Perioperative Hypothermia: An Old Nemesis Revisited

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A Real Life Case…

- 74 year old female
- Self inflicted GSW
- S/P ex lap
- 7 units of blood products overnight in the ICU
- Hx hypothyroidism, depression, HTN
- Presents to OR at 0730 for emergent splenectomy
- Hypotensive, bradycardic, lethargic, early signs of DIC
- Verrrrry sick…
After Induction…

- 8 mg etomidate & 50 mg rocuronium.
- Bp 74/42, hr 48, etco₂=12, BIS=7…
- Nasopharyngeal temperature = 83 degrees F.
- Splenectomy successful (25 min. skin to skin)
- Warmed with forced air blanket to 87 degrees
- Transported, intubated to ICU whereupon…
Presentation Outline

- Normal thermoregulation
- Effects of anesthesia
  - General
  - Neuroaxial
- Causes of hypothermia
- Consequences of mild hypothermia
- Preventing & managing hypothermia
Normal Thermoregulation

- Narrow presets...37 degrees C (+/- 0.2)
- Positive and negative feedback
- Three phase process:
  - Afferent thermal sensing
  - Central regulation
  - Efferent responses
Afferent Input

- Both “warm” and “cold” receptors
  - Brain
  - Spinal cord
  - Abdomen
  - Thorax
  - Skin

- Cold signals travel in A delta and unmyelinated C fibers
- Ascend to the brain in anterior spino-thalamic tracts
Central Control

- Hypothalamus integrates information from the CNS and periphery
- Autonomic responses determined by core input
- Behavioral responses primarily reflect skin surface input
Efferent Responses

- Increase heat production
  - Non shivering thermogenesis (minor in adults, major in infants)
  - Shivering (absent in infants, major in adults)

- Reduce heat loss
  - Cutaneous vasoconstriction
  - Closure of thermoregulatory arteriovenous shunts
  - Behavioral responses
Hypothermia During Anesthesia

- Heat is lost to the environment
- Presets are “re-set”
- Compensatory mechanisms are dampened or eliminated
- Winter sets in…
Causes and Patterns of Heat Loss

- **Radiation**: major source of heat loss, temperature gradient dependent
- **Conduction**: minor (adjacent surfaces)
- **Convection**: wind chill (moving conduction)
- **Evaporation**: heat lost through wounds, can be significant
Causes and Patterns of Heat Loss

- Initial rapid decrease in core temperature
- Slow reduction in core temperature
- Core temperature stabilizes
Effects of General Anesthesia

Diagram showing the effects of normal and anesthesia on vasoconstriction, nonshivering thermogenesis, shivering, sweating, and vasodilation across different temperatures (33°C to 41°C).
Effects of General Anesthesia
Effects of Neuroaxial Anesthesia

- Vasoconstrictive and shivering thresholds are lowered.
- Thermal inputs from blocked segments are altered.
- Sedatives impair thermoregulatory control.
- Patients may not “feel” cold.
Benefits of Mild Hypothermia

- Substantial protection against ischemia and hypoxia (1-3 degrees).
- May be indicated for carotid endarterectomy or neurosurgery.
- Malignant hyperthermia is more difficult to trigger and is less severe.
Complications of Hypothermia

- Coagulation defects
  - Impaired platelet aggregation
  - Impaired coagulation enzyme activity
- Increased wound infections
- Postop thermal discomfort
- Increased myocardial events
- Altered drug kinetics and dynamics
## Complications of Hypothermia

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<tr>
<td>Wound infections</td>
<td>6%</td>
<td>19%</td>
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<tr>
<td>Blood loss</td>
<td>1.7 +/- 0.3 L</td>
<td>2.2 +/- 0.5 L</td>
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<tr>
<td>Cardiac events</td>
<td>1%</td>
<td>6%</td>
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<tr>
<td>Duration of vecuronium</td>
<td>28 +/- 4 min</td>
<td>62 +/- 8 min</td>
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<tr>
<td>Time in PACU</td>
<td>53 +/- 36 min</td>
<td>94 +/- 65 min</td>
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Challenges in Management

- Initial reduction in core temperature is difficult to prevent (thermoregulatory effect). *Hint: try pre-warming.*
- Surgeons are resist to raising ambient temperatures.
- Vasoconstriction goes. Both ways.
Interventions to Preserve Heat

- Airway warming
  - Passive: HMEs
  - Active: heaters
- Fluid warmers…it’s all about the same
- Cutaneous warming
  - Room temperature
  - Passive insulation
- Forced air, the undisputed champion…
Passive Insulation I

Heat Loss (W)

Time (min)
Passive Insulation II

![Graph showing Heat Loss (W) vs. Time (min) with lines for 1 Unwarmed, 1 Warm, 3 Unwarmed, and 3 Warm conditions.]
Stuff That Really Works...
Looking at the Big Picture…

- Fluid warmer can make a difference.
- Force air blankets are the most effective at putting heat into the system.
Conclusions...

- Heat loss during surgery is nearly unavoidable.
- Prevention of hypothermia is preferable to treatment, and is cheaper.
- Use the things that work.
- Discourage those that don’t.
Questions?