Blood Warming - A Hot Topic?

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Objectives

- To learn / review the deleterious systemic effects of hypothermia
- To appreciate that hypothermia secondary to fluid administration can largely be avoided
- To introduce some of the hardware available for blood warming and learn their limitations.
I have no commercial association with any company / product associated with blood warming... but I am open to any reasonable offers.
Hypothermia

Definition: Core body temperature less than 35°C

**Primary**: Overwhelming cold stress
**Secondary**: Alterations in thermoregulation and heat production.
Primary Hypothermia
Secondary Hypothermia
Deleterious Effects

Cardiovascular
Metabolic
Infection
Coagulation
Morbidity and Mortality
Cardiovascular Effects

Hypothermia causes:
- Decreased cardiac output
- Decreased blood pressure
- Increased systemic vascular resistance
- Dysrhythmias
Cardiovascular Effects

Rhythm disturbances:

- Atrial fibrillation / flutter common under 32°C
- <30°C Bradycardia and ventricular dysrhythmias
- 24-28°C Asystole
Cardiovascular Effects

Shivering increases metabolic demands by 40%

- Fifty percent of operative patients have temps < 36°C
- Thirty-three % have temps < 35°C
- Left shift of Oxygen-Hemoglobin dissociation curve.
Shivering

Perioperative cardiac events (ischemia, angina, MI) are around 1.4% for normothermic patients undergoing major surgery.

Rate increases to 6.3% in patients <35°C

Dramatically increases rates of acidosis
“Gut” Effects

Decreased splanchnic blood flow causes:
- Gastric erosions
- Ileus
- Bowel wall edema
- Hepatic and renal dysfunction
Altered Glycemic Control

Hypothermia:
- Decreases insulin release
- Increases tissue insulin resistance

Overall result is HYPERGLYCEMIA that is difficult to control
Acidosis

One third of hypothermic patients are acidemic secondary to:

- Respiratory depression
- Lactic acid build-up
- Decreases hepatic clearance of acids
Coagulation

Control of hemorrhage in cold patients is almost IMPOSSIBLE.

Underestimated in lab because samples warmed to 37°C for testing.

Even with NORMAL factor levels, cold plasma (31°C) acted the same as plasma with 2.5% factor activity.
Platelets

Hypothermia can decrease both platelet number (clumping) and function. Isolated limb studies show platelet function problems. Bleeding despite NORMAL platelet counts.
Dilutional Coagulopathy

Commonly co-exists with hypothermic coagulopathy
Due to decrease in platelets and factors
Low temperature exacerbates it because of decreased coagulation kinetics
PLATELET AND FACTOR REPLETION ARE USELESS WITHOUT REWARMING
Infection

Increased risk of infection:

- Decreased WBC count
- Neutrophil and macrophage function inhibited
50% of all trauma pts are hypothermic
10-15% are “severely” hypothermic
Stats improving because of better awareness.
EASIER TO KEEP WARM THEN TO REWARM
Primary hypothermia of 32°C mortality is 21%
Almost always lethal <32°C in trauma
Fluid Warming Devices

Ideal warmer would:
- Be able to warm at both high and low flow rates
- Have excellent thermal control
- Be safe for the patient (temp., air, burns)
Fluid Warming

Three main types of fluid warmers:

- Immersion warmers
- Dry heat (conductive plates)
- Counter-current warmers
Fluid Warming

A. Room Temperature (21°-23°C)

- IV fluid tube warmer
- Dry heat plate warmer
- Water bath warmer

B. Ice-cold temperature (3°-5°C)

- IV fluid tube warmer
- Dry heat plate warmer
- Water bath warmer
Counter Current Devices

Example: “Hotline”
Most frequently used at CDHA
Efficient at low to moderate infusion rates
Pole mounted.
Hotline / Level 1 Infuser
Dry Heat

Examples: Ranger, Enflow, Belmont, Fenwal
Fluid is heated by a conductive plate
Best type for high flow rates (1000 cc/min)
Dry heat plate warmers
Immersion

Not widely used anymore because of size and difficulty maintaining fluid temp at low flow rates.
What can be warmed

Crystalloids
Colloids (Voluven)
Plasma
RBC

Generally **DO NOT** put platelets through a warming device!
Guidelines

- ALL warming of blood products should be done using a device that is licensed for use with blood products.
- The device should not allow the temperature of blood to exceed 42°C.
- The warming system shall have an alarm system and a visible thermometer.
- All blood warming devices shall be maintained and validated on a regular basis by the Biomedical Engineering department.
Summary

- Hypothermia can significantly impact physiology of the patient and may result in increased morbidity and mortality.
- The infusion of cold fluids/blood will cause hypothermia.
- Fluids should ALWAYS be warmed when given at more than a “trickle”.

Department of Anesthesia
Questions?