

Is Hypothermia in Trauma Protective?

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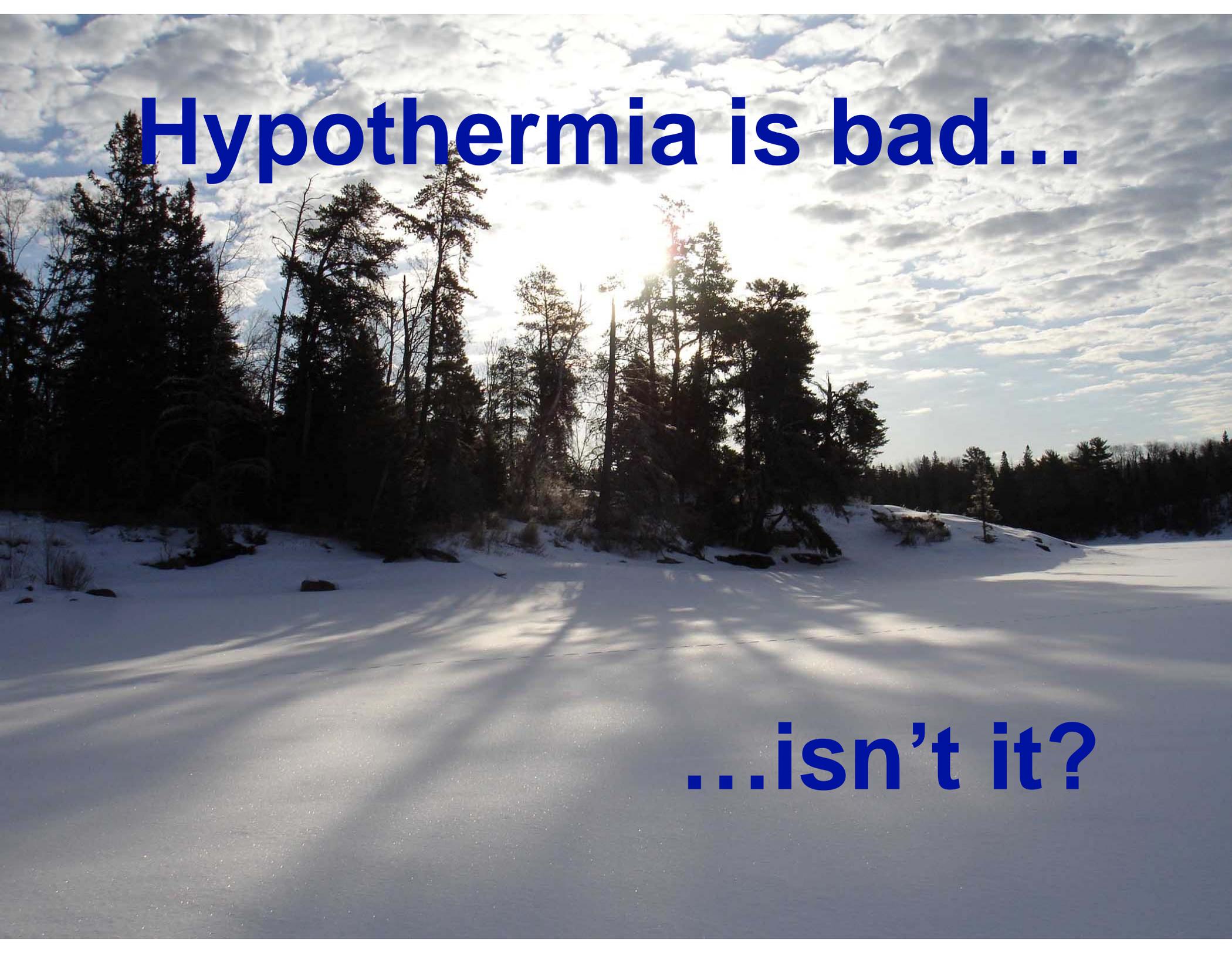
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North Memorial
Medical Center



A winter landscape with snow-covered ground, evergreen trees, and a bright sun shining through a cloudy sky. The sun is positioned in the upper center, creating a lens flare effect. The sky is filled with soft, white clouds. The trees are dark green and stand against the bright background. The snow is white and covers the entire foreground and middle ground.

Hypothermia is bad...

...isn't it?

Hypothermia

- Hypothermia is common in severely injured trauma patients (Jurkovich, J Trauma 1987, others)
- “Bloody vicious cycle” (Kashuk and Moore, J Trauma 1982)
- Hypothermia associated with increased mortality (Martin, Shock 2005)

Hypothermia

- Increasingly used to preserve cerebral function after cardiac arrest. (Hypothermia after Cardiac Arrest Study Group, NEJM, 2002)
- Some authors have proposed as a means to salvage exsanguinating trauma patients. (Wu, Circulation 2006, Alam, Surgery 2002)

QuickTime™ and a
decompressor
are needed to see this picture.

- Prospective, observational trial
- 7 Level I Trauma Centers
- Trauma Patients in Shock (BD>5, SBP<90) and requiring blood transfusion

Annals of Surgery, May 2009



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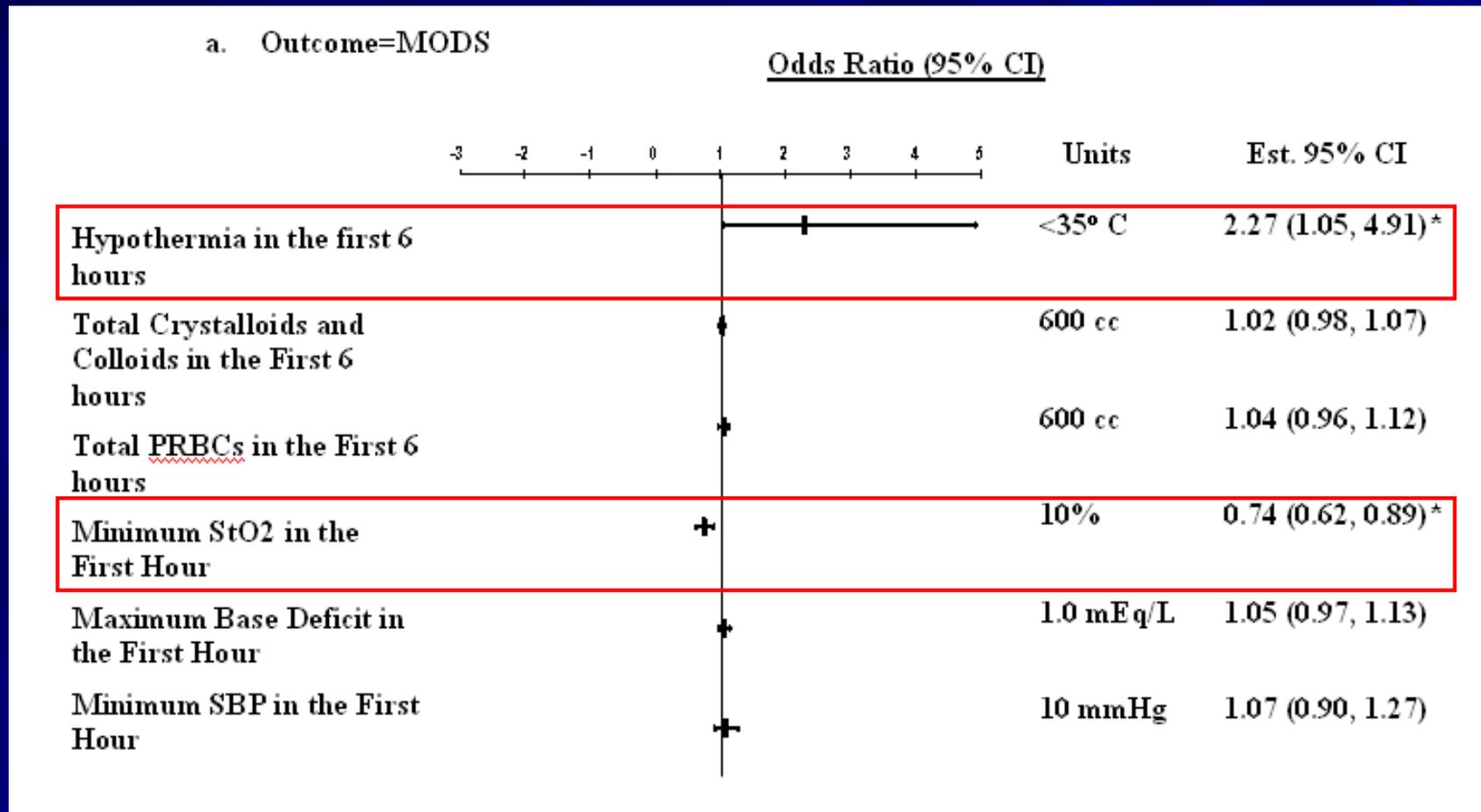
Demographic and experimental variables in patients with and without hypothermia

Mean ± SD (Median) Min – Max	Patients with Hypothermia in the First 6 hours (N=155)	Patients without Hypothermia in the First 6 hours (N=204)	p-value*
Age	39 ± 17 (35) 18 – 89	39 ± 17 (36) 18 – 89	0.9117
Gender (% Male)	72%	73%	0.8119
ISS	30 ± 16 (29) 4 – 75	26 ± 14 (26) 1 – 75 N=203	0.0133
Total PRBCs (mL) in first 6 hours	3281 ± 4242 (2100) 0 – 30900	1543 ± 2094 (734) 0 – 13200	<0.0001
Total Crystalloids and Colloids in first 6 hours	8366 ± 4479 (7500) 940 - 28700	6268 ± 4634 (5632) 160 - 42000	<0.0001
ICU Free Days (median)	18 days, N=152	23 days	0.0001
Hospital Free Days (median)	3.5 days, N=152	12.5 days	0.0002
Mortality	25/152 (16%)	25/204 (12%)	0.2826
Multiple Organ Failure	28/134 (21%)	17/187 (9%)	0.0033

N is only reported when different from the header in the table.

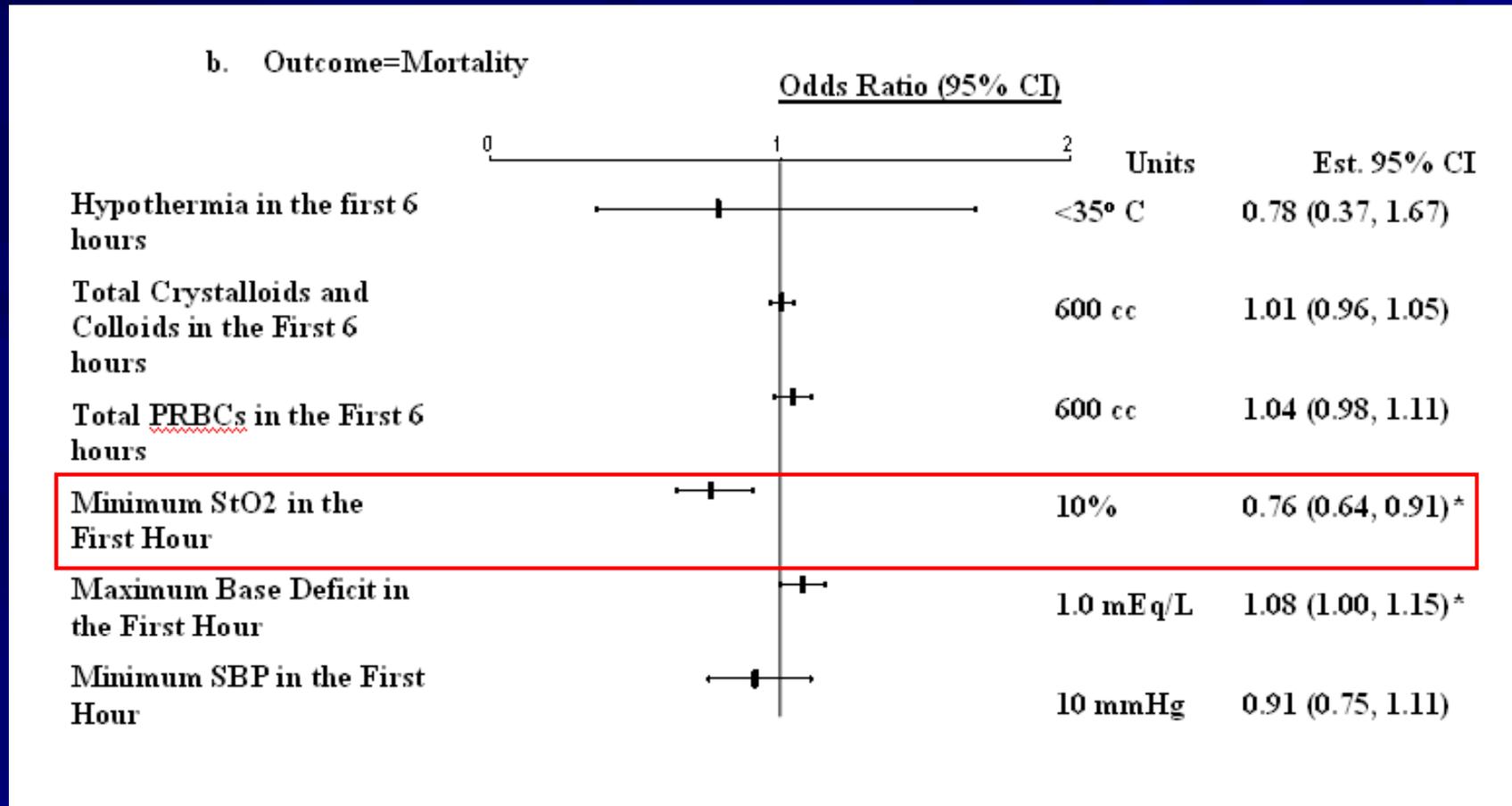
*Wilcoxon Two Sample Test or Fisher's Exact Test.

MODS risk related to various risk factors



* $p < 0.05$. Calculations of odds ratios based on following changes within risk groups: Crystalloids and blood: 600 cc, Minimum StO₂:10%, Maximum base deficit: 1mEq, Minimum SBP 10 mm Hg. Crystalloid and colloid infusion not significant when included in model (MODS $p=0.30$, mortality $p=0.94$).

Mortality risk related to various risk factors



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Conclusions

- Hypothermia is common in severely injured trauma patients, occurring irrespective of environmental factors
- Hypothermia is a risk factor for MODS but not mortality



Induced Hypothermia Reduces Mortality in a Porcine Model of Hemorrhagic Shock

Mark George, Kristine Mulier, Greg Beilman

AAST 2007, Surgical Forum 2007,
J Trauma, in press

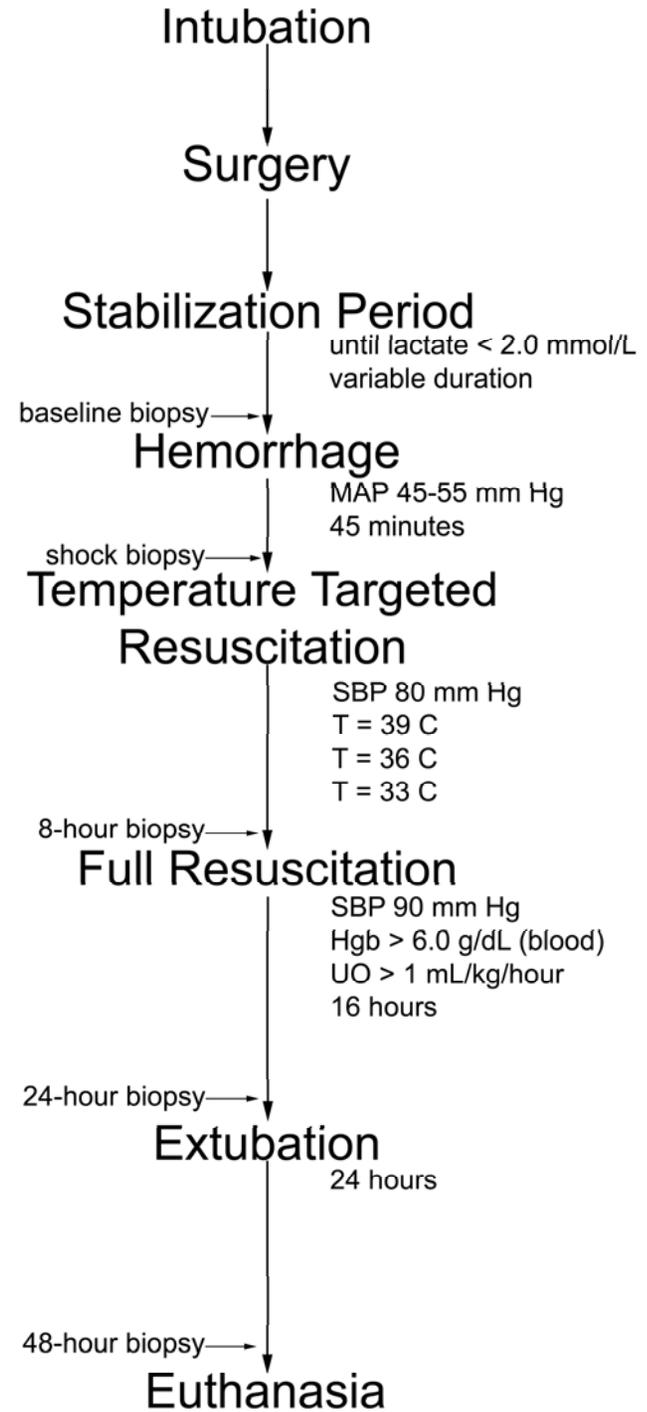


Clinical Question

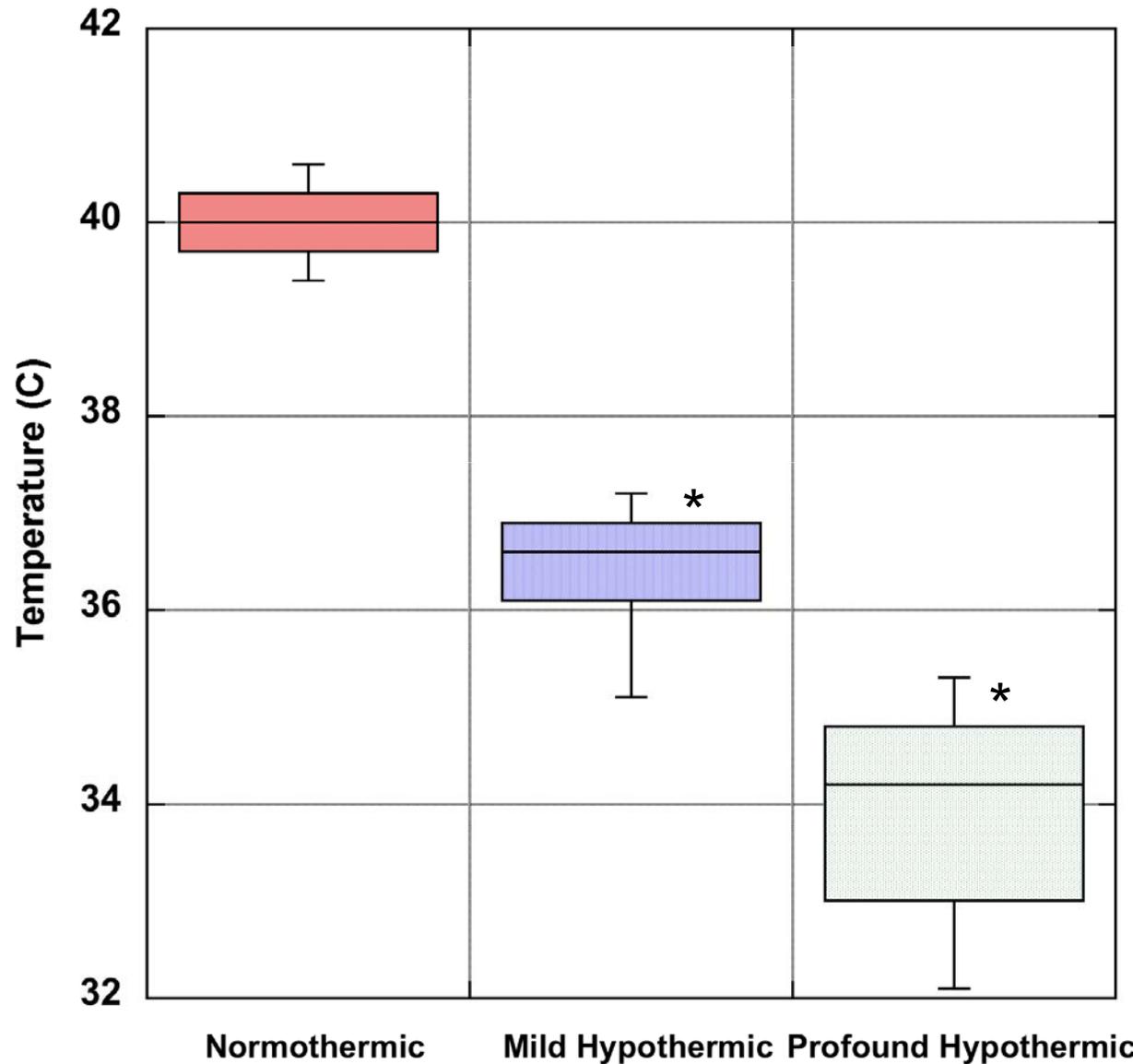
- How aggressive must rewarming efforts be in the field to prevent consequences of hypothermia?

Hypothesis

- Hypothermia is associated with increased mortality in a porcine model of hemorrhagic shock mimicking prolonged evacuation times



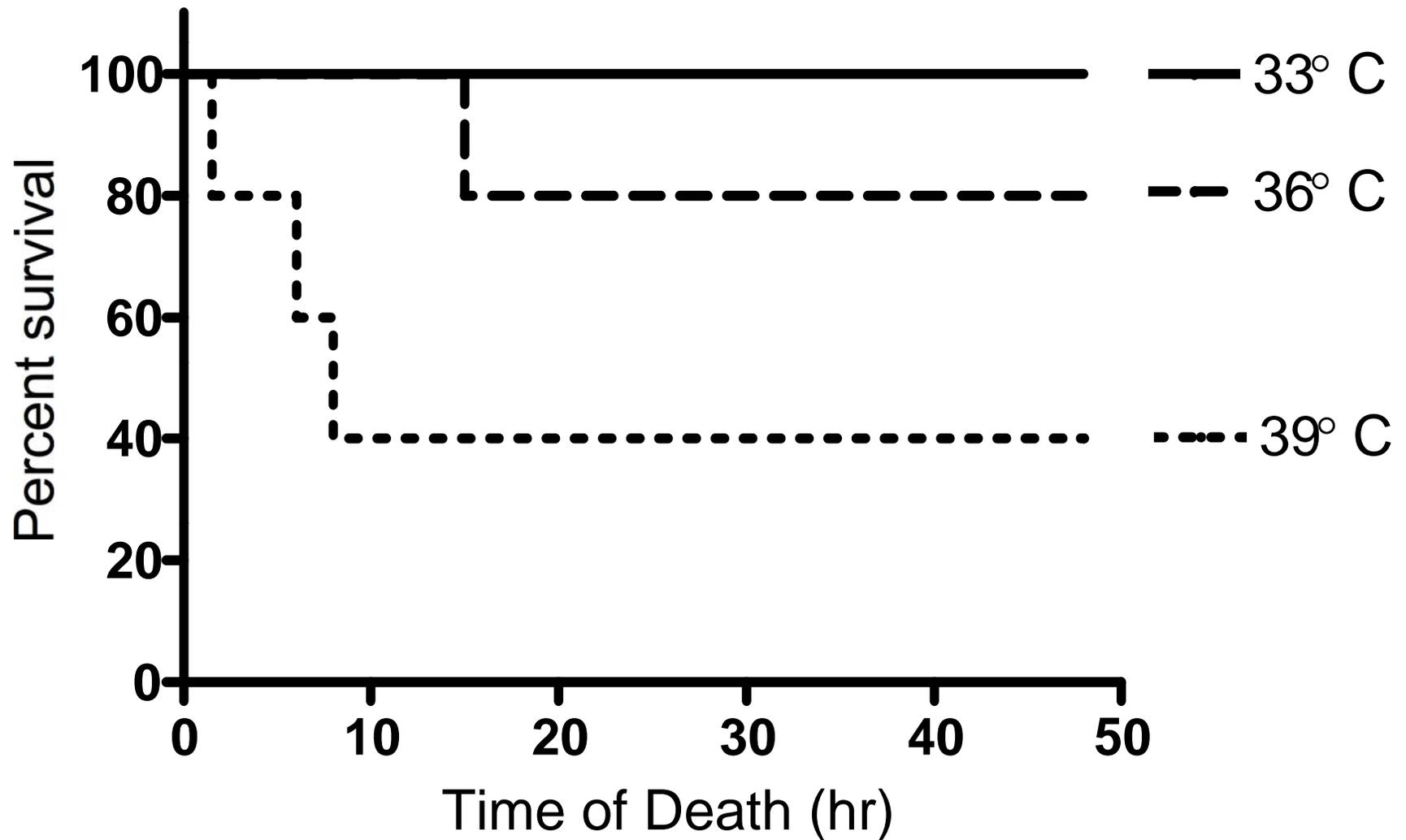
Temperature 8 hours post resuscitation



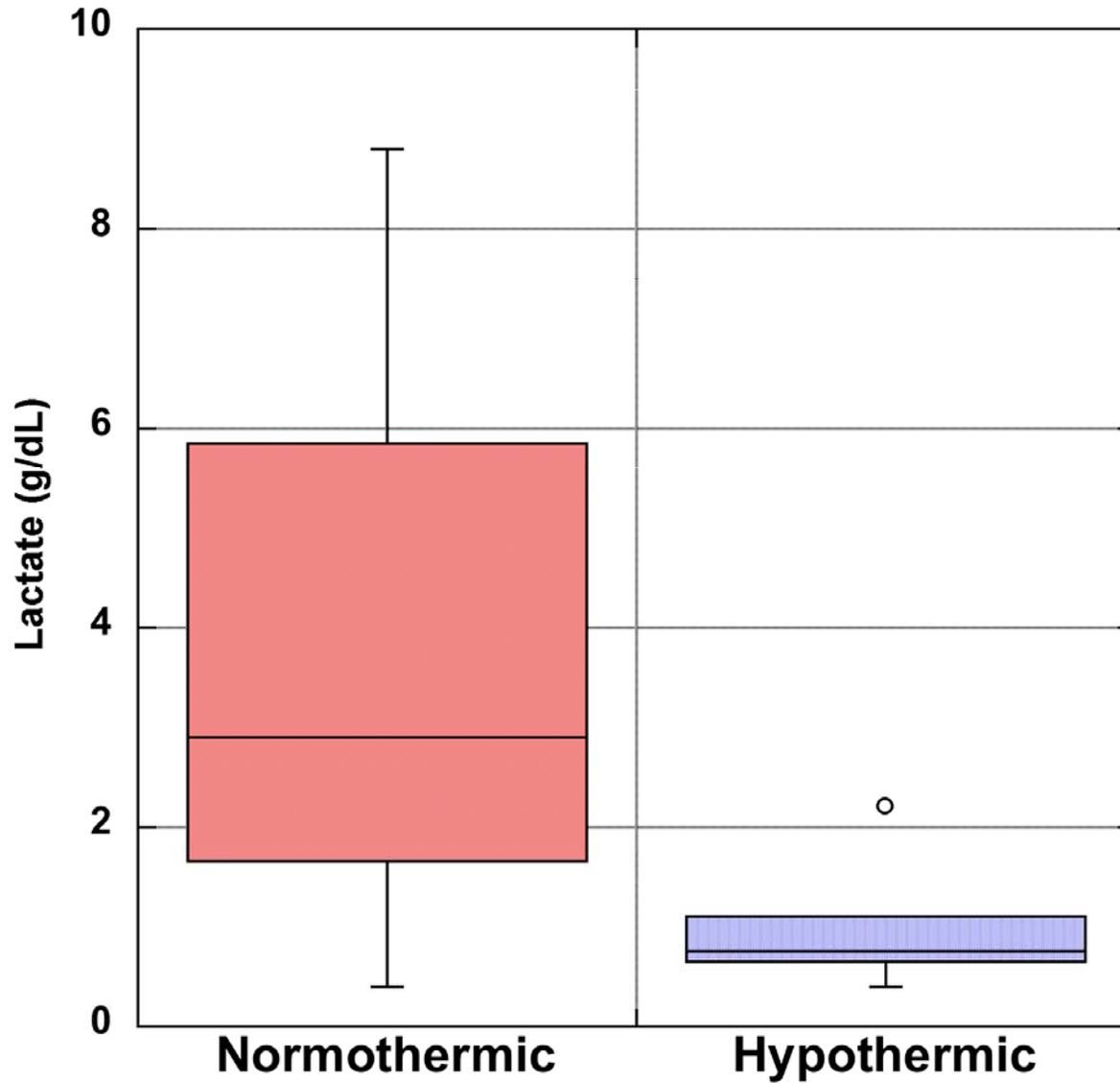
P<0.05 compared to normothermic animals, n=5 in each group

George, et al, AAST 2007

Hypothermic Resuscitation Survival

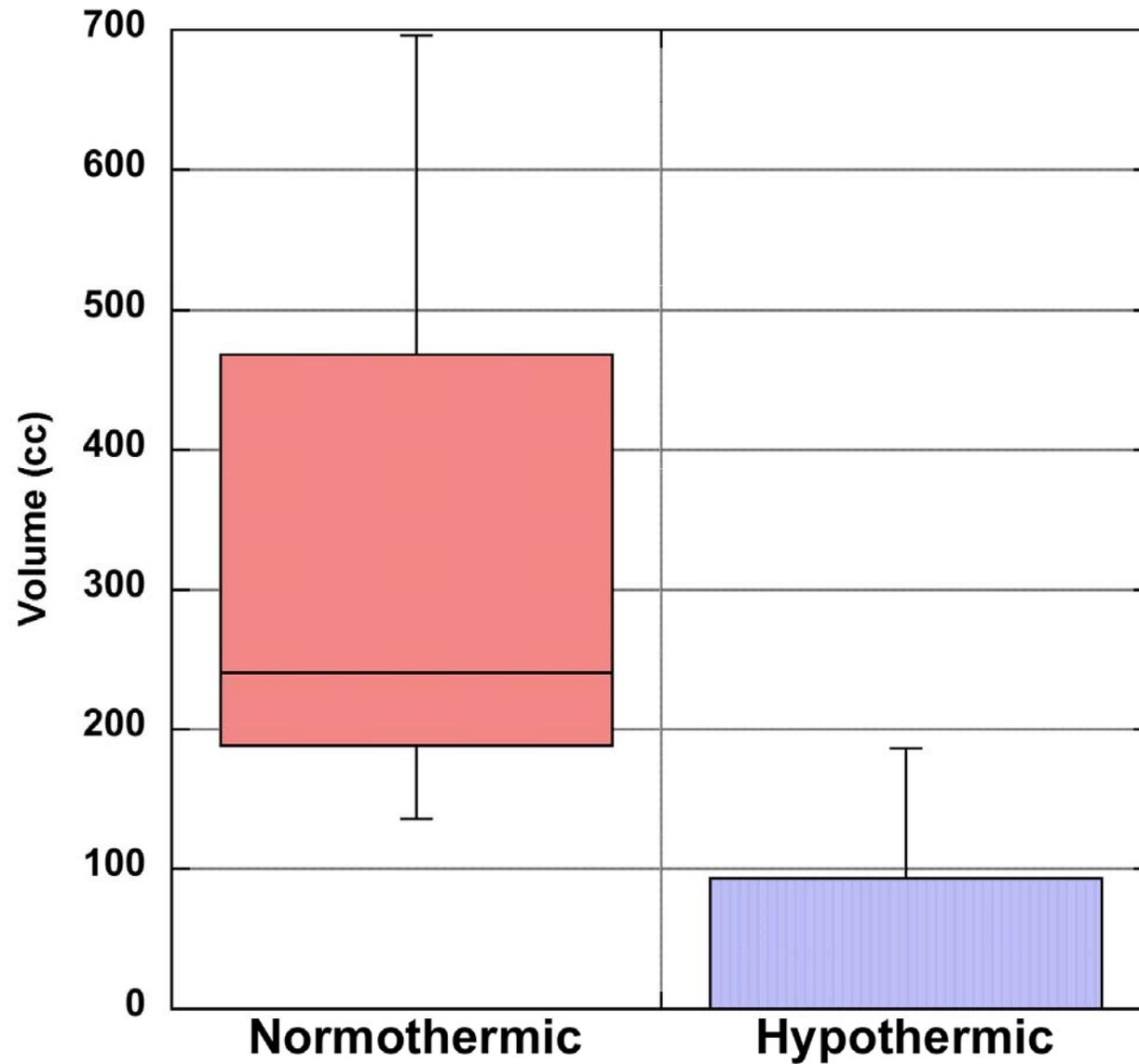


Lactate 48 hours post resuscitation



P<0.05 compared to normothermic animals

Total crystalloid infused



P<0.05 compared to normothermic animals

Conclusions

- Hypothermia immediately after injury resulted in lower mortality rates, with lowest rates in the profoundly hypothermic group of animals.
- Induced hypothermia was associated with lower resuscitation fluid requirements and lactate levels after hemorrhagic shock.

Caveats!!

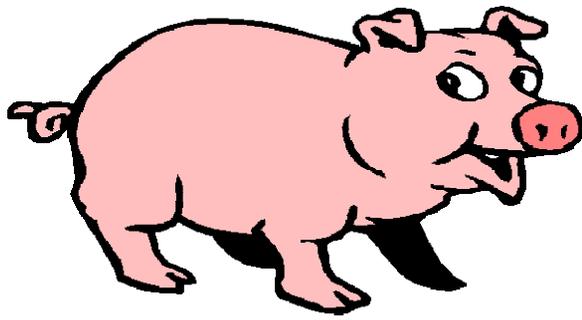
- Induction of coagulopathy in pigs
- Controlled model of hemorrhage
- Prolonged hypotensive resuscitation not congruent with current civilian practice.
- TBI



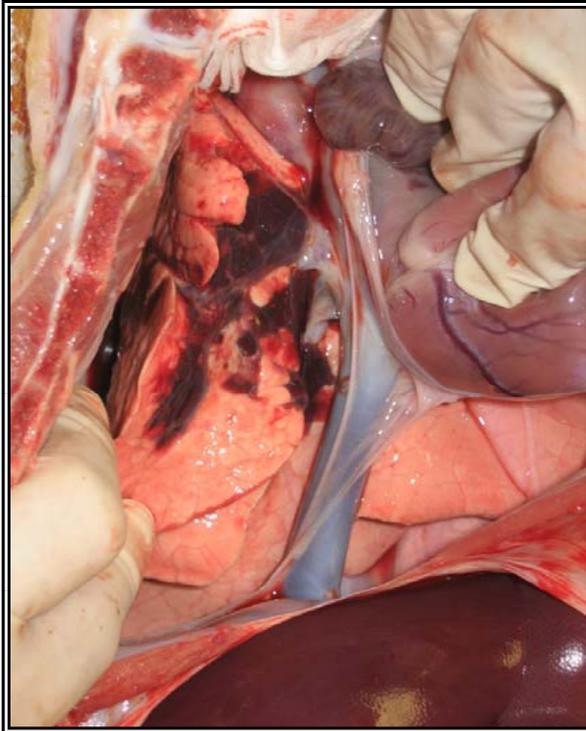
Polytrauma Model

- What are the effects of hypothermia in the setting of polytrauma and a resuscitation strategy more closely mimicking current practice?





Anesthesia, Surgical
Prep, Instrumentation,
Lactate < 2



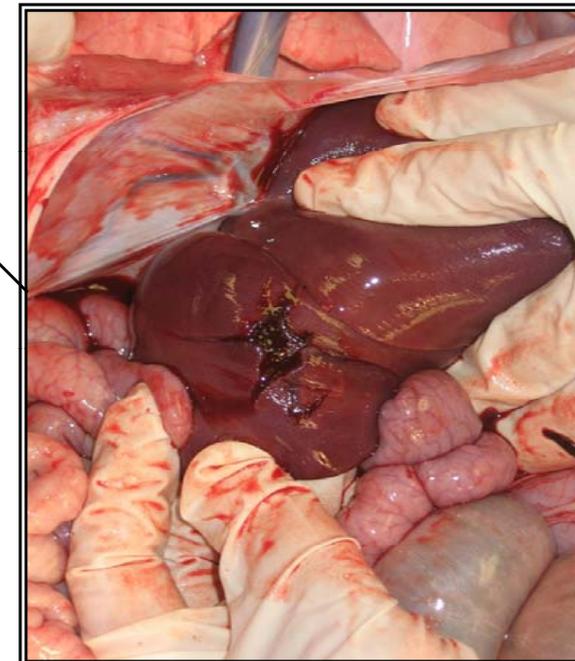
Pulmonary Contusion
(captive bolt gun)

Controlled Hemorrhage
SBP 50 for 1 hour

Liver Fx
"Holcomb" clamp

Randomize:
normothermic vs hypothermic

Limited Resus
1 hour: SBP 80
Temp targets (39° vs 34°C)



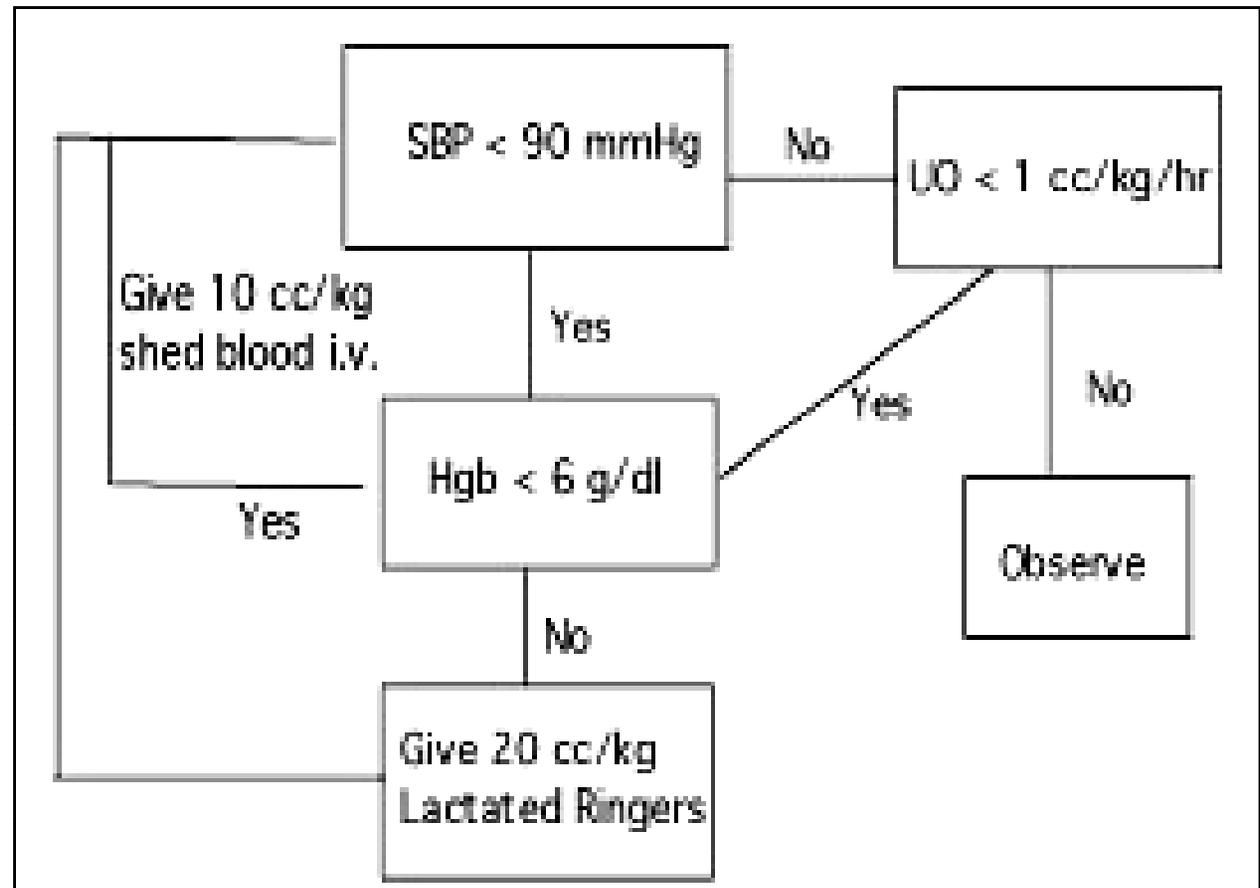
Endpoints:

Standard physiologic measures
Blood gasses, lactate,
Organ injury measures
Vet GCS

Full Resus
SBP 90
Temp target (39°)

Resuscitation

First 24 hours



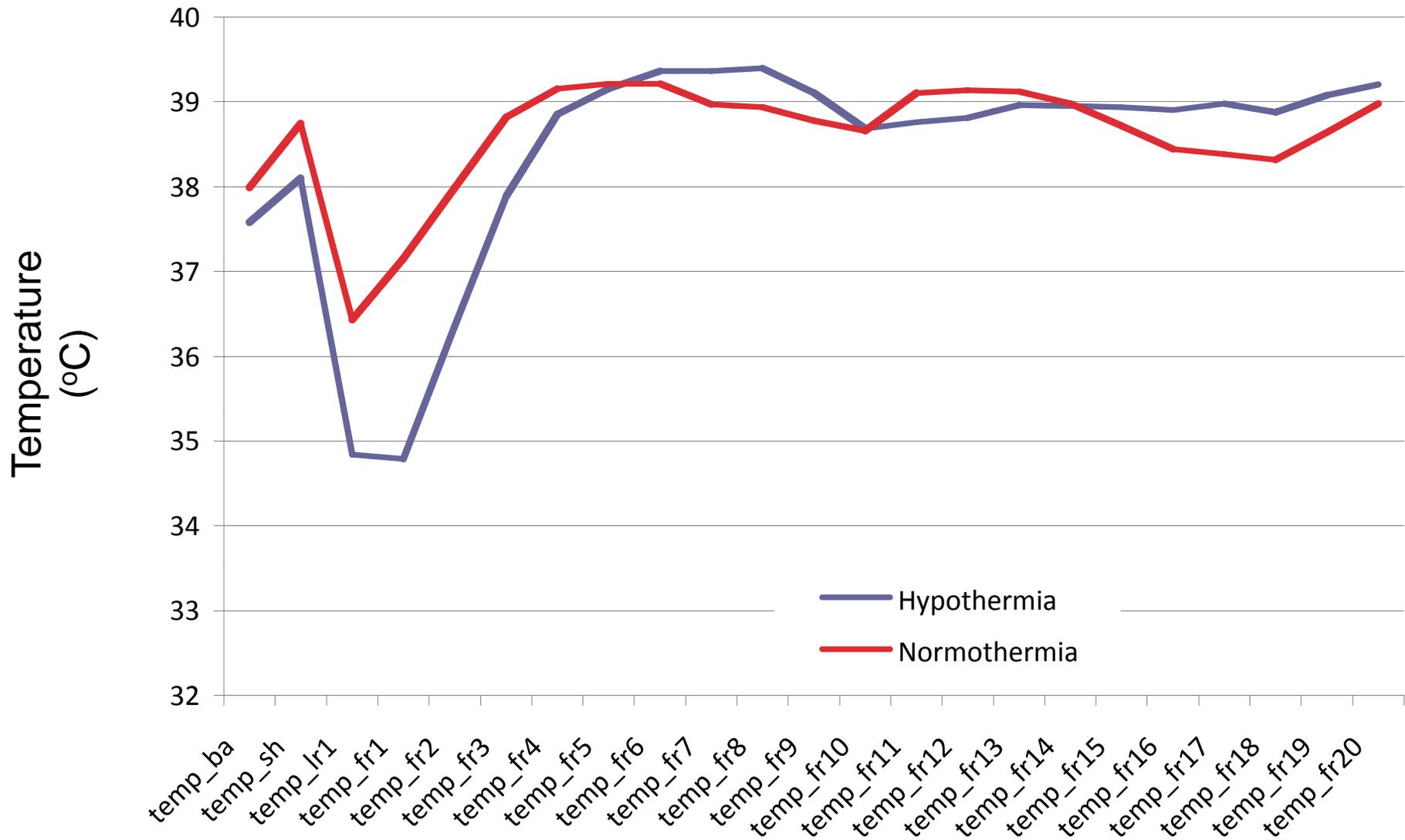
Second 24 hours: extubated, observed



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Core Temperature



Mortality

18 animals



Died prior to randomization

(n=2)



Mortality

Normothermic

2/8

Hypothermic

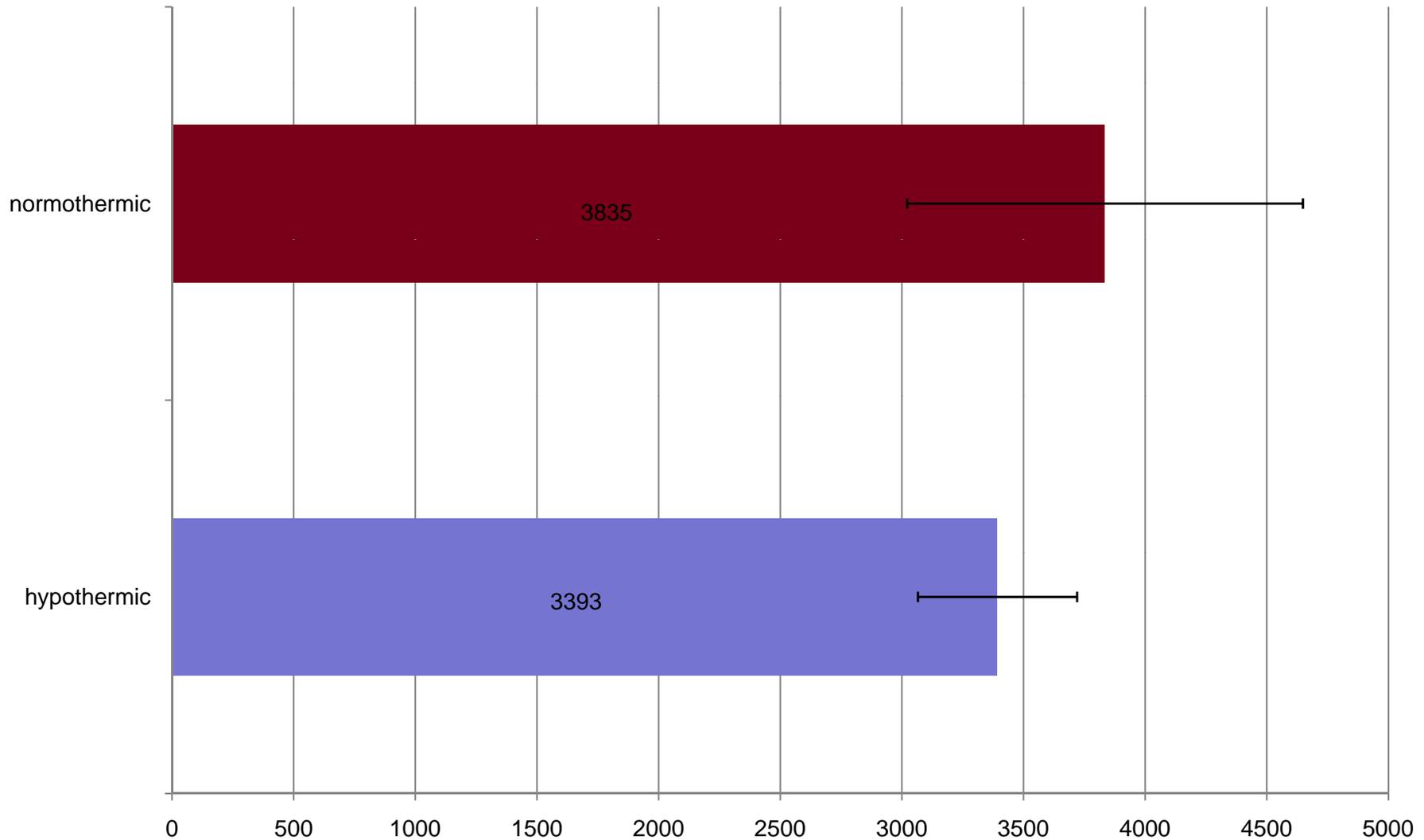
1/8



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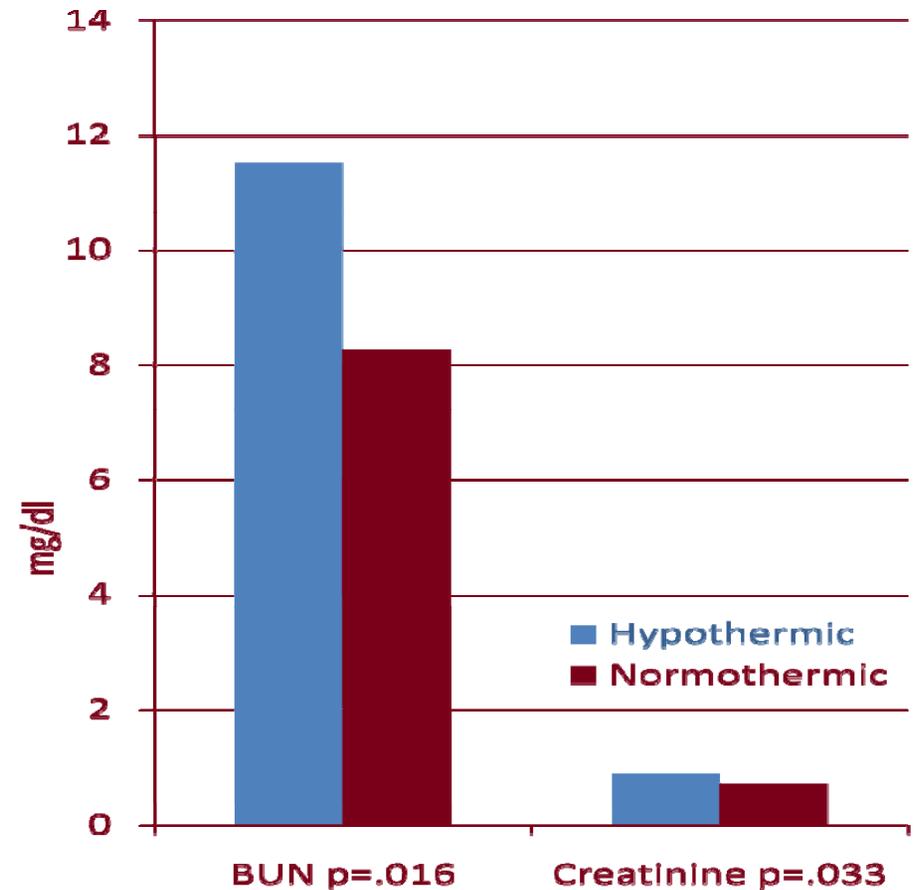
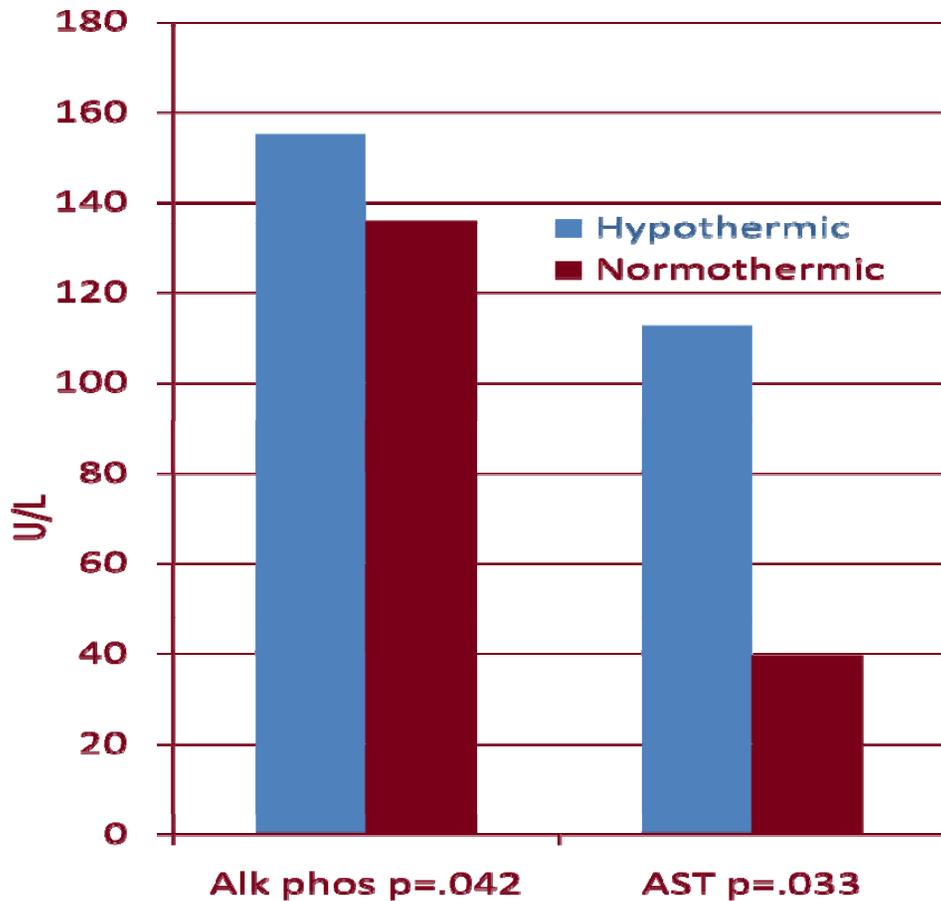
Resuscitation Fluid (1st 24 hours)



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Markers of Organ Injury



24 hours post-shock



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No Differences

- SBP
- Urine Output
- Cardiac Index
- $DO_2/VO_2/O_2ER$
- pH/lactate/BD
- Intraperitoneal blood loss
- Bilirubin
- Albumin
- Creatine kinase
- Cr clearance
- IL-6
- Vet GCS



Differences

- StO₂ (lower in hypothermia)
- Heart rate (higher in hypothermia)
- Hemoglobin (lower in hypothermia)
- Platelets (lower in hypothermia)



Conclusions

- In this model of polytrauma and uncontrolled hemorrhagic shock, moderate hypothermia was safe.



Issues

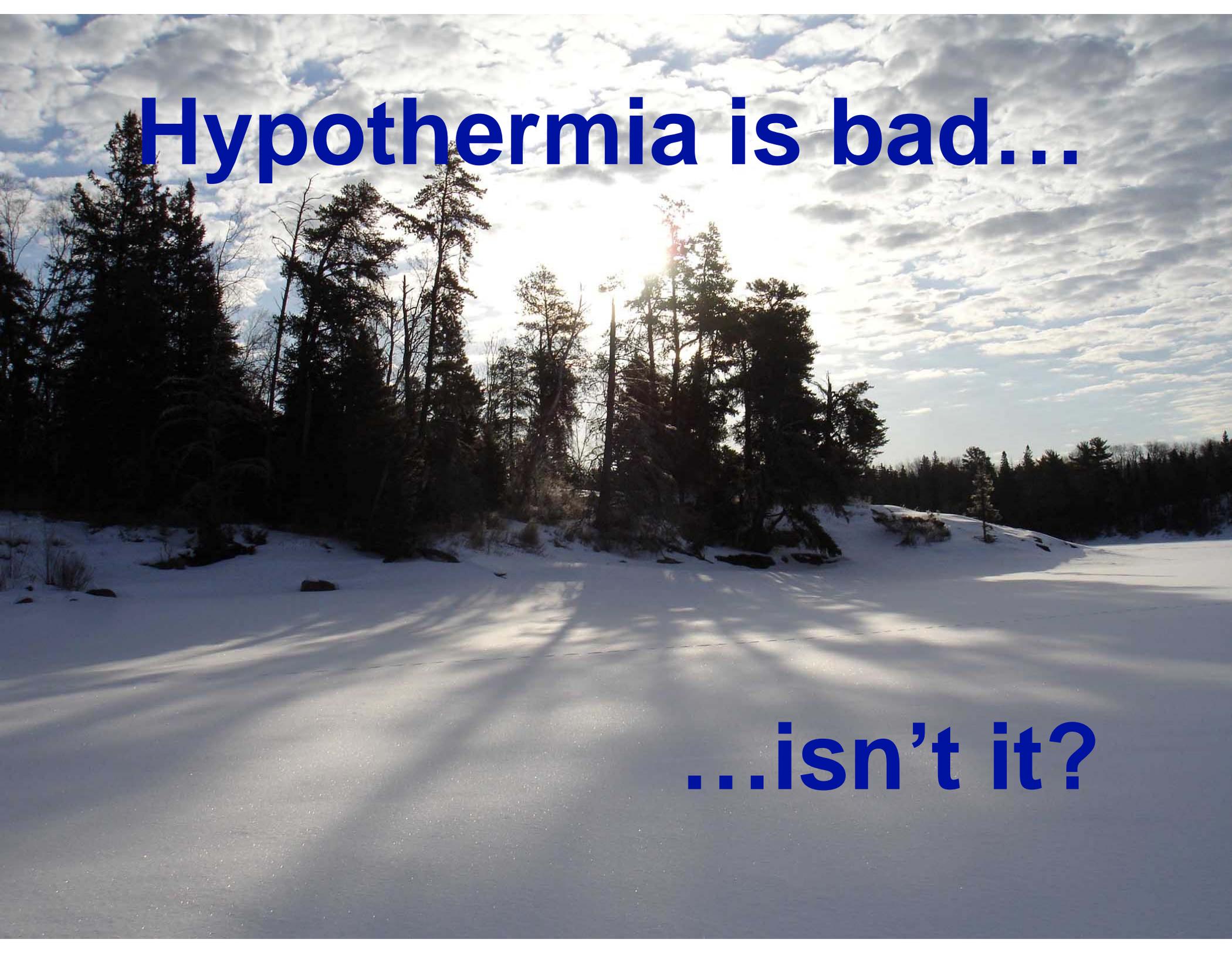
- Underpowered
- Lower than expected mortality



Hypothermia: Two Circumstances

- Environmental: Hypothermia is induced, beneficial effects of slowing of metabolism, biochemical effects
- Shock-induced: Results from metabolic failure, associated with acidosis, coagulopathy



A winter landscape with snow-covered ground, evergreen trees, and a bright sun shining through a cloudy sky. The sun is positioned in the upper center, creating a lens flare effect. The sky is filled with soft, white clouds. The trees are dark green and stand against the bright background. The snow is white and covers the entire foreground and middle ground.

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