

體溫控制與手術傷口感染

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Defining Perioperative Hypothermia



- Unplanned Core temperature below 36.0 Celsius (96.8F)
- Mild: 34-36 Celsius (93.2-96.8F)
- Normal body temperature is between 36.0 and 38.0 Celsius (96.8-100.4 F)
- Normothermia is a balance between heat production and heat loss

Measuring Core Temperature



- Four sites can accurately measure core temperature
 1. Distal esophagus
 2. Pulmonary artery
 3. Tympanic membrane
 4. Nasopharynx

Estimating Core Temperature



- Sites that can be used to estimate Core temp (if core temp is 36 C, this site is...)
 1. oral (35.8)
 2. axillary (34.5)
 3. skin (33)
 4. bladder (36.3, is volume dependent)
 5. rectum (36.5)

Methods of Heat Loss



- **Radiation** (accounts for approx 60% heat loss)
 - Heat transfer from one object to another without physical contact (heat dissipates to cooler surroundings)
- **Evaporation** (accounts for approx 20% heat loss)
 - Loss of heat during conversion of water to gas state
- **Convection** (accounts for approx 15% heat loss)
 - Losing heat as air or water molecules move across the skin
- **Conduction** (accounts for approx 5% heat loss)
 - Heat loss through physical contact with another object or body

Risk factors for hypothermia



- Extremes of age
- High surface area to weight ratio (infants)
- Preexisting conditions such as hypothyroidism, hypoglycemia, acute alcohol intoxication, malnourishment, burns, trauma, and low preoperative temperature
- Both General and Regional anesthesia, highest with combined GA and RA (Cattaneo et al, 2000)
- Anesthesia for >30 minutes

Perioperative risks for Hypothermia

(Macario et al, 2002 and Kasai et al, 2002)

- Neonates
- Cold OR temperatures (<64F)
- General anesthesia with neuraxial anesthesia
- Geriatric patients
- Preoperative hypothermia
- Low preoperative blood pressure
- Thin body habitus
- Large blood loss (>30ml/kg)
- Large body surface area exposure
- Case longer than 2 hours
- Cold wound irrigants



Pathophysiologic Causes of Intraoperative Hypothermia

- Redistribution of blood (1-1.5 C in first hour) and impaired thermoregulation due to anesthesia, slow linear decline after
- Surgical site evaporation
- Decreased metabolism
- Decreased tissue perfusion



Morbid Cardiac Events

- Cold-induced HTN in elderly is assoc w/ 3x increase in [Norepinephrine] (Sessler, 2001)
- A study of 300 participants with a core temperature change of 1.3 degrees C between treatment groups
 - Normothermic 1.4%
 - Hypothermic 6.3%
 - 4.5 x greater risk with hypothermia

(Frank et al, 1997)



Increased risk of surgical site infections

- Decreased tissue oxygen levels
- Vasoconstriction with poor perfusion
- Potential for delayed wound healing
- Decreased neutrophil and macrophage fxn
- A drop of core temperature 1.5-2 degrees Celsius increases SSI risk by three-fold (Kurz et al, 1996, colorectal study N=200)
- Flores-Maldonado et al 2001 study of 290 cholecystectomy patients: SSI was 2% for 36.2 degrees vs. 11.5% @35.4 degrees



Medicare and SSIs, what can anesthesia do to help?

- 2006 Mauerman and Nemergut discuss the Anesthesiologist's role in SSI
 - "With all that is now known regarding the complications of hypothermia, it should be every clinician's goal to maintain normothermia unless contraindicated."
- Medicare statement released August 4, 2008
 - Beginning October 1, 2008, Medicare **will no longer pay hospitals at a higher rate for the increased costs of care that result** when a patient is harmed by a hospital-acquired condition listed (includes SSI sp)
 - Medicare **will pay for physician** and other services needed to treat the acquired condition



Intraoperative Blood Loss

Consequence	Author	N	▲Tcore (degree C)	Normothermic	Hypothermic	P
Intraoperative Blood Loss	Schmied et al	60	1.6	1.7 +/- 0.3L	2.2 +/-0.5L	<0.001
Intraoperative Blood Loss	Winkler et al	150	0.4	488ml	618ml	<0.005
Intraoperative Blood Loss	Widman et al	46	0.5	516 +/- 272ml	702 +/- 344ml	<0.05
Intraoperative Blood Loss	Johanson et al	50	0.8	665 +/- 292ml	698 +/- 314ml	NS



Temperature-Related Coagulation Disorders



- Contributing factors
 - Impaired platelet function
 - Reduced release of thromboxane A₂
 - Impaired clotting factor enzyme function
 - Fibrinolytic activity
- Side note
 - Lab draws for PT, PTT normally run at 37°C, regardless of patient's temp

Increased need for blood product transfusion



- 2008 meta-analysis of study results from 1996-2006 by Rajagopala et al. noted that even mild hypothermia (median temperature of 35.6°C) increases blood loss by 16% and increases risk for transfusion by 22%

Increased patient discomfort and anxiety with shivering



- Decreased patient satisfaction (thermal discomfort noted as more disturbing than pain and may aggravate pain perception, Kurz et al, 1995)
- Increased oxygen consumption (Just et al. noted increase in VO₂ 37% and minute ventilation 52%)
- Increased carbon dioxide production
- Possible increased risk for patients w/CAD and severe pulmonary compromise

Duration of Postanesthetic Recovery



- Study of 150 participants (Lenhardt et al, 1997)
 - 1.9 degree core temp change
 - Normothermic group
 - 53 +/- 36 minutes
 - Hypothermic group
 - 94 +/- 65 minutes
- Prolonged emergence and recovery from increased solubility of PIA's, and reduced metabolism of IV drugs

Duration of Hospitalization



- (Kurz et al, 1996)
 - N:200
 - 1.9 degree core temp difference in treatment groups
 - Normothermic group
 - 12.1 +/- 4.4 days
 - Hypothermic group
 - 14.7 +/- 6.5 days

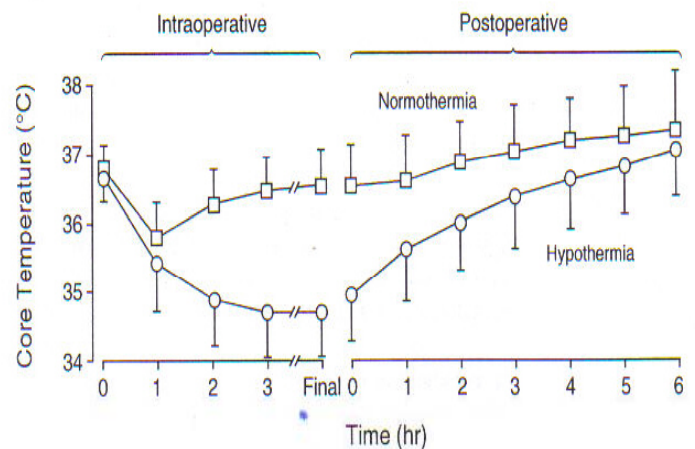


Figure 1. Core Temperatures during and after Colorectal Surgery in the Study Patients.

Normothermia for colorectal surgery



- A Kurz, NEJM 1996; 334:1209-15
- 200 patients, double-blind study
- Followed for 2 weeks
- 34.7 ± 0.6 Celsius VS 36.6 ± 0.5 Celsius
- SSI 18.8% VS 5.8% ($p=0.009$)
- Sutures were removed one day later ($p=0.002$)
- Hospital LOS prolonged by 2.6 days ($p=0.01$)

Normothermia for colorectal surgery



- 1.9°C core hypothermia triples the incidence of surgical wound infection after colon resection
- Hypothermia increases by 20% the duration of hospitalization

Normothermia for colorectal surgery



- A Kurz, NEJM 1996; 334:1209-15
- Intraoperative vasoconstriction was present in 74% vs 6% of patients and persisted throughout the 6 hr recovery period

Hypothermia and cholecystectomy



- Flores-Maldonado et al. 2001
- 290 consecutive patients
- 30-day follow-up
- Patients that received blood transfusion were excluded
- $35.4^{\circ} \pm 0.4^{\circ}\text{C}$ vs $36.2^{\circ} \pm 0.2^{\circ}\text{C}$
- 11.5% vs 2% SSI

Preoperative Measures to Prevent Hypothermia



- Assess thermal comfort of patients in SAU
- Note preoperative temperature in SAU
- Keep SAU room warm
- Apply stockings and blankets

Poor Warming Techniques



- Hot water containers
 - Temp often exceeds 45 degrees C
 - If placed in axilla, can result in thermal burns
 - Rationale...small surface area, tissue unable to absorb and transfer heat to circulation. Heat accumulates locally, causing tissue burns
- Review of ASA closed-claims database...
 - Hot water bottles were by the leading cause of perioperative thermal injuries

Ineffective Warming Techniques



- Airway Heating/Humidification (Anamed)
 - Less than 10% of metabolic heat production is lost via the respiratory tract
 - Many studies indicate that active heating/humidification systems contribute little to the preservation of core temperature in adults undergoing large operations. (Sessler, 2001)
 - Anamed Temps $>41^{\circ}\text{C}$ can induce thermal airway burns
- Bair Hugger without Bair Blanket
 - Good way to burn your patient under GA

Evidence-Based Intraoperative Measures to Prevent Hypothermia



- Educate OR staff re: appropriate increased operating room temperature!!!
- Warming IV fluids (for any case with IV fluids >2 liters/hr, or greater than 500cc)
- Warming blood transfusion products
- Vasoconstrictors to treat vasodilation

More Evidence-Based Recommendations



- 2 blankets on all preop patients
 - 1 blanket = 30% reduction in heat loss
 - 2 blankets = 50% reduction in heat loss
- Preoperative warming (bair vests)
 - \$7-\$21 for active warming devices vs. \$1000/day in ICU or \$465/day hospital floor bed
 - Estimated that complications from hypothermia can lead to increased hospital costs of \$2,500 to \$7,500. (Cohen et al, 2002).
- Always attempt to monitor core temp
 - Better accuracy than peripheral sites

Evidence-Based Recommendations



- Preoperative warming with active methods
 - This will become more important when MEDICARE reimbursements really start to sting the hospital's budget
- Minimize prep time without active warming initiated
 - Large heat loss from radiation and convection
- Maintain closed or low flow circuits
- 2 x (upper and lower) active warming devices for big cases, warm water under blankets for full exposure cases

Cutaneous warming



- Passive insulation reduces heat loss by approximately 30%
- Active cutaneous heating: efficacy will be proportional to the skin surface warmed
Circulating water, Forced air, Radiant warmers

Active cutaneous warming systems



- Forced-air systems
- Circulating-water mattresses
- Resistive heating systems (ICU, trauma)
Carbon-fiber patient cover
- Circulating-water garments Water has a conductivity of heat 26 times higher than air
- Infrared radiation (neonates, pediatric Sx)

Core temperature monitoring

- Pulmonary artery
- Nasopharynx
- Tympanic membrane
- Aural thermocouples probe
- Infrared thermometer
- Distal Oesophagus
- Rectal temperature during neuraxial anesthesia



Fluid warming

- If more than 2 liters/hr
- One liter of crystalloid or 1 unit of refrigerated blood decreases core temperature by 0.25°C



Safer Healthcare Now! Campaign Sunnybrook and Women's College Health Sciences Centre Data Collection Record		BRADMA
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Procedure <input type="text"/>		
Normothermia		
Is Temperature ≥ 36 ° on leaving OR		<input type="radio"/> Yes <input type="radio"/> No Temperature <input type="text"/> OR Temp <input type="text"/>
OR		
Is Temperature ≥ 36 ° on Arrival in PACU		<input type="radio"/> Yes <input type="radio"/> No Temperature <input type="text"/> PACU Temp <input type="text"/>

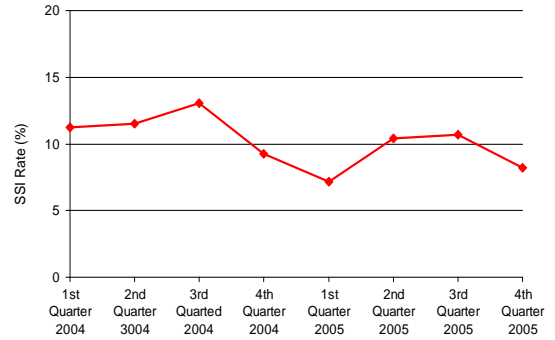
Infection rates in colorectal



	Infection	No Infection	Total
Hypothermic	N=13 46.4%	N=15 53.6%	N=28
Normothermic	N=2 12.5%	N=14 87.5%	N=16
Total	N=15	N=29	N=44

P=0.022

Quarterly Incidence of Infections Among Isolated ACB's 2004-2005



AANA/ASA Guidelines



- AANA
 - “recommend patient body temp monitoring during local, regional, and general surgical procedures, as deemed necessary.”
- ASA
 - “during the administration of all anesthetics when clinically significant changes in body temperature are intended, anticipated, or suspected.”
- NICE Guideline

懇請賜教

