

-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.

Disclaimers

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 fib / 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 $< 36^{\circ}\text{C}$
- Thirty-three % have temps $< 35^{\circ}\text{C}$
- 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 $< 35^{\circ}\text{C}$

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

Trauma Data

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

Trauma- Mortality

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)

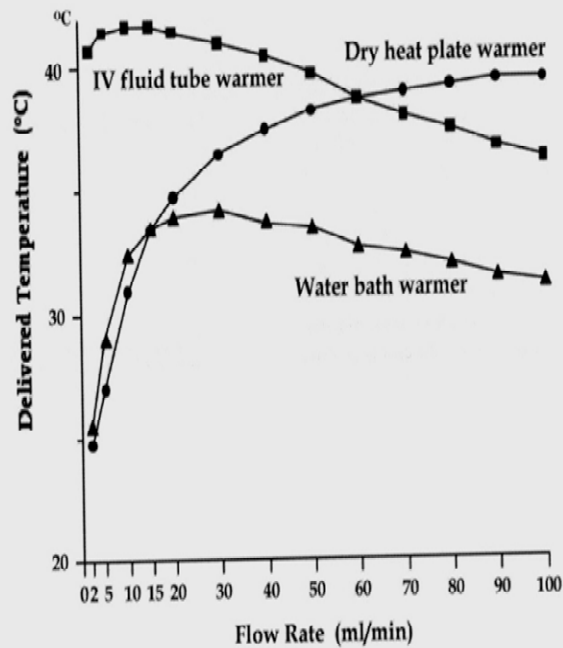
Fluid Warming

Three main types of fluid warmers:

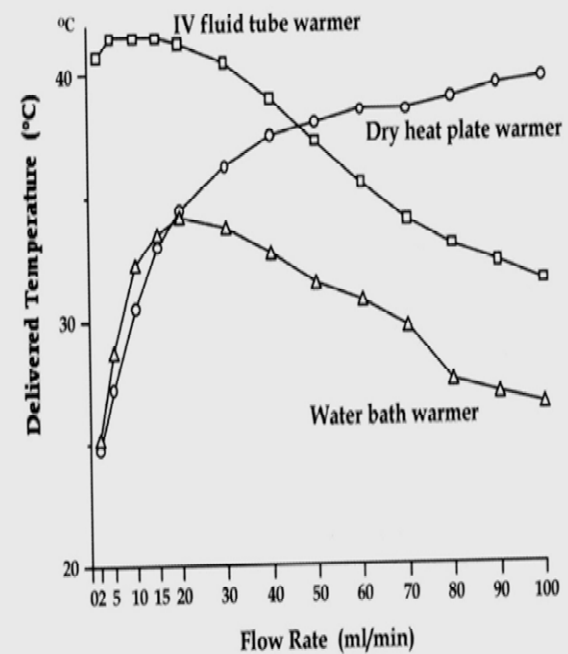
- Immersion warmers
- Dry heat (conductive plates)
- Counter-current warmers

Fluid Warming

A. Room Temperature (21°-23°C)



B. Ice-cold Temperature (3°-5°C)



Counter Current Devices

Example: "Hotline"

Most frequently used at CDHA

Efficient at low to moderate infusion rates

Pole mounted.

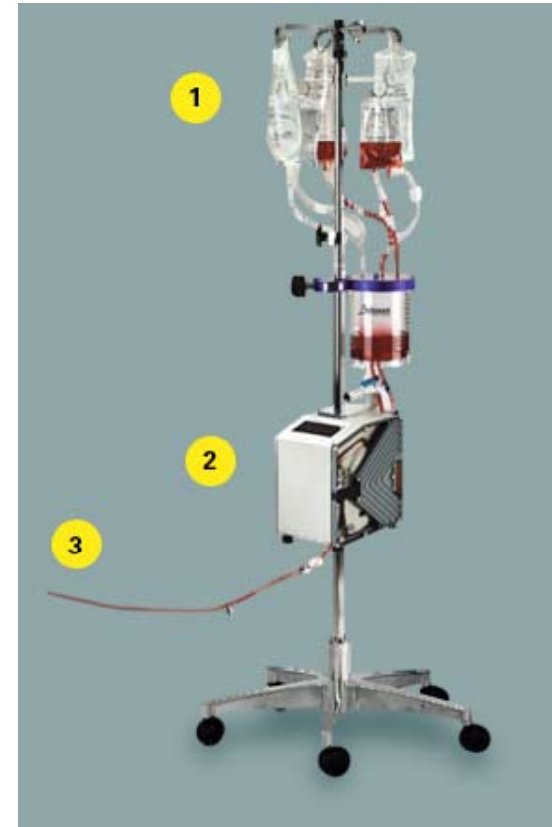
Hotline / Level 1 Infuser



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 on 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”.

Questions?

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