

*Wissenschaftliches Programm IGIP - 2. Hauptthema
Grad-Wanderungen auf der Intensivstation
Von der malignen Hyperthermie zur therapeutischen Hypothermie*

*Programme scientifique CISI - 2ème thème principal
Variations de température dans les services de soins intensifs
De l'hyperthermie maligne à l'hypothermie thérapeutique*

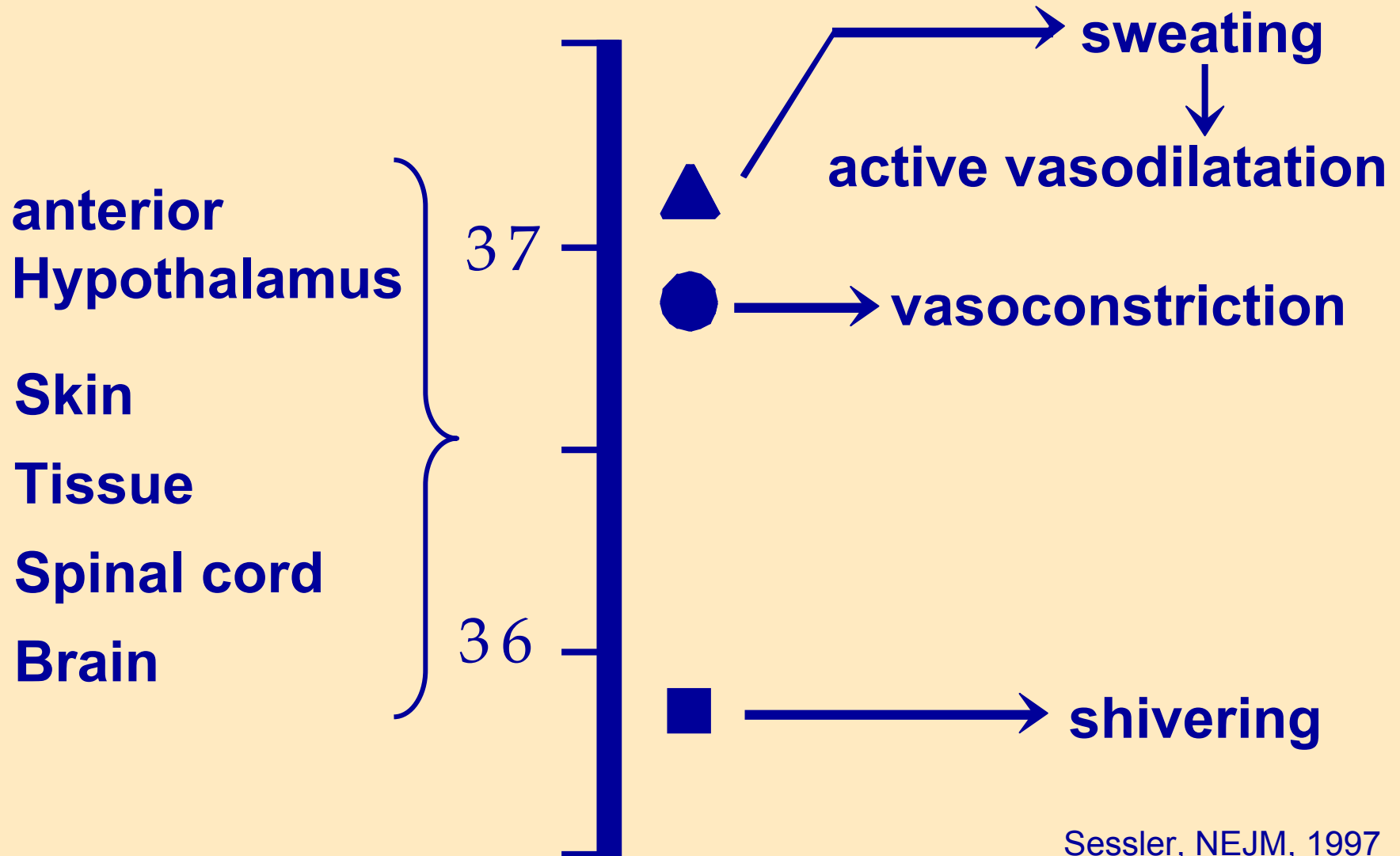


Die normale Temperaturregulation Physiologie de la thermorégulation

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Klinik und Poliklinik für Anästhesiologie und Schmerztherapie,
Inselspital, Universität Bern*

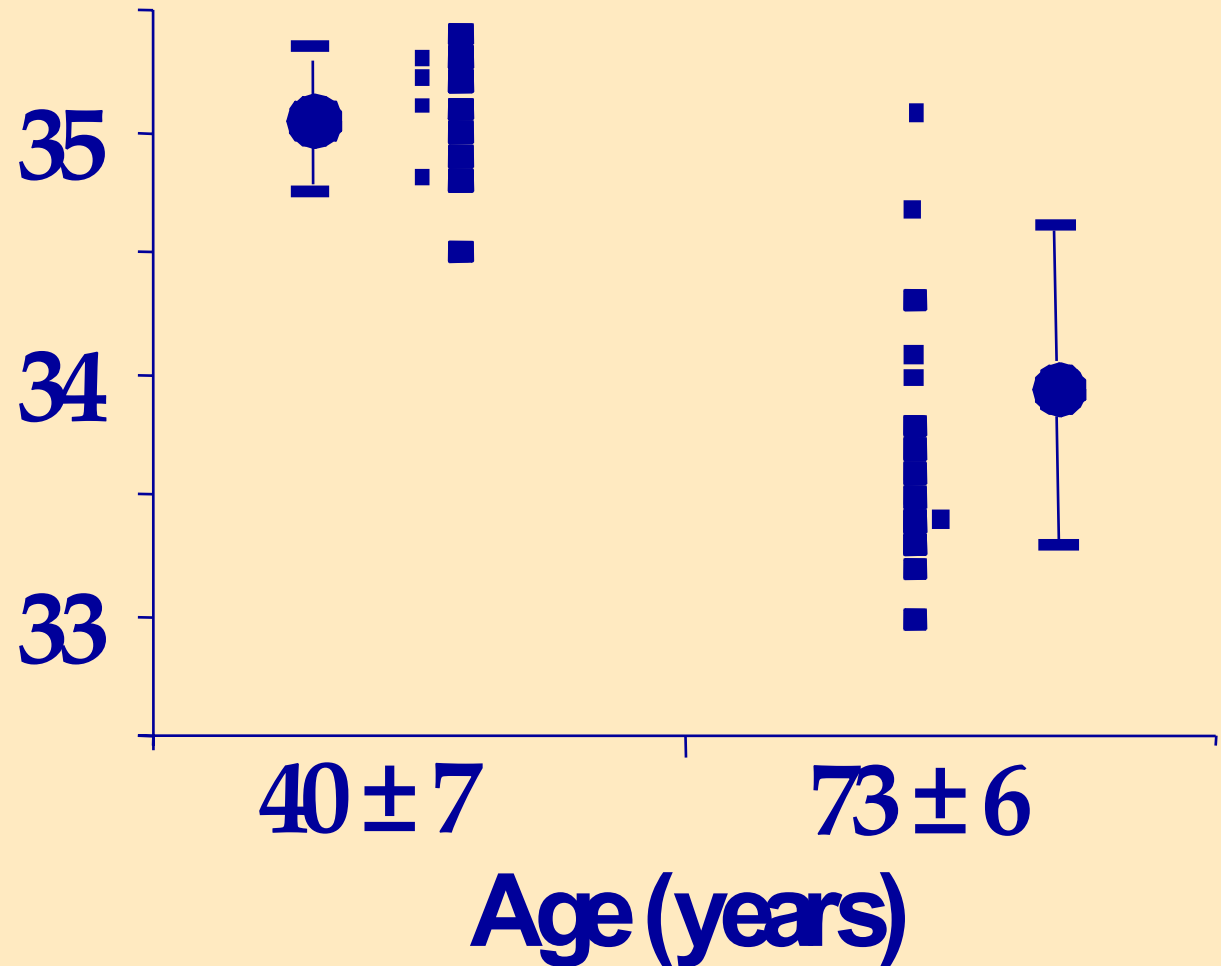
- **Relevance of Thermoregulation**
- **Effects of Hypothermia**
- **Consequences for your practice**





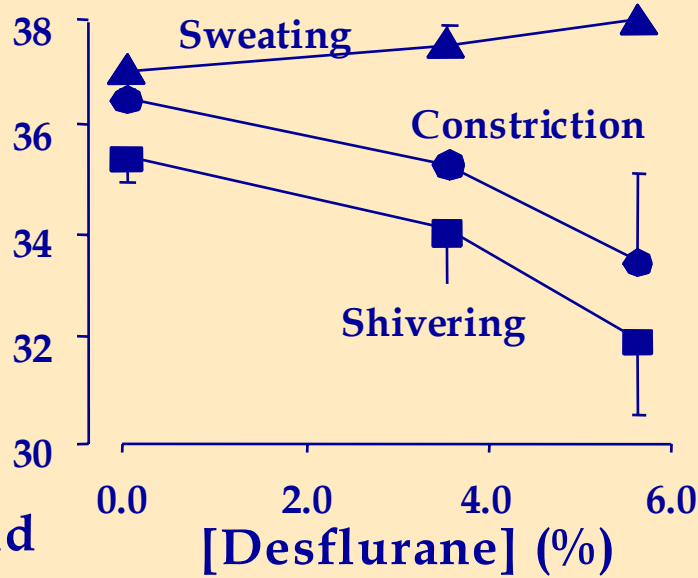
Sessler, NEJM, 1997

Threshold
(°C)

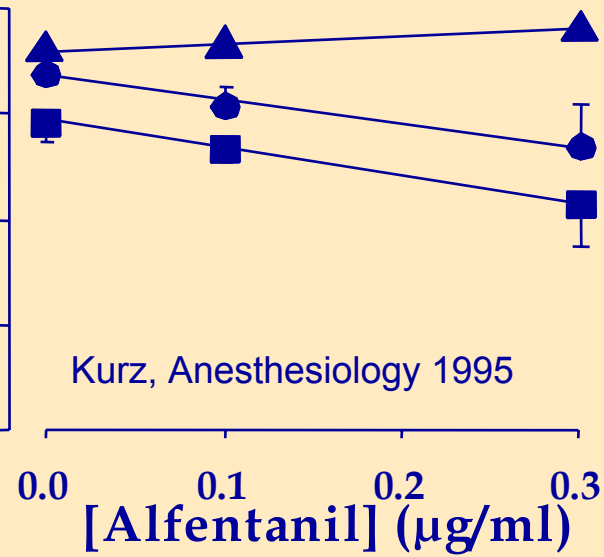


Kurz et al., Anesthesiology, 1993

Annadata
 Anesthesiology
 1995

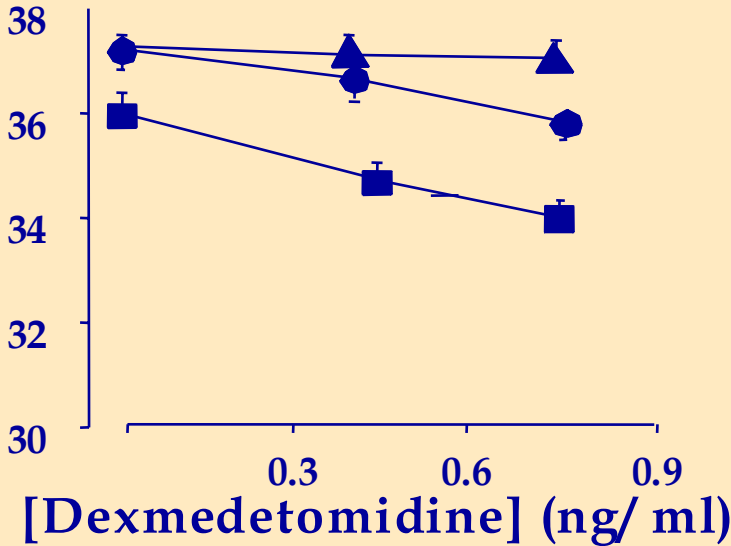


Kurz, Anesthesiology 1995

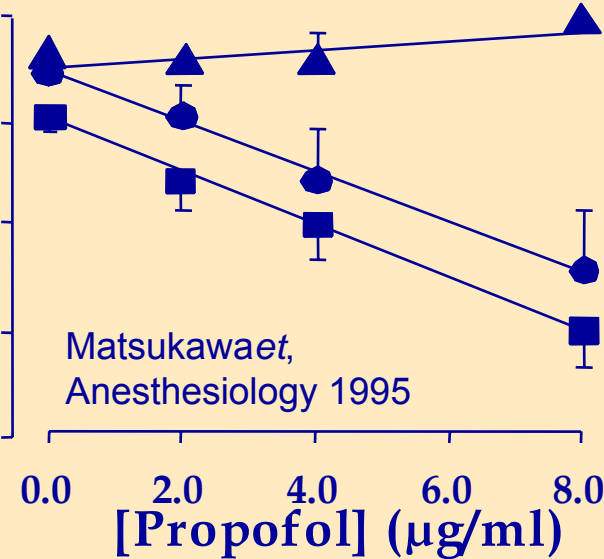


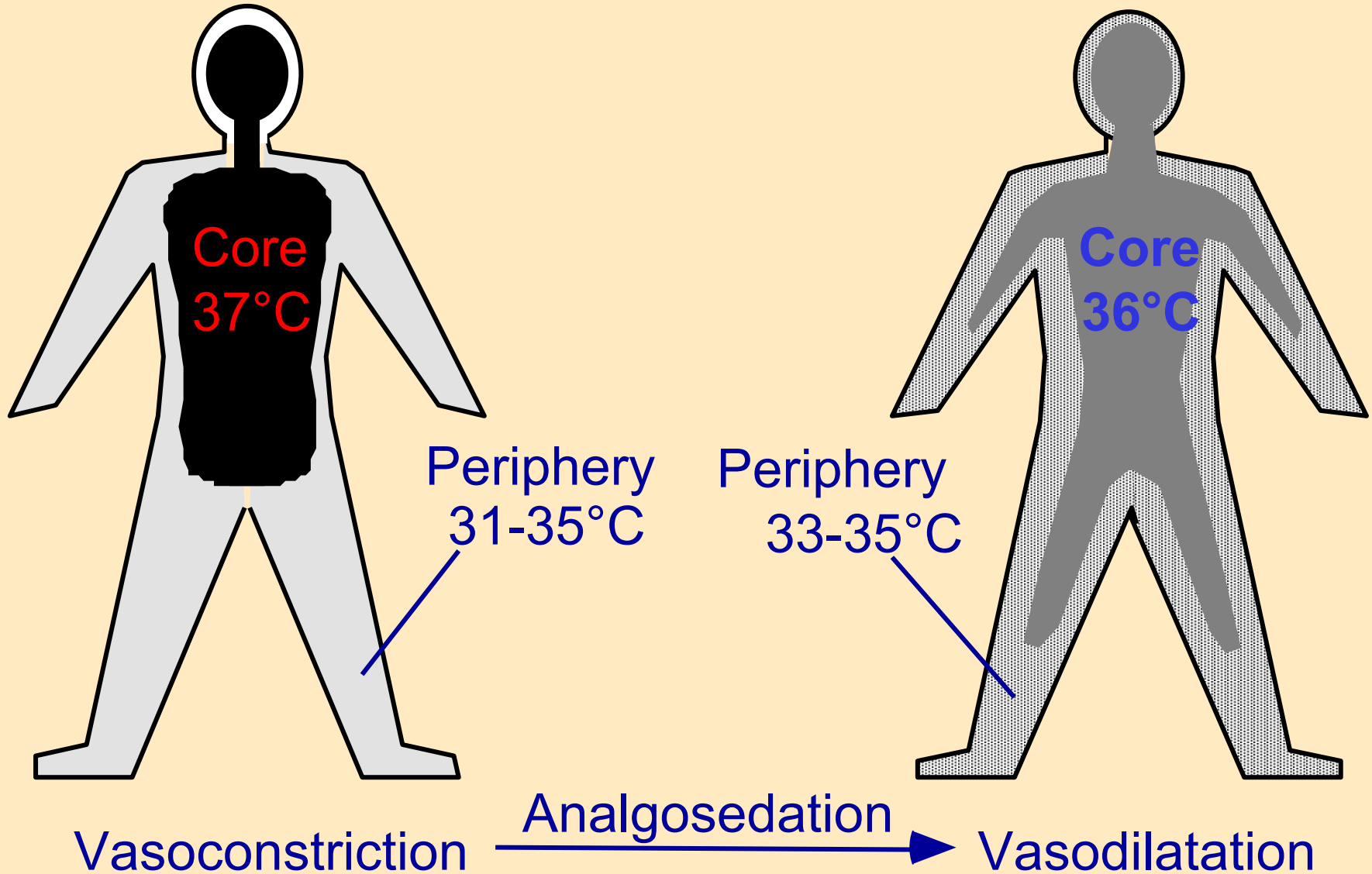
Threshold (°C)

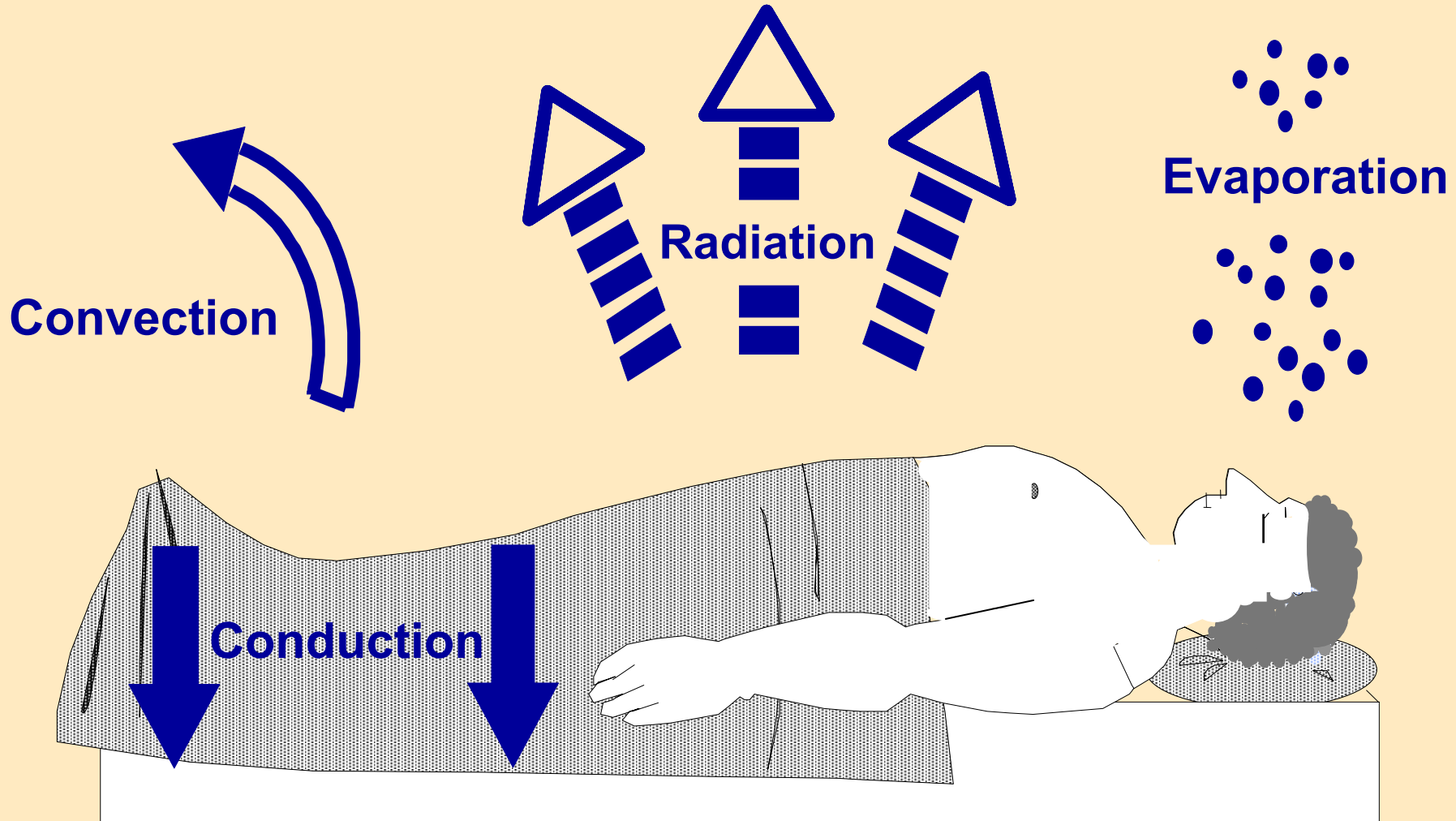
Talke
 Anesthesiology
 1997

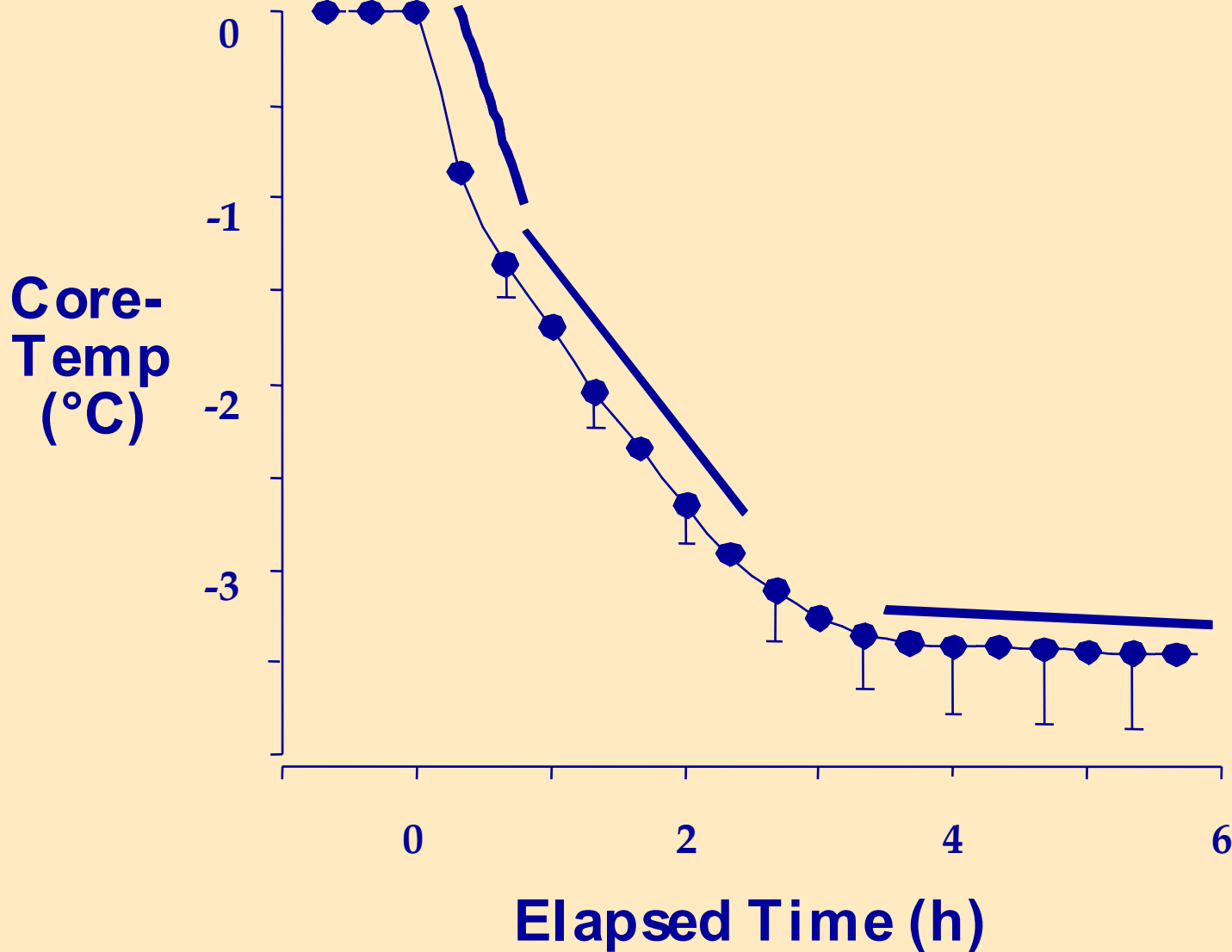


Matsukawa et,
 Anesthesiology 1995







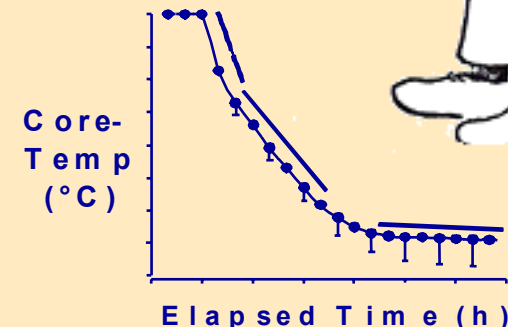


Central thermoregulatory inhibition

- Dose-dependent increase in interthreshold range
- More impairment of cold than warm responses

Ablauf der Hypothermie

1. Redistribution of heat (primary $\text{Temp}_{\text{core}} \downarrow$)
 2. loss > heat production (slow linear \downarrow)
 3. Core Temperature Plateau (Vasoconstriction again)
- cutaneous heat loss \downarrow ; thermal steady-state
 - Separation of core and peripheral compartments



Pathophysiology - Highlights

Effect of milde therapeutic Hypothermia

- **Neuroprotection**

Side effects of milde Hypothermia

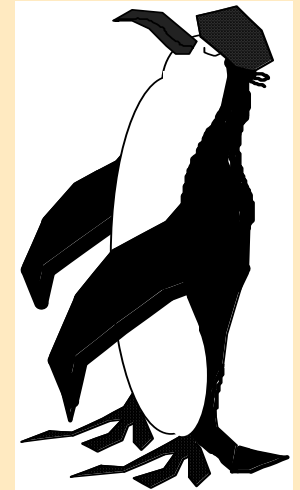
- **Cardic Events**

- **Coagulation**

- **Surgical Wound Infection**

- **Drug Metabolism**

- **Recovery - Patient Satisfaction**



Consequences for your practice

Global Hypoxemia – CPR with ROSC

- State of the Art - AHA, ERC
- 24-h, 33°C, as fast as possible
- CPR Ventricular Fibrillation ↑ Neuro Outcome

(HACA-Holzer + Bernard; NEJM 2002)

Traumatic Brain Injury (TBI)

- **Clifton, NEJM 2001:** 48-h, 33°C, 6-Mt. follow up: no Benefit (Mortality: 33°C-group 28% vs. 27%, P=0.79)
- **Polderman, ICM 2003:** Ultima Ratio ICP > 20 mmHg after Babuturate coma (good neuro-outcome: 16% vs. 10% controls, P<0.02)
- **4 Meta-Analyses TBI & Hypothermia**

- *Harris, Arch Neurol 2002;*
Hypothermia is not beneficial in the management of severe head injury, additional studies are needed.
- *Henderson WR, ICM 2003;*
Hypothermia in the management of TBI not strongly supported by the available evidence
- *McIntyre LA, JAMA 2003;*
Prolonged therapeutic hypothermia after TBI in adults. Evidence is not sufficient to recommend routine use of therapeutic hypothermia for TBI outside of research settings
- *Alderson P., Cochrane Review (Issue 3) 2004;*
No evidence that therapeutic hypothermia is beneficial to treat TBI, use is inappropriate outside of controlled trials

Global Hypoxemia – CPR with ROSC

- State of the Art - AHA, ERC
- CPR Ventricular Fibrillation ↑ Neuro Outcome
(HACA-Holzer + Bernard; NEJM 2002)

Traumatic Brain Injury

- **Clifton, NEJM 2001:** no Benefit
- **Polderman, ICM 2003:** Ultima Ratio
- **Meta-Analyses:** not recommended, only research

Neurosurgery :

- **Todd, NEJM 2005:** IHAST 2: 1000 patients SAB – Aneurysm-Surgery - no benefit

Mild Hypothermia (33-35°C)



Frank, JAMA 1997

n=300	Normothermic	Hypothermic	P
Temperature	36.7 ± 0.1	35.3 ± 0.1	<0.001
Morbid Cardiac Events (%)	2	7	=0.04
Ventricular Tachycardia (%)	3	8	=0.03

- Three-fold increase in norepinephrine during hypothermia
- No correlation between ischemia and shivering

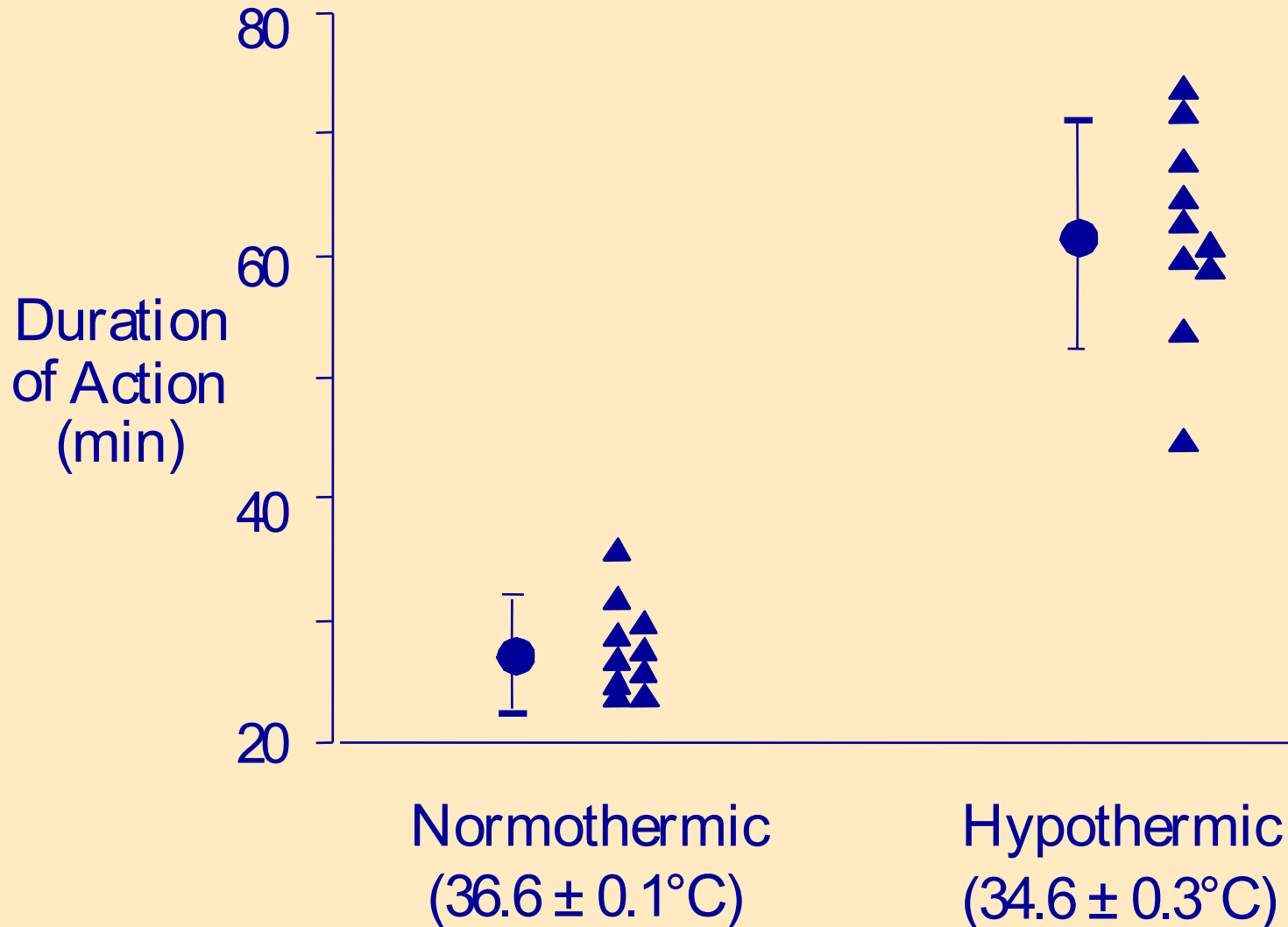
n=60, Hip-TEP	Normothermic	Hypothermic	P
Temperature	36.6 ± 0.4	35.0 ± 0.5	<0.001
Blood Loss (L)	1.7 ± 0.4	2.2 ± 0.6	<0.001
Allogeneic Blood (ml/ pt)	10 ± 55	80 ± 154	=0.02

Kurz NEJM 1996

n=200	Normothermic	Hypothermic	P
Temperature	36.6 ± 0.5	34.7 ± 0.6	<0.001
Infections (%)	6	19	<0.01
Hospitalization (days)	12.1 ± 4.4	14.7 ± 6.5	=0.001

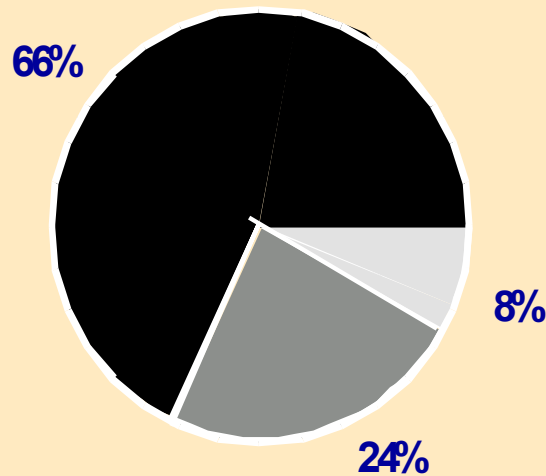
Drug-Action Vecuronium

Heiler, Anesthesiology 1991

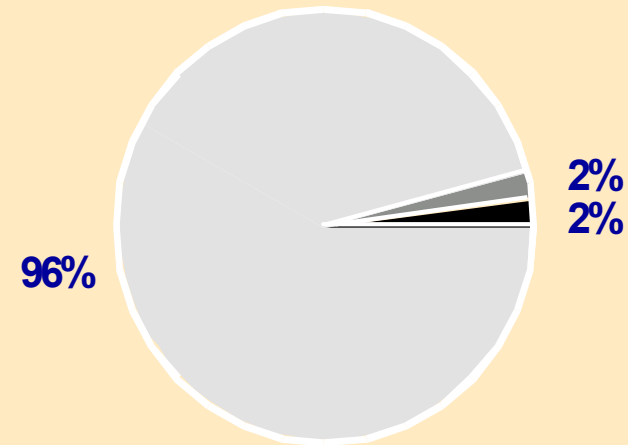


Kurz, J Clin Anesth 1995

Passive Warming



Resistive Heating



- Good or very good
- Satisfactory
- Barely acceptable or unacceptable

Benefits

- Protects against global cerebral ischemia – CPR
- No benefit TBI and Neurosurgery

Major complications

- Myocardial ischemia and ventricular tachycardia
- Bleeding and increased transfusion requirement
- Surgical wound infections

Management Strategy for Core Temperature



Pathophysiology - Highlights

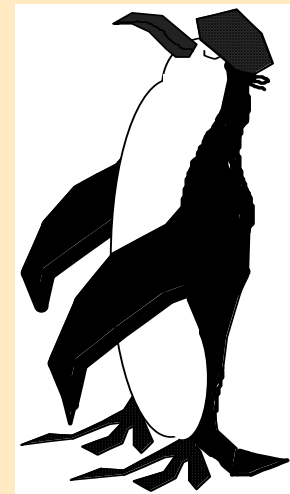
Effect of milde therapeutic Hypothermia

Consequences for your practice

Regulation of body temperature

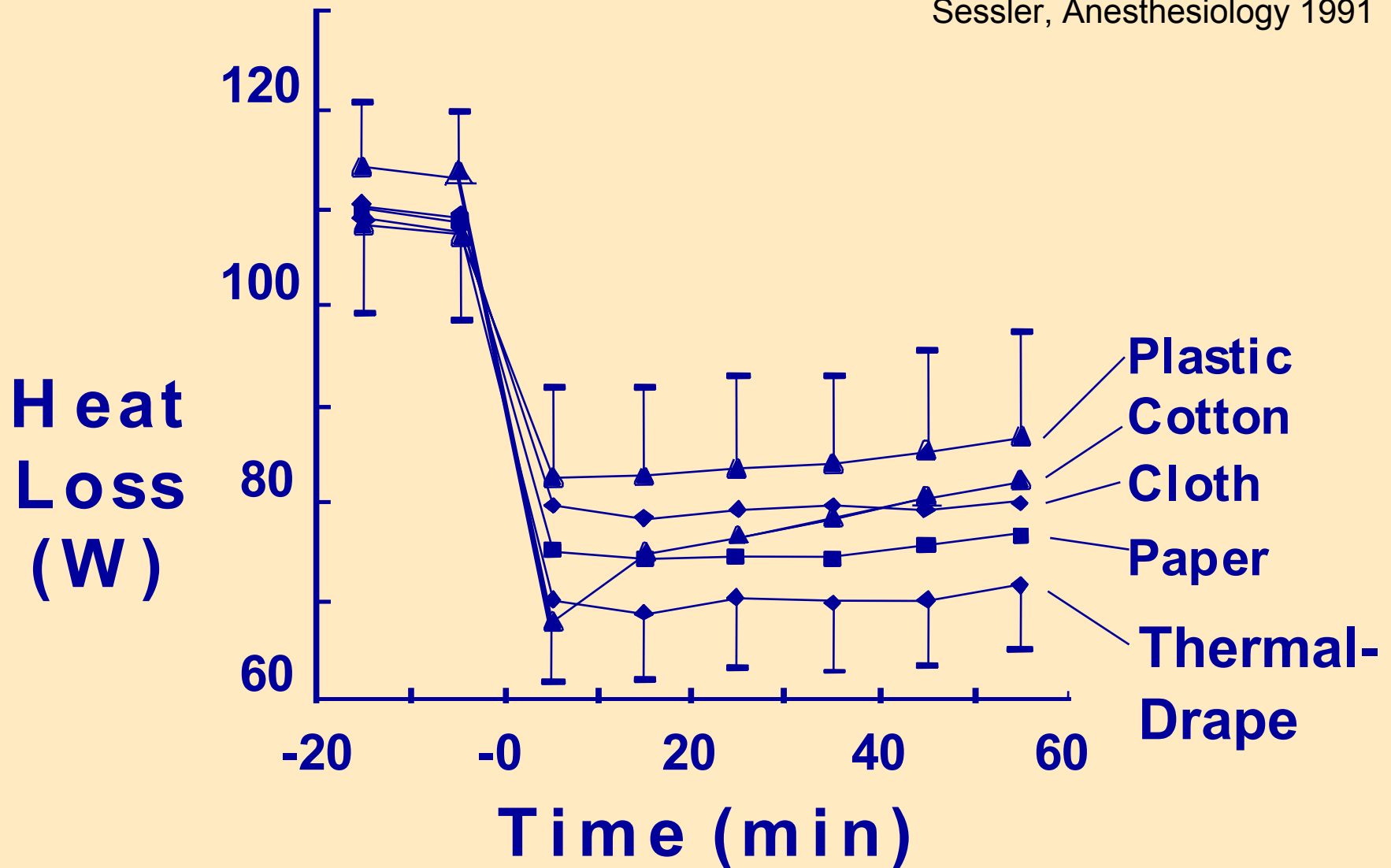
Thermoregulatory Shivering

Monitoring of Temperature



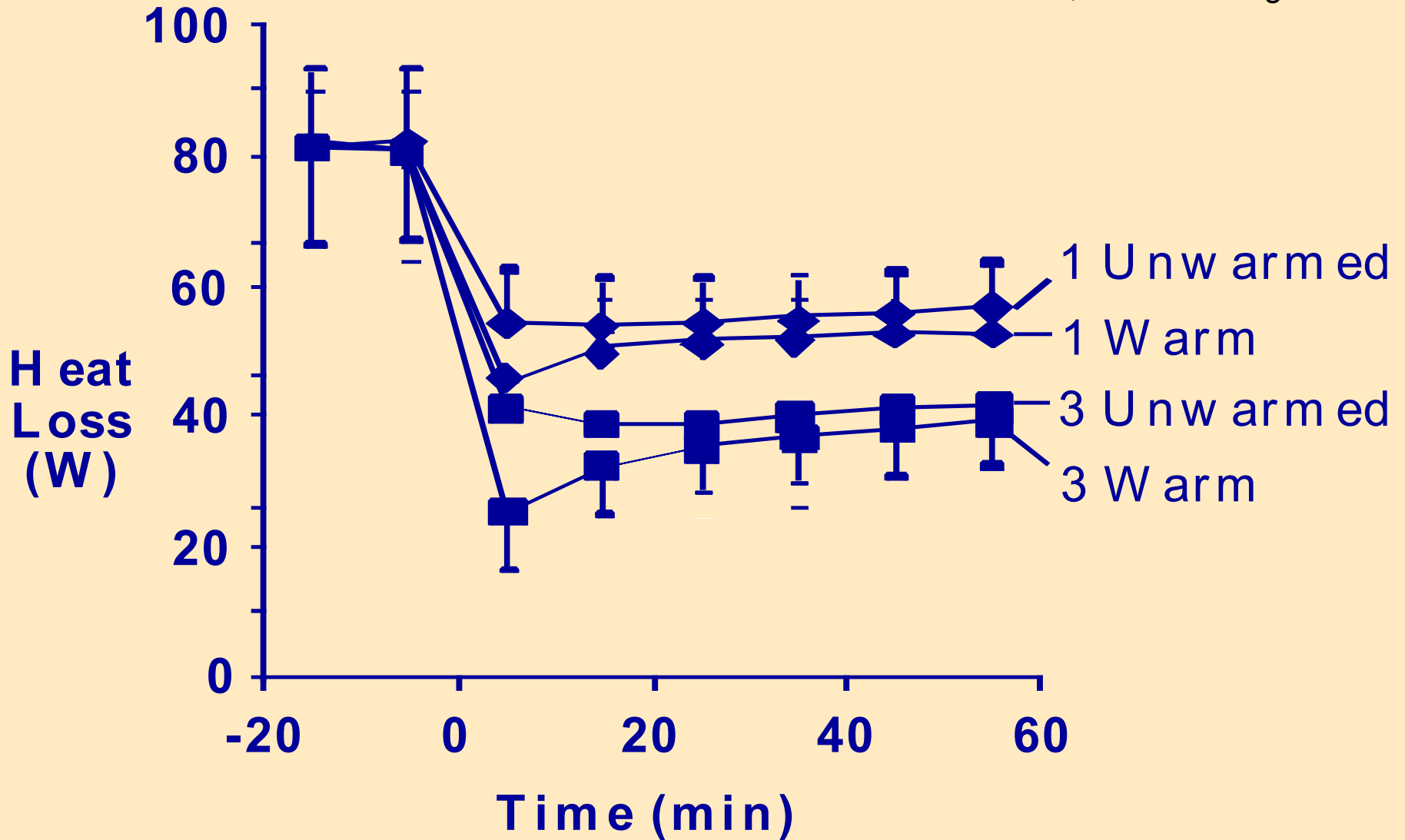
Insulating Covers

Sessler, Anesthesiology 1991



More Layers ??

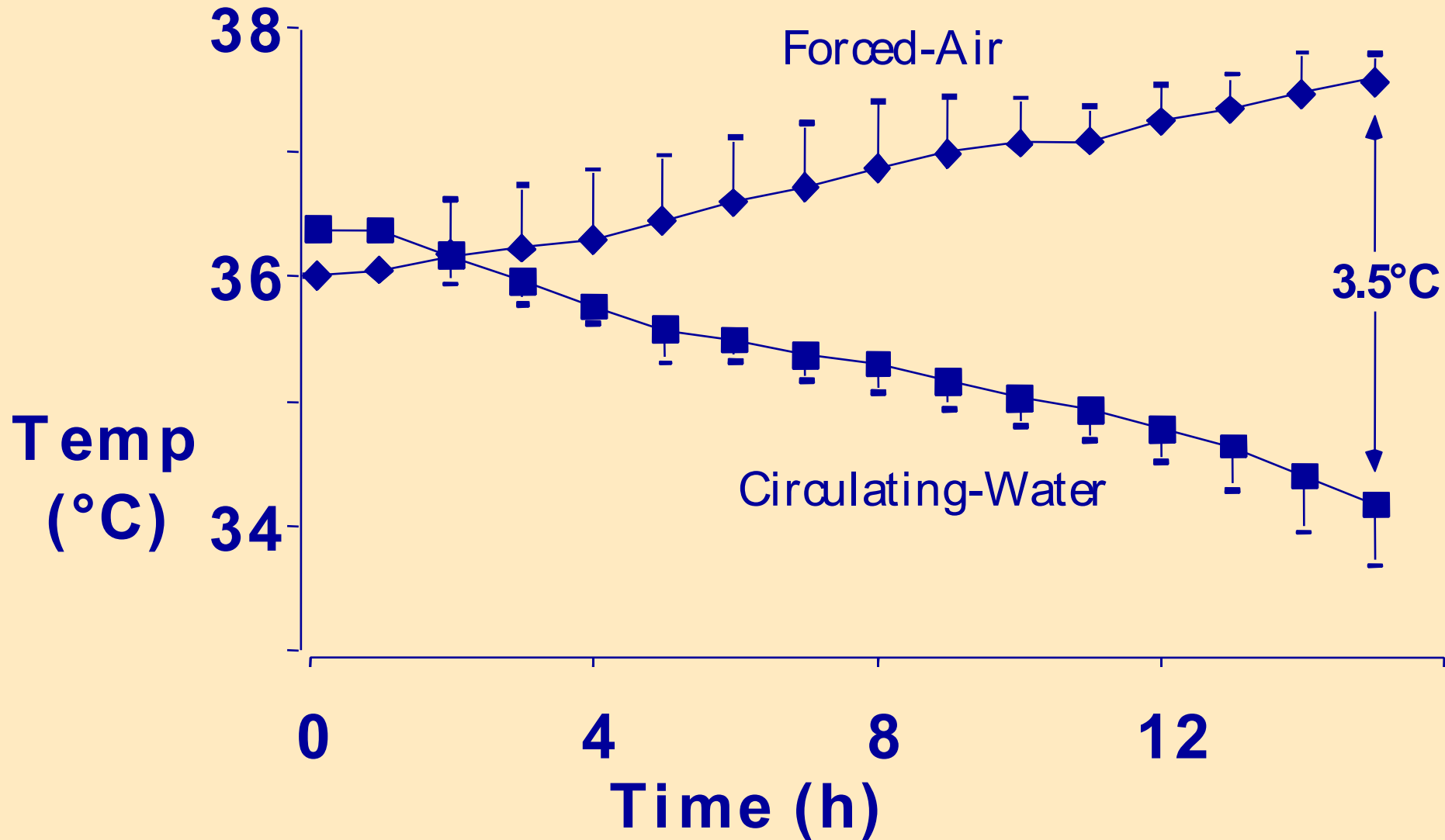
Sessler, Anesth Analg 1993



- 2 minutes setup time
- Transfer ~ 100 watts (86kcal/h)
- \perp adult metabolic rate



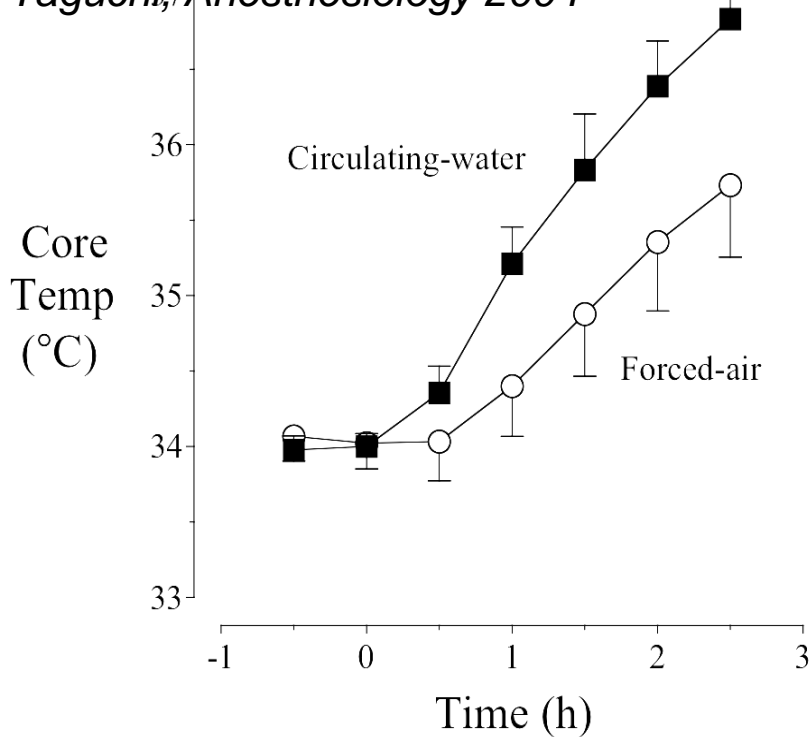
Kurz, A&A 1993

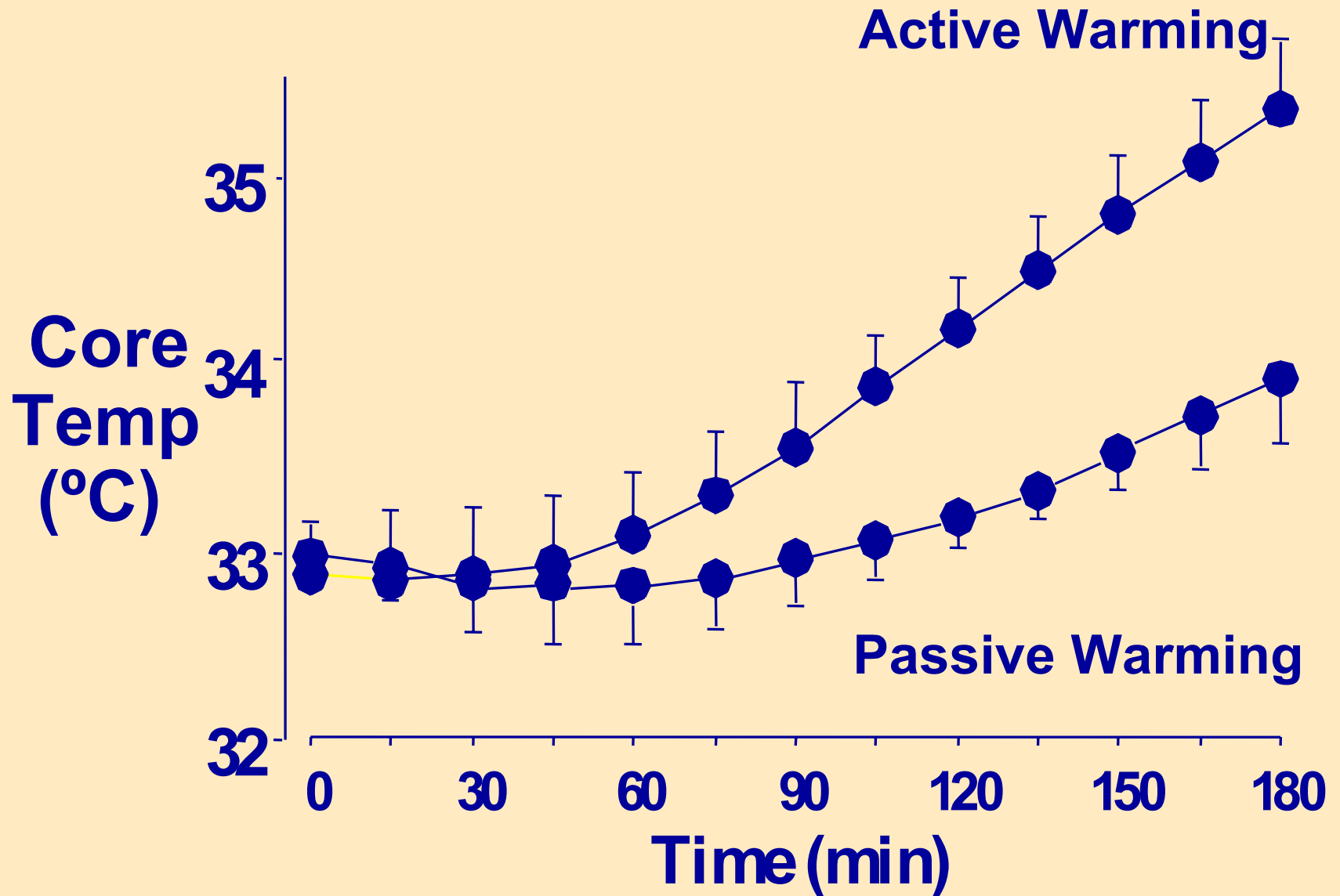


- No setup time
- Transfer ~ 20 W (17kcal/h)
- 20% of metabolic rate
- beneath patient – little effective

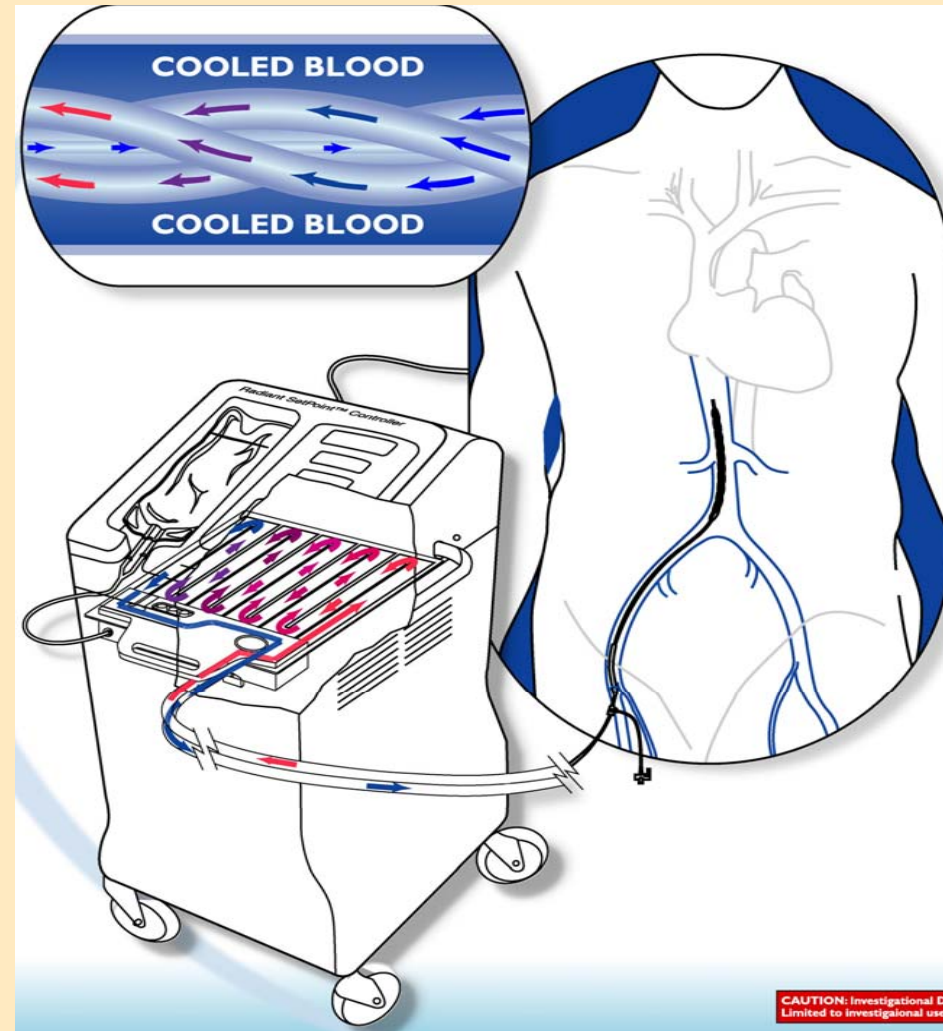


Taguchi, Anesthesiology 2004

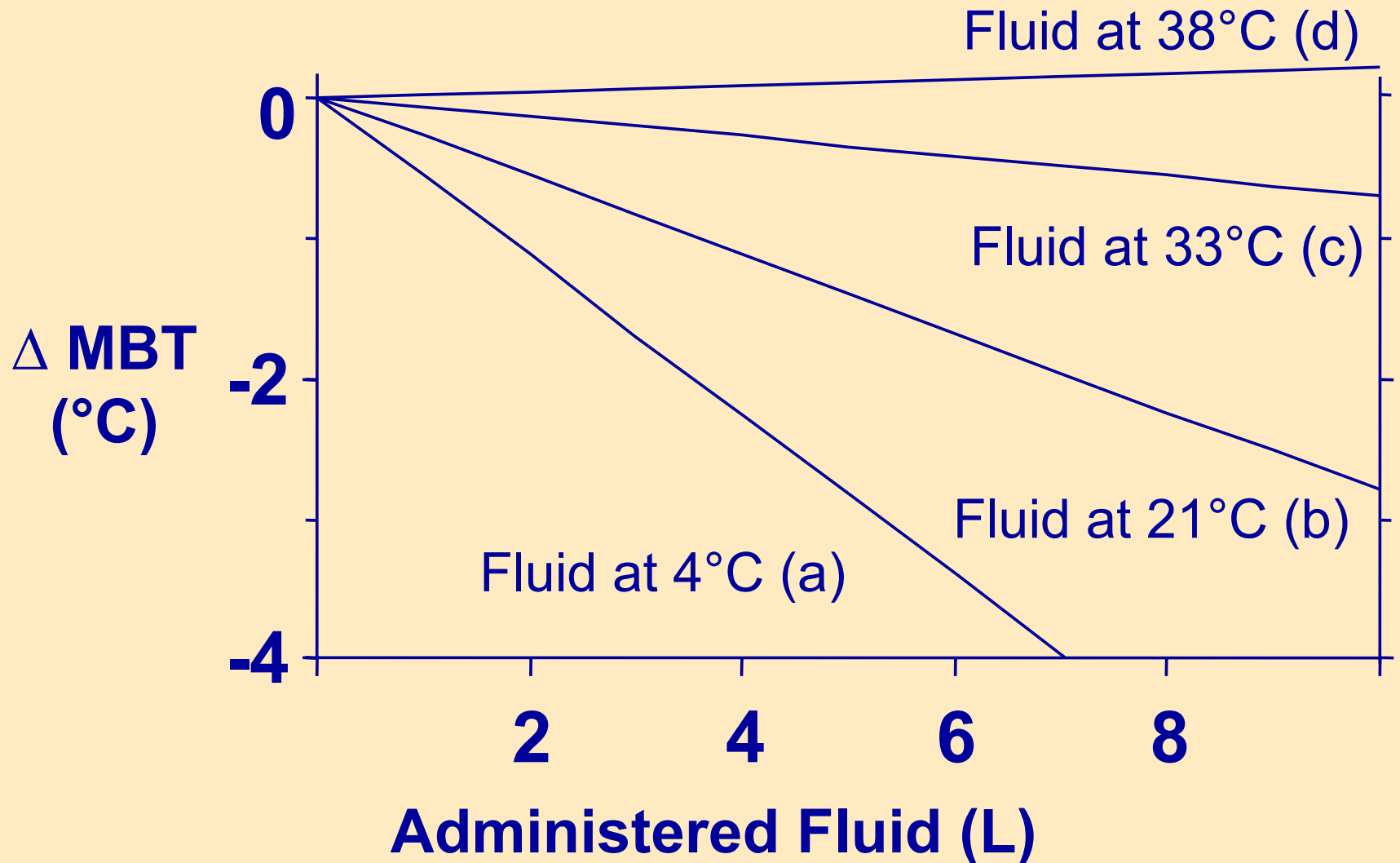




- Closed loop – Heat Exchanger (sterile NaCl)
- Central venous Catheter
- 10F, 25 cm
- Heat transfer: 400-700 W
- Warming: 2-3°C/h
- Cooling: 4-6°C/h



Sessler, Anesthesiol Clin North Am 1994



- Incidence \approx 40% in unwarmed surgical patients
- \uparrow Schmerzen im Wundgebiet de Witt, Anesthesiology 2002
- \uparrow Intraocularen Druck Mahajan, Anesthesiology 1987
- \uparrow ICP Rosa, Acta Anaesth Scand 1995
- \uparrow O₂-Verbrauch 2-3 x Ciofalo, Anesthesiology 1989

Treatment

- Skin-surface warming (5°C skin warming compensates for 1°C core hypothermia – 20% skin contribution)
- α 2-Antagonisten Clonidin (75 - 150 μ g) NNT = 2
- Opioide Meperidin (25 mg) NNT < 2
- Alfentanil (250 μ g) NNT = 2

De Witte, Anesthesiology 2002
Kranke, Anesth Analg 2002

Core Sites – continuous

- Pulmonary artery
- Distal esophagus
- Nasopharynx
- Tympanic membrane

less reliable site

- Mouth
- Axilla
- Bladder
- Rectum

- Central thermoregulatory inhibition by analgosedative drugs
- Heat-Redistribution – Heat Production↓ - Separation Core/ Periphery
- Management Strategy for Core Temperature
- Importance of Temperature Monitoring
- Regulation of body temperature based on pathophysiology
- *Major Hypothermia Complications*
 - Myocardial ischemia and ventricular tachycardia
 - Bleeding and increased transfusion requirement
 - Surgical wound infections
- No benefit TBI/Neurosurgery → ***Hyperthermia*** - disastrous
- Mild Hypothermia standard in post-CPR-Treatment