HYPOTHERMIA IN INJURY CARE

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HYPOTHERMIA

- Neuroprotective
- Cold cardioplegia
- Pediatric heart anomalies
- Environmental exposure: prolonged survival (drowning)

- Trauma

Guy Clifton

- Randomized, prospective
- 392 patients from 7 level I centers
- Isolated major brain injury

	37 °C	33 °C
Poor outcome (%)	57	57
Mortality (%)	27	28
Complications (%)	70	78

better outcome 1. age < 35
2. hypothermia on arrival to ED

Clifton, Miller, Sung, et al. Lack of Effect of Induction of Hypothermia after Acute Brain Injury NEJM 2001

NEUROPROTECTION

Hypothermia:

- reduces intracranial pressure
- diminishes harmful biochemical cascade

neurologic outcomes

improved	worse / no better
Marion - 1997	Shiozaki - 1993
Jiang - 2000	Clifton - 1993

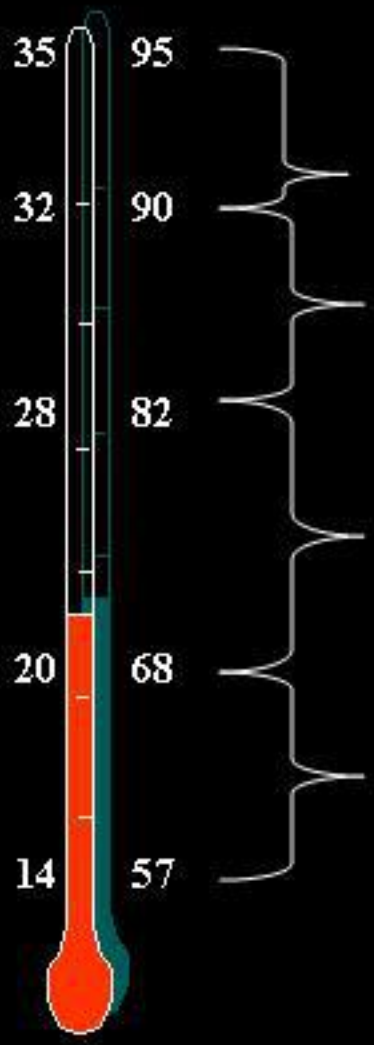
NEUROPROTECTION
after
CARDIAC ARREST

Induction of hypothermia within one hour in survivors of cardiac arrest resulted in significantly improved neurologic outcomes.

- Bernard, Gray, Buist, et al. NEJM 2002
- Holzer. NEJM 2002

We need a study of hypothermia as a neuroprotectant in traumatic brain injury with induction beginning < 1 hour of injury.

GRADES OF HYPOTHERMIA

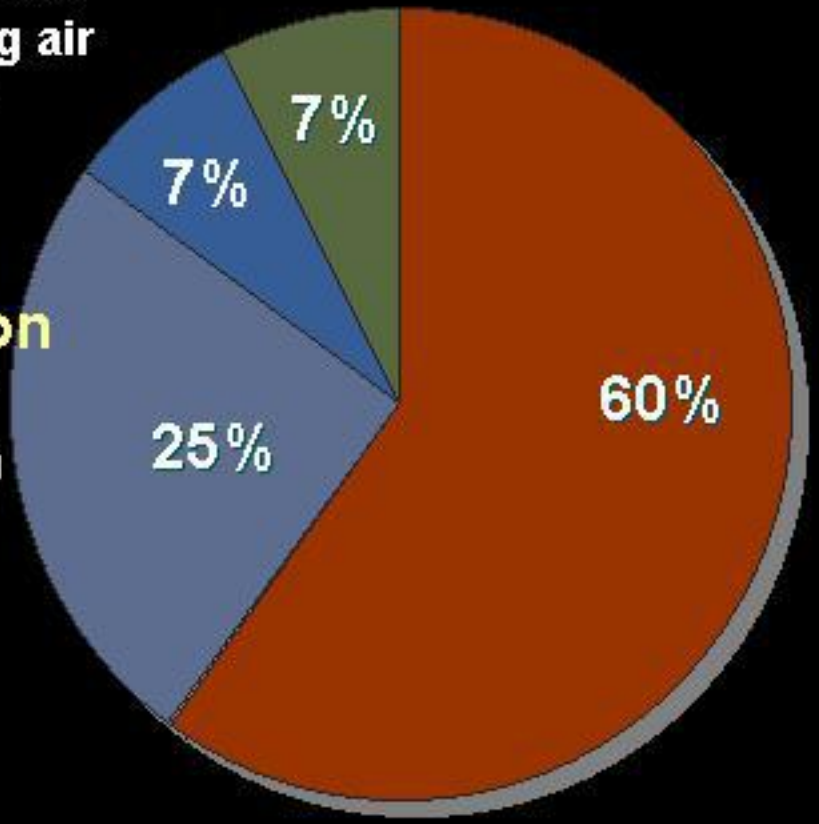


Mild	tachycardia, tachypnea, diuresis, apathy, vasoconstriction, shivering
Moderate	cardiac conduction disturbances, hypo-ventilation, hallucinations
Severe	severe dysrrhythmias, ↓renal bl. flow decreased metabolism, areflexia shivering stops
Profound	asystole

4 MECHANISMS OF HEAT LOSS

conduction:
direct contact with cold surface

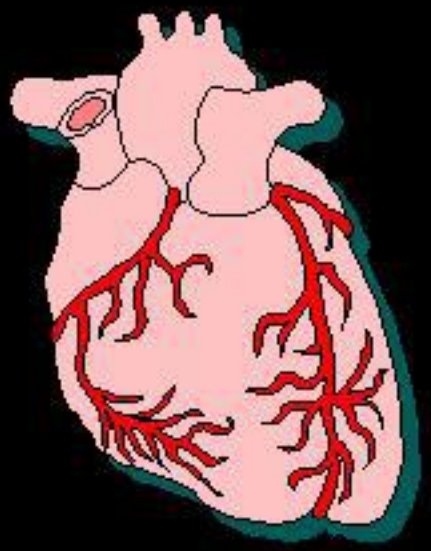
convection:
heat loss to overlying air currents

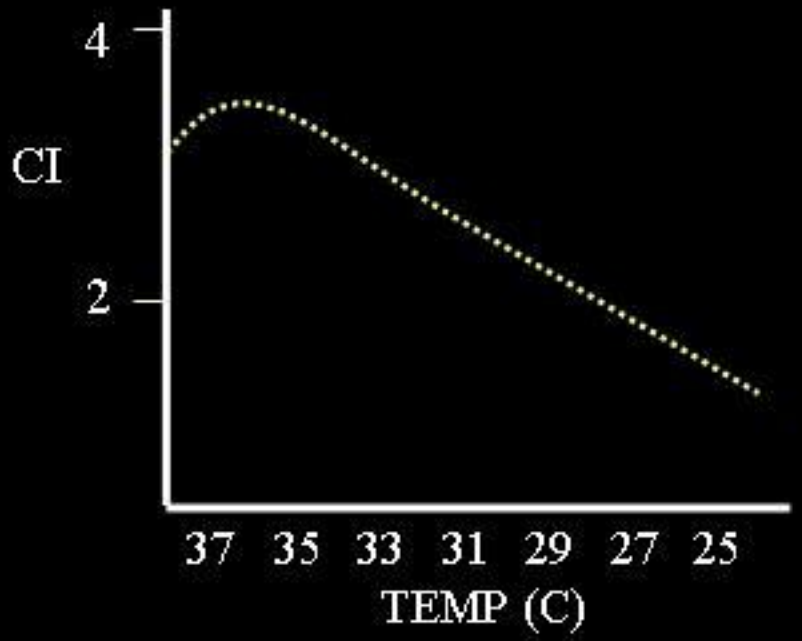


evaporation
heat loss to vaporization of water

radiation:
heat loss to surrounding objects

CARDIAC OUTPUT & BLOOD PRESSSURE



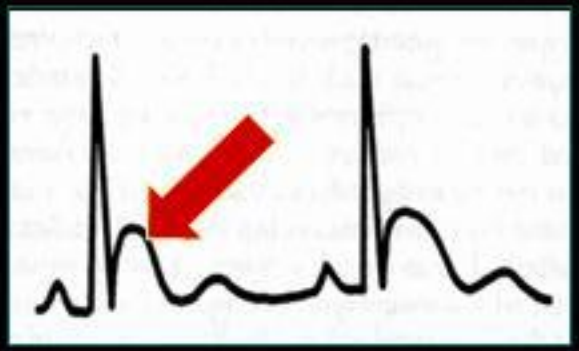


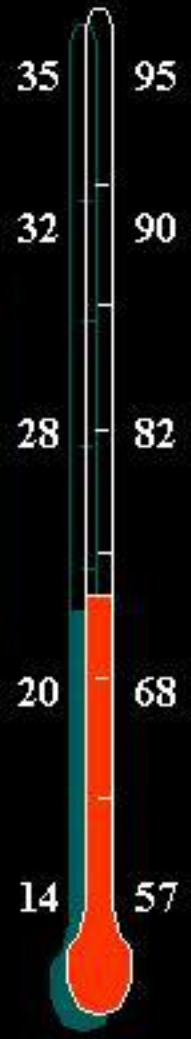
↓ myocardial compliance

=

↑ filling pressures required

MYOCARDIUM





- slowing of depolarization

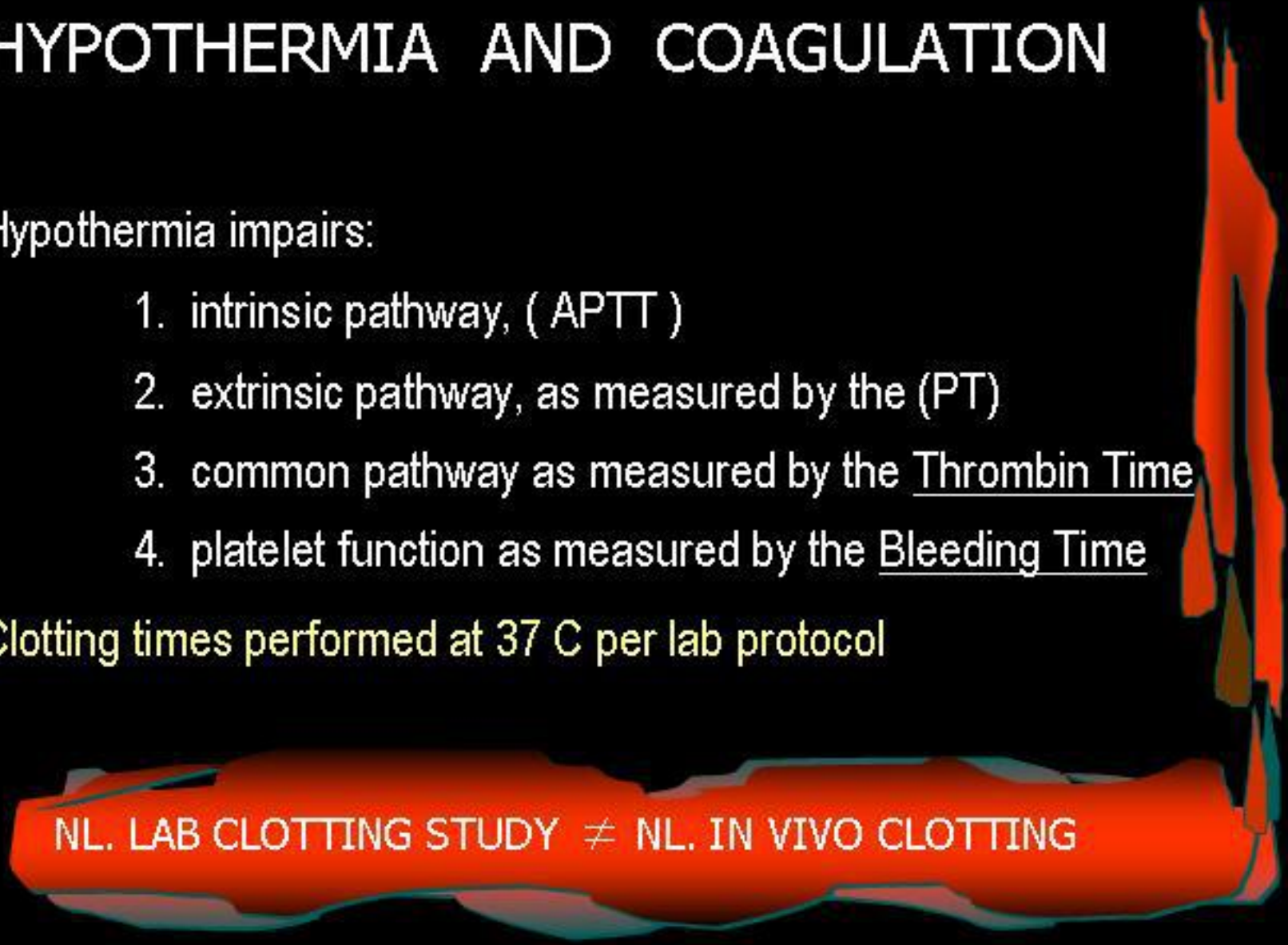
- QRS widening
- PR prolongation
- T inversion
- J waves
- a-fibrillation, bradycardia
- low threshold for V-fib
- asystole

HYPOTHERMIA AND COAGULATION

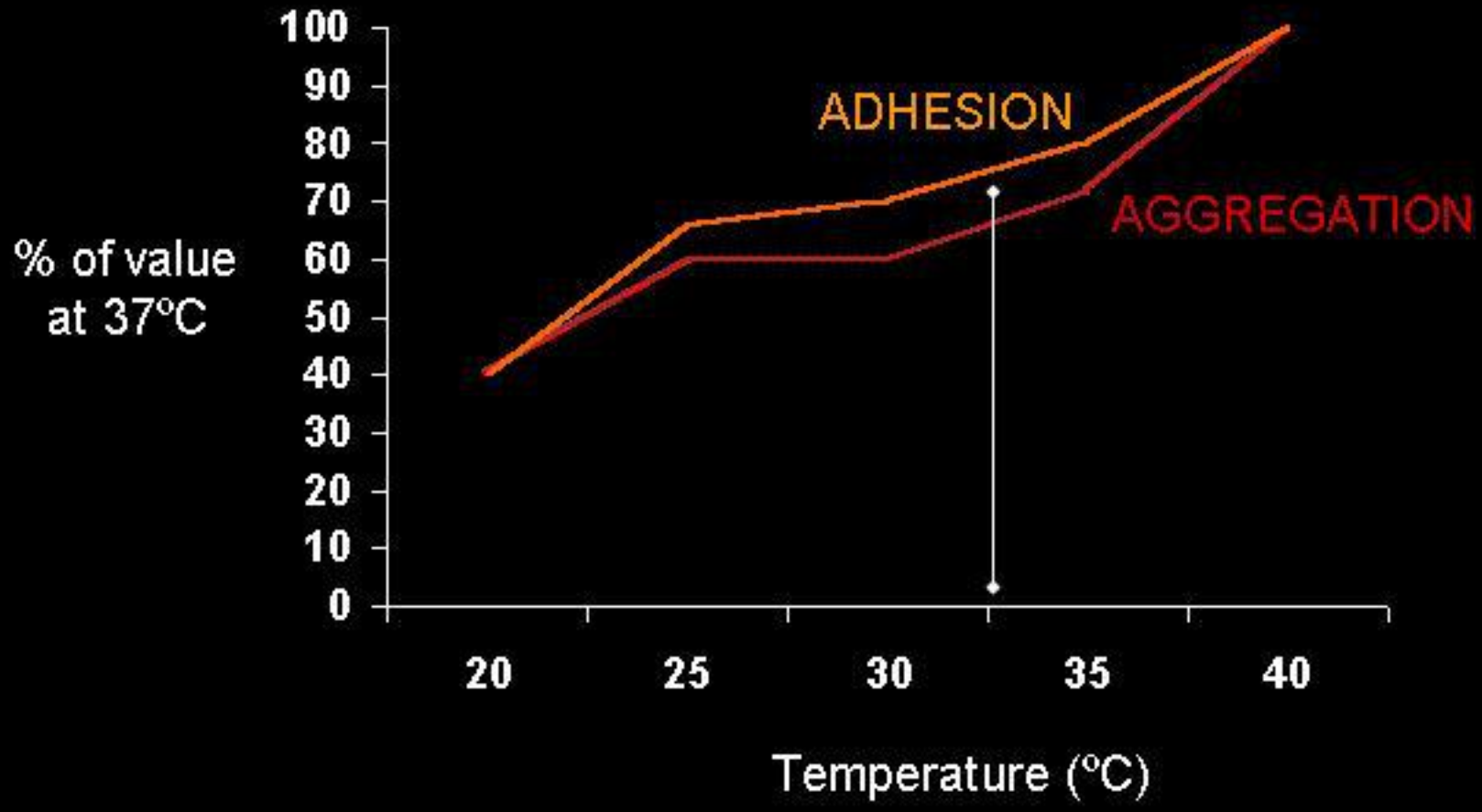
Hypothermia impairs:

1. intrinsic pathway, (APTT)
2. extrinsic pathway, as measured by the (PT)
3. common pathway as measured by the Thrombin Time
4. platelet function as measured by the Bleeding Time

Clotting times performed at 37 C per lab protocol



TEMPERATURE EFFECTS on PLATELET FUNCTION



Wolberg, et al, J Trauma, June 2004

RECOMBINANT FACTOR VIIa

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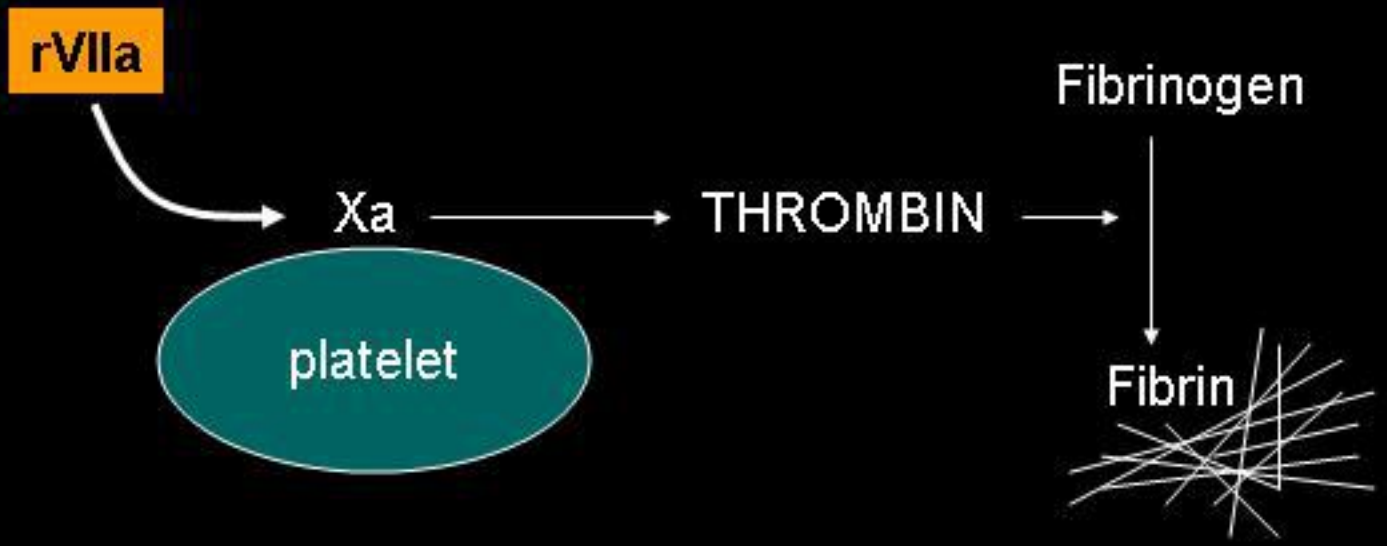
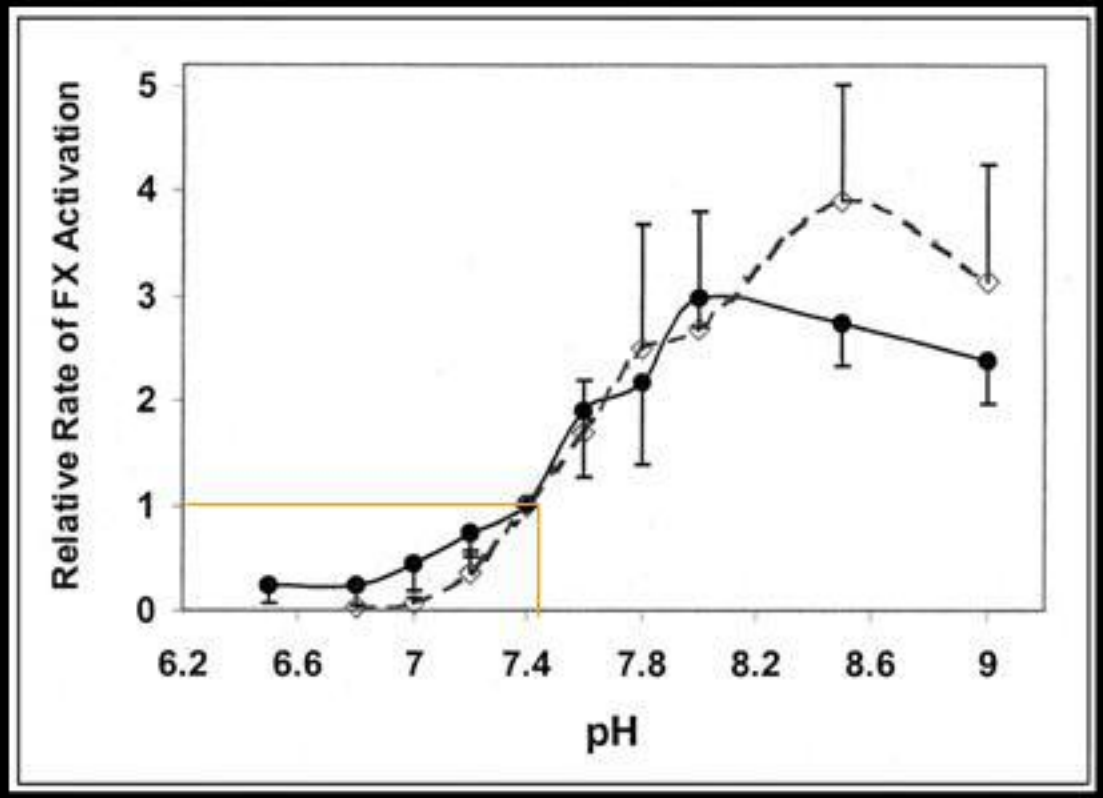


Will rFVIIa work in cold trauma patients?

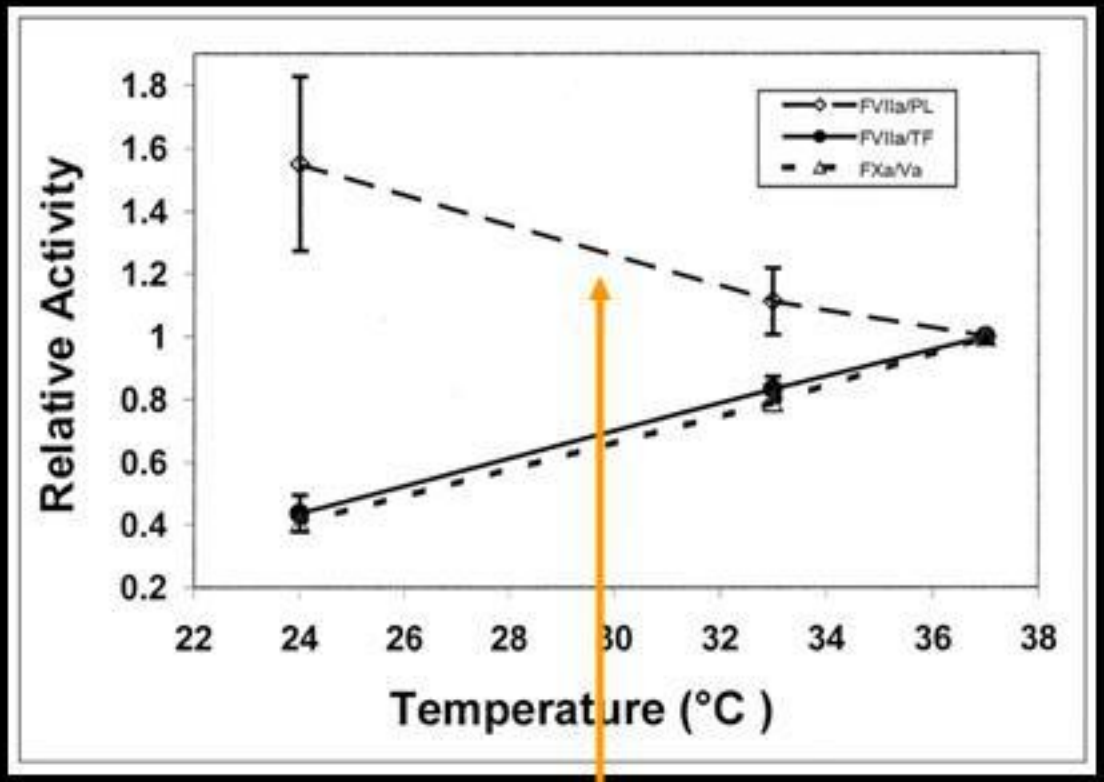
RECOMBINANT FACTOR VIIa



Decreasing the pH of the reactions decreased the rate of FXa formation by the FVIIa/TF complex.

Meng et al, J Trauma, Nov 2003

RECOMBINANT FACTOR VIIa



Rate of FX activation by rFVII was actually increased by falling temperature

Meng et al, J Trauma, Nov 2003

RECOMBINANT FACTOR VIIa

"RFVIIa should be effective in enhancing hemostasis in hypothermic patients… however.. its efficacy may be reduced in acidotic patients."

Meng et al, J Trauma, Nov 2003

HEMATOLOGIC EFFECTS of HYPOTHERMIA

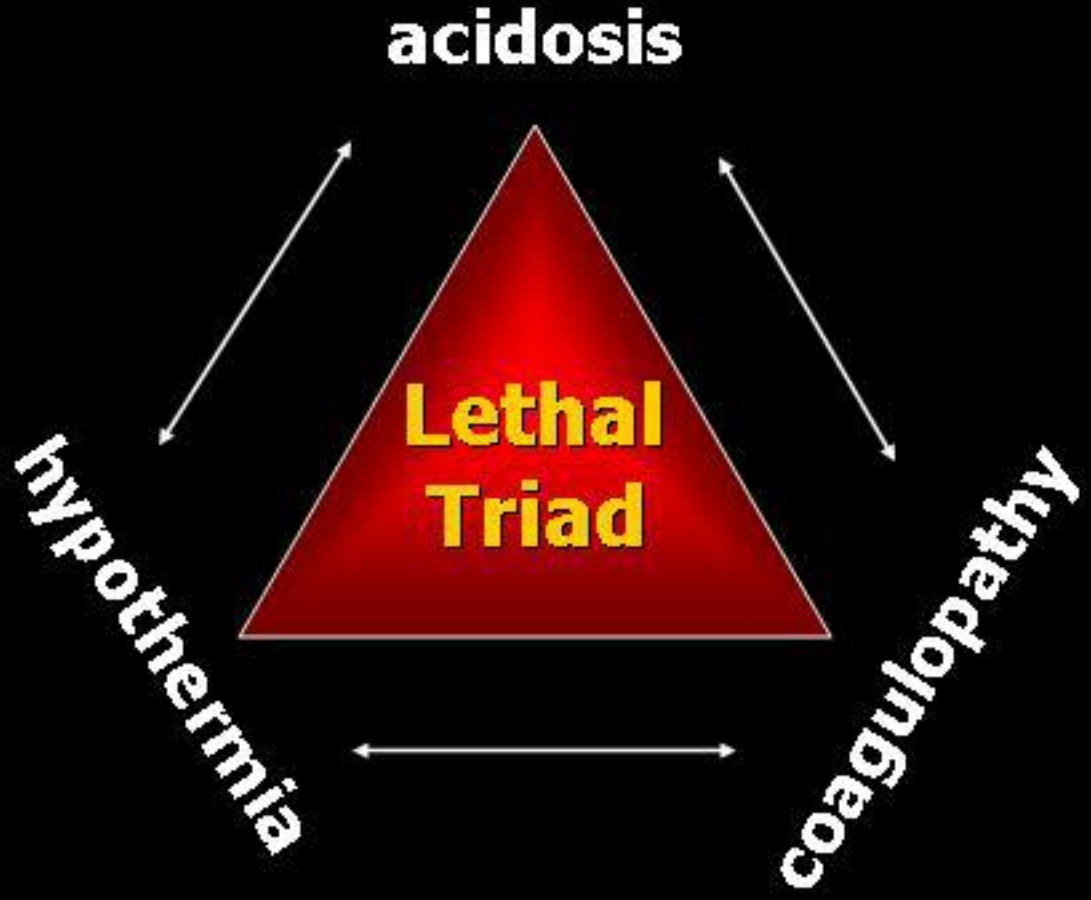
1. Increased blood viscosity
   - ⇩ microcirculatory flow
   - ⇩ O_2 delivery

   → tissue hypoxia

2. Hgb P_{50} : shift to left

3. Diminished clotting function
   - platelets
   - clotting factors

   → continued hemorrhage


acidosis
Lethal
Triad
hypothermia
coagulopathy

HYPOTHERMIA IN TRAUMA: PREDICTOR OF SURVIVAL?

ISS	CORE TEMP (C)	MORTALITY (%)
> 50	< 32	100
	32-33	40
	> 33	25
25-29	< 32	100
	> 32	3

Jurkovich GJ, et al
J. Trauma 27:1019,1987

PREVENTION

1. Avoid cold fluids
2. Avoid cold rooms
3. Avoid wet surfaces
4. Cover the patient
5. Treat shock well and quickly

PREVENTION

Minimize exposure heat loss

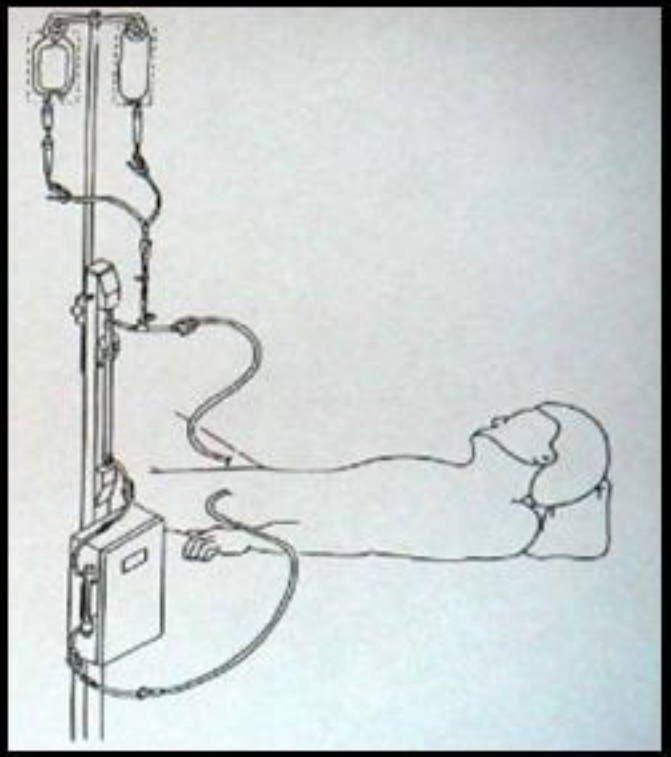
PREVENTION

Control Your Thermostat

REWARMING TECHNIQUES

ACTIVE CORE REWARMING

1. warm intravenous fluids
2. airway rewarming
3. warm peritoneal / pleural lavage
4. continuos arteriovenous rewarming
5. continuos venovenous rewarming
6. cardiopulmonary bypass



Standard Rewarming vs. CAVR

- Randomized, prospective
- 57 hypothermic patients
- 85% blunt trauma

CAVR

- Faster rewarming
- Less fluid requirements (24 vs. 32 L)
- Lower early mortality

But no overall mortality advantage or differences in complication rates

Gentilello, et al, J Trauma, 1997

REWARMING TECHNIQUES

Forced air convection blankets

aka: BAIR Hugger

IV Fluid warmers

HOW HOT is TOO HOT?

- Anaesthetized beagles cooled to 30 C and shocked to MAP of 40 mm Hg
- Ringer's Lact. Soln via central vein

60 °C vs. 40 °C

No difference in:

- RBC destruction (as measured by osmotic fragility or plasma free hb)
- endothelia cell damage

- Faster warming (3.6 °C / hr. vs. 1.9 °C / hr)

Hyperthermic crystalloid is safe and faster

Wiley, et al. J Trauma 2000


Thank you