 70 kilocalories heat/hour
  - Anesthetized: 42 kilocalories

- 80-year-old (70kg) patient
  - Awake: 60 kilocalories heat/hour
  - Anesthetized: 38 kilocalories

Adapted from: Morrison, International Anesthesiology Clinics, 1988
Thermoregulation: Under Normal Circumstances

The body’s normal response to temperature (°C)


Thermoregulation: Under Anesthesia

4.0°C Interthreshold Range

Vasoconstriction

NST

Vasodilation

Sweating

Hypothermia: < 36.0°C

Anesthesia-impaired response to temperature (°C)


Anesthesia-Impaired Response to Temperature

• The hypothalamic response to regulate temperature is degraded³
• Interthreshold range widens to 4°C³
• Anesthetized patients get warmer or colder before thermoregulatory responses are triggered³
Heat Redistribution
Characteristic Patterns of General Anesthesia-Induced Hypothermia

• Core temperature can drop 1.6°C in the first hour of general anesthesia

• 81% of this temperature decrease is due to core-to-peripheral heat redistribution

• Commonly known as redistribution temperature drop

Phases of Hypothermia Development

Typical Pattern of Hypothermia during General Anesthesia

Phase I: Rapid decrease in core temperature primarily caused by redistribution of heat. Heat loss: 81% redistribution; 19% environmental.

Phase II: Slower, linear decrease in temperature primarily caused by heat loss which exceeds the body’s ability to produce heat.

Phase III: Temperature plateaus once it has dropped beyond the widened interthreshold range and triggers the thermoregulatory response.

Prewarming Patients
Definition of Prewarming

• Prewarming is the application of heat prior to induction of anesthesia for the purpose of increasing the total heat content of the body

• Prewarming can increase the temperature of the periphery, which means that the temperature gradient within the body’s core is reduced
AORN Guideline for the Prevention of Unplanned Perioperative Hypothermia

• Assess the patient for risk of unplanned perioperative hypothermia

• Create a plan of care to minimize the risk of unplanned perioperative hypothermia

• The core temperature of patients at risk for unplanned hypothermia should be monitored preoperatively, intraoperatively, and postoperatively

• Interventions should be implemented to prevent unplanned hypothermia

• Prewarming the patient for a minimum of 15 minutes immediately prior to induction of anesthesia should be considered for patients at risk of unplanned hypothermia

• Utilize a warming modality such as:
  • Forced-air warming
  • Circulating-water garments
  • Energy transfer pads

ASPAN Recommendations on Normothermia

- ASPAN’s Evidence-Based Clinical Practice Guideline for the Promotion of Perioperative Normothermia: Second Edition

- Specific recommendations for pre-op include:\textsuperscript{7}
  - Implement passive thermal care measures
  - Maintain ambient room temperature at or above 24 C (75 F)
  - Institute active warming for patients who are hypothermic
  - Consider preoperative warming to reduce the risk of intra/postoperative - Evidence suggests prewarming for a minimum of 30 minutes may reduce the risk of subsequent hypothermia

\footnotesize{\textsuperscript{7} ASPAN: Evidence-Based Clinical Practice Guideline for the Promotion of Perioperative Normothermia: Second Edition}
Prewarming and Heat Redistribution

- Core temperature drop happens too quickly for active warming to compensate during the first hour following anesthesia induction[^2]
- In essence, the ability to maintain normothermia in the OR depends on the length of surgery and the time required to “re-warm” following temperature drop[^8]

Prewarming Benefits

• 30-60 minutes of prewarming with forced-air warming can “bank heat” in the periphery and reduce or eliminate redistribution temperature drop\(^8\)
  • Even 15 minutes of prewarming can add to the total heat content of the body

• Move from “Treatment” to “Prevention” of hypothermia
Prewarming vs. Intraoperative Warming


Duration of Prewarming and Postoperative Temperatures

Study Details

- Effects of prewarming duration on perioperative hypothermia and post-operative shivering
- 200 patients under general anesthesia with a length of surgery between from 30 to 90 minutes

Study Findings

- Prewarming utilizing forced-air warming methods is effective at preventing hypothermia perioperative and shivering postoperatively
- Approximately 70% of patients who received passive insulation (no prewarming) experienced hypothermia
- Short durations of prewarming at 10 or 20 minutes before anesthesia induction generally prevents hypothermia
Surgical Site Infection Rates

- Melling et al. studied 421 patients receiving 30 minutes of prewarming vs. no prewarming \(^{11}\)
- 30 minutes of prewarming appears to assist in the prevention of SSIs

Infection Rates


Interprofessional team collaboration and successful prewarming practice change\textsuperscript{12}

- This quality improvement project was focused on implementing prewarming to maintain patient normothermia in a pediatric specialty hospital. The facility had been utilizing cotton blankets in the pre-op and FAW blankets pediatric blankets in the OR.
- In 2011, the staff initiated a short trial period to evaluate the pediatric FAW gowns in place of FAW blankets.
- The staff was able to standardize their warming methods with the FAW gowns to warm the patient from pre-op to OR to PACU.
- The rate of active warming compliance nearly doubled (57.7\%)
- Feedback was positive from both parents and patients
- Agreement was reached to permanently implement prewarming with the FAW gown.
- This project highlighted how working with an interprofessional team resulted in the implementation of a successful perioperative practice change.

Prewarming and Patient Experience
Prewarming and Patient Satisfaction

- Prewarming can provide both clinical and comfort benefits.
- Studies have examined the effects of prewarming on patient comfort, satisfaction, and preoperative anxiety\textsuperscript{13,14,15}
- Prewarming with a forced-air warming gown vs. warmed cotton blankets can positively affect patient comfort satisfaction, and decrease preoperative anxiety\textsuperscript{13,14,15}

Warmth can play a role in a positive patient experience

Thermal Comfort

• A study by Fossum, et al found that:
  • Thermal comfort is greater in actively warmed patients\textsuperscript{16}
  • No actively warmed patients verbalized being cold\textsuperscript{16}
    • 66\% reported “most comfortable” on a comfort scale

• Warmth is the top nursing concern, followed by pain management and position\textsuperscript{17}

• Maintaining normothermia is important clinically and as a means of increasing patient comfort\textsuperscript{13,14}
Extended Warming

Wasfie, TJ, Barber, KE Int Surg. 2015

- This RCT of 94 patients compared the rates of hypothermia (core temp <36°C), patient well-being and the costs of warming.
  - The two groups compared were extended warming (using FAW gown system from pre-op, through surgery and during recovery until discharge) and standard warming (using FAW blankets from time of anesthesia induction until end of surgery).
  - Extended warming helped to prevent hypothermic events (hypothermia rate was 48% lower in the extended warming group, but this was not statistically significant) and minimized the intraoperative core temperature drop.
  - Patients in the extended warming group had decreased anxiety levels and apprehension, and an increase in patient comfort.
  - Extended warming with the FAW warming gown system resulted in a cost savings of $84.00 per patient vs. standard warming processes in this study.

Core body temperature is typically $2^\circ C$ to $4^\circ C$ warmer than the periphery under normal conditions.
Test Question

The main cause of rapidly-developing intraoperative hypothermia is:

induction of anesthesia.

a. Admission to the pre-op holding area
b. Induction of anesthesia
c. Surgical incision
d. Surgical skin prep
Test Question

The most common cause of unintended perioperative hypothermia following the administration of anesthesia is ________________.

- Convection
- Prolonged surgery time
- Redistribution temperature drop
- Shivering
Effects of Unintended Hypothermia
Adverse Effects of Unintended Hypothermia

• There are many documented adverse effects of unintended hypothermia including:\(^{19}\)
  
  • Wound infection
  • Myocardial ischemia and cardiac disturbances
  • Coagulopathy
  • Prolonged and altered drug effect
  • Increased mortality
  • Shivering and thermal discomfort
  • Delayed emergence from anesthesia
SSIs and Normothermia

• Improving patient safety and reducing surgical complications, such as SSIs, are an important focus for healthcare.

• Maintaining normothermia has been identified as a key contributor to reducing SSIs by various organizations.
The Numbers are Staggering

• Hospital infections, including SSIs, are the fourth largest killer in the U.S., claiming more lives than AIDS, breast cancer and traffic accidents combined

• SSIs may result in yearly medical costs of $1 to $10 billion

• Patients who acquire SSIs are more likely to be:
  • Readmitted to the hospital
  • Admitted to the ICU
  • Two times more likely to die

Surgical Wound Infections

- Hypothermic colorectal surgical patients with mild hypothermia have: \(^{23}\)

\[
\begin{array}{c|c|c}
\text{Hypothermic} & \text{Normothermic} & \text{Infection Rate} \\
0\% & 5\% & 10\% & 15\% & 20\% \\
\end{array}
\]

Adapted from: Kurz et al., *New Engl J Med*, 1996

\[
\begin{array}{c|c|c}
\text{Length of Hospital Stay} \\
0 & 2 & 4 & 6 & 8 & 10 & 12 & 14 & 16 \\
\end{array}
\]

Adapted from: Kurz et al., *New Engl J Med*, 1996

Surgical Site Infection Rates

- Hogenmiller et al. initiated a project targeting the reduction of SSIs in total hip and knee arthroplasty patients\textsuperscript{24}

- Implementation and adherence to the checklist significantly reduced the number of SSIs on THA/TKA patients\textsuperscript{24}

Coagulopathy

- Blood loss is higher in hypothermic patients during surgery and postoperatively.\textsuperscript{25}
- Even a core temperature drop of $<2^\circ$C was found to increase blood loss by 500mL (1 unit).\textsuperscript{25}

End of Surgery Blood Loss

Adapted from: Schmied et al., \textit{The Lancet}, 1996

**Delayed Emergence from Anesthesia**

- Hypothermic patients need an average of 90 minutes longer in PACU vs. normothermic patients\(^{26}\)
- Maintaining normothermia is likely to decrease PACU time\(^{26}\)

\[\text{Graph showing recovery time from anesthesia for normothermic and hypothermic patients.} \]


© 3M 2015. All Rights Reserved
Prolonged and Altered Drug Effect

- Drug metabolism is reduced by hypothermia\(^ {27}\)
- Vecuronium, a neuromuscular blocking agent, was found to have an average duration of: \(^ {27}\)
  - 28±4 minutes in normothermic patients
  - 62±8 minutes in hypothermic patients

Duration of Action of Vecuronium

Adapted from: Heier et al., Anesth, 1991

Shivering

• Shivering occurs in 40-60% of unwarmed patients recovering from general anesthesia\textsuperscript{3,28}

• Some patients have expressed the feelings of thermal discomfort and shivering to be more significant than post-surgical pain\textsuperscript{3}

• It is rare to see intense shivering postanesthetically in patients with normothermic temperatures\textsuperscript{19}

Table Top Activity

• At your table discuss some of the adverse affects of unintended hypothermia that may have a negative impact at your facility

• Record the top three at your table
Benefits of Normothermia

• Studies have suggested that maintaining normothermia may yield positive results such as:  
  • Reduction in the use of blood products  
  • Shortened length of stay  
  • Decreased ICU time  
  • Reduced rate of wound infection  
  • Decreased likelihood of myocardial infarction  
  • Lower mortality rates
Active vs. Passive Warming
Active Warming vs. Passive Warming

- It is important to understand the differences between active warming and passive warming
- Active warming is the active application of heat, i.e. forced-air warming or conductive warming
- Passive warming uses insulative techniques, i.e. cotton blankets or surgical drapes
- Active warming with forced-air warming is referenced as the standard of care for managing perioperative normothermia

Relative Effectiveness of Warming Methods

Forced-air warming is the most effective method for maintaining normothermia\(^3\)

Change In Mean Body Temperature (°C)

Elapsed Time (Hours)
Prewarming is achieved through **active** warming modalities.
Test Question

Patient warming should start in the OR

False
Table Top Activity

• Using your list of top three adverse affects of unintended hypothermia that could negatively impact your facility...discuss ways that you could combat or prevent them from occurring

• Record the top three at your table; report off to the group
Patient Warming in the ASC: Summary

• Redistribution temperature drop occurs in both general anesthesia and regional (neuraxial) anesthesia patients
• Prewarming (in the preoperative area or prior to induction) helps patients avoid unintended hypothermia by “banking heat”
• Patient satisfaction and comfort is related to their level of warmth
• Research shows that even mild hypothermia can result in significant negative outcomes
Questions?
References

6. AORN. Guidelines for Perioperative Practice. 2015 Denver, CO


References


Thank you