



INDUCED HYPOTHERMIA

“A Hot Topic”

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Conflicts of Interest

- Sadly, we have no financial or industrial conflicts of interest to disclose.
- Off-label Discussion: Therapeutic hypothermia is not FDA approved



Therapeutic Hypothermia Objectives / Discussion items:

- Brief history
- Definition
- Who benefits?
- When to induced hypothermia?
- Methods to initiate and maintain
- Complications
- How therapeutic hypothermia fits in post-cardiac arrest care?



History of Therapeutic Hypothermia

- Ebers Papyrus ~ 3400 - 1500 BC ¹
- Hippocrates ~ 460 – 370 BC ¹



- Battlefield Surgeon Baron Dominique Jean Larrey 1766 – 1842 ¹
- First modern article / study in 1945 for TBI
- 1950 First application in cerebral aneurysm

What is Therapeutic Hypothermia?

- Focus is on Post Cardiac Arrest Victims
 - Protecting the Brain
 - Protecting the Heart
 - Protecting the body as a whole
- Controlled induction of **MILD** hypothermia by any number of means to result in a core body temperature of 32° to 34° C (89.6 – 93.2° F) for a period of usually 12 to 24 hours with passive re-warming

Who Benefits from Therapeutic Hypothermia?

- 2005 European Resuscitation Council / American Heart Association ²
- Unconscious adult patients with ROSC after out of hospital VF arrest ²
- AHA recommended therapy in non-VF arrest and in-hospital cardiac arrest ²



What is the Evidence?

- Bernard study (1997) Patients:
 - Mortality rate 77 % to 45 %
 - Good neurological outcome 14 % to 50% ³
- RCT (2002) N=77: Mortality rate 68 % to 51 %
- Good neurological outcome 26 % to 49 % ⁴
- European Hypothermia After Cardiac Arrest Patients RCT (2002) N=273 ⁵
 - Mortality rate 55 % to 41 %
 - Good neurological outcome 39% to 55%

What is the Evidence?

- Bernard (RCT 2002)
 - Absolute risk reduction of 23%
 - NNT 4.5
- Hypothermia After Cardiac Arrest (RCT 2002)
 - Absolute risk reduction of 24%
 - NNT 4



What are we trying to protect?

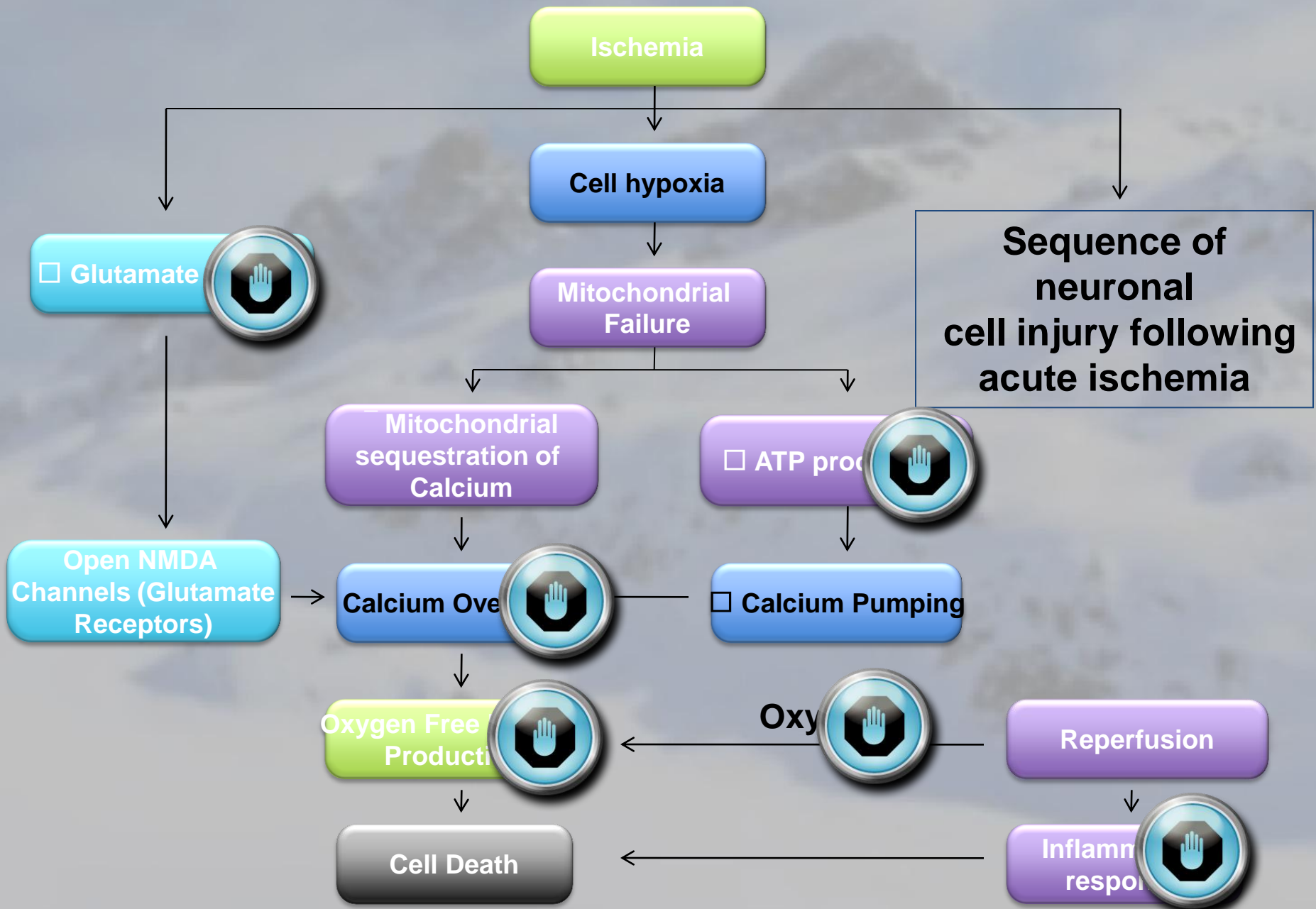
PATHOPHYSIOLOGY OF CARDIAC ARREST

Pathophysiology of Cardiac Arrest

- First process is the etiology of the arrest
- Second process is the reaction of the body to the global ischemia
 - Post Cardiac Arrest Brain Injury
 - Post Cardiac Arrest Myocardial Injury
 - Systemic Ischemic / Reperfusion Response
 - Persistent Precipitating Pathology

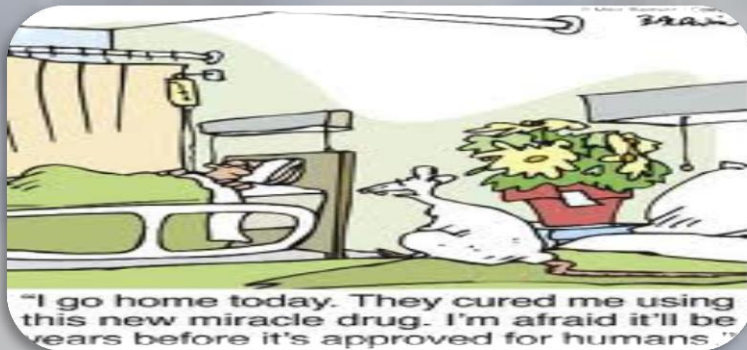
How does Hypothermia protect?





How to Initiate and Maintain Therapeutic Hypothermia?

- Best Method Unknown



- Ice Packs, IV Fluids, Extra-vascular, Endovascular techniques
- Our local utilization



When to Initiate Therapeutic Hypothermia?

- Current recommendation is after ROSC in the patient which remains unconscious



Indications / Inclusion Criteria

- Area remains controversial
- ROSC (any rhythm) where patient remains unconscious / no purposeful response
- ROSC < 30 minutes downtime
- < 6 Hours from ROSC
- MAP > 65 mmHg (includes use of vasopressor agents)

Exclusion Criteria

- ROSC with purposeful response / following commands
- No ventilator requirement
- DNR / MOST limiting scope of treatment
- Terminal illness
- Traumatic etiology leading to arrest
- Poor baseline neurological status pre-arrest

Relative Exclusion Criteria

- Pregnancy
- Active bleeding or intracranial bleeding
- Recent major surgery (Cranial / Thoracic / Abdominal)
- Severe sepsis / shock

When do we start cooling?

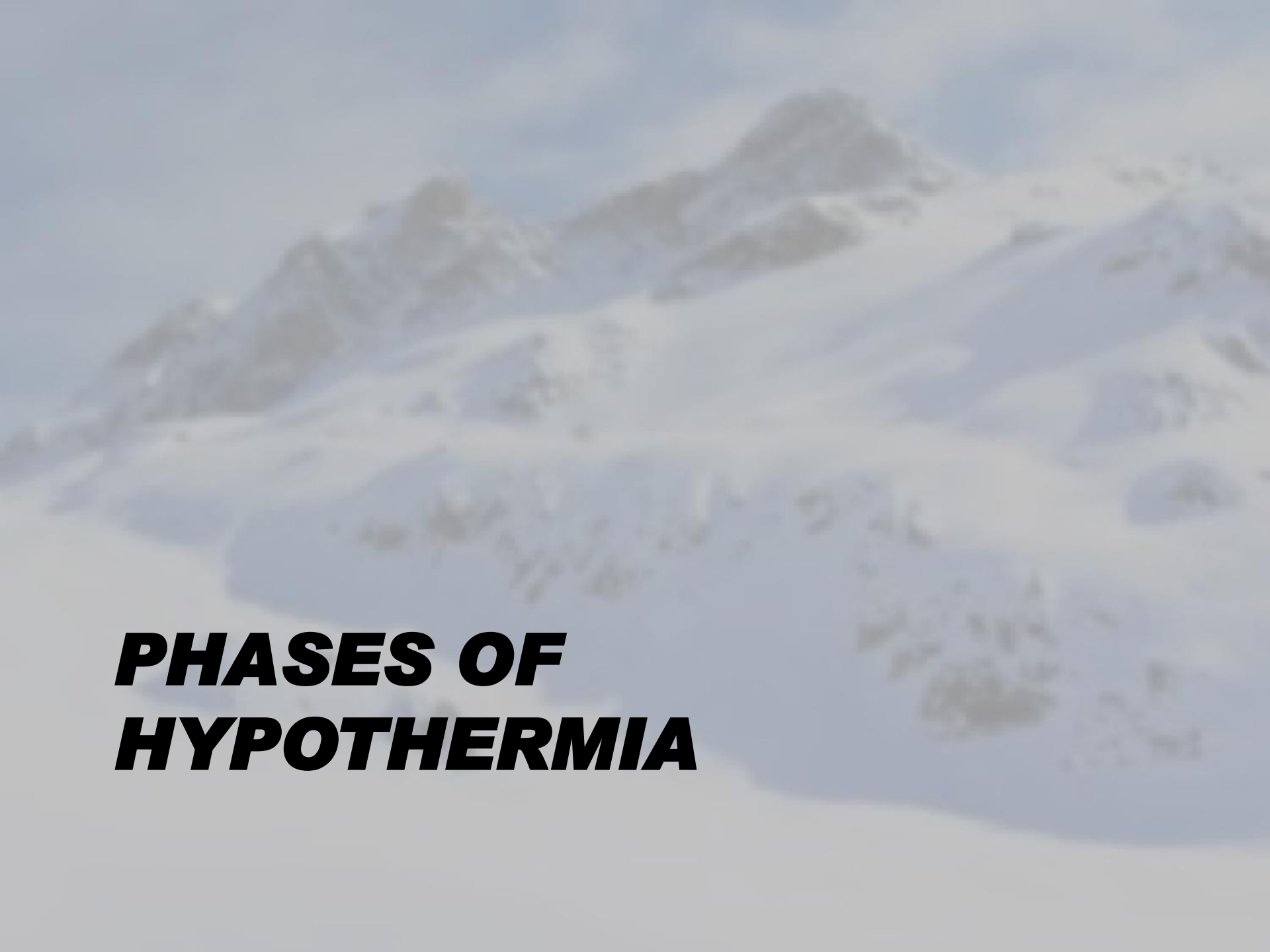
- Answer is unknown
- No conclusive evidence pre-hospital cooling offers a benefit
- Typically reach target temperature 1 hour faster

When do we start cooling?

- November 2013 JAMA
- Washington State: Randomized study
- 1359 patients
 - 583 VT
 - 776 some other rhythm
- No difference in survival or good neurological outcome whether EMS cooled or did not cool
 - Kim F et al. Effect of prehospital induction of mild hypothermia on survival and neurological status among adults with cardiac arrest: A randomized clinical trial. JAMA 2013 Nov 17

How cool do we go?

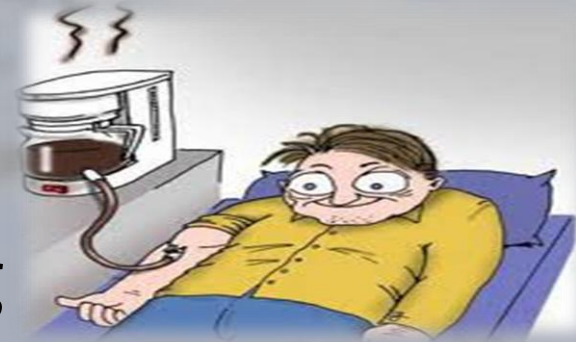
- European study with 950 patients
- Randomized to target temperatures of 33 and 36°C
 - 460 died
 - Mortality similar in both groups
 - Neurological function similar in both groups
 - Serious adverse events similar in both groups
 - No difference
 - This may be we are controlling for fever



PHASES OF HYPOTHERMIA

Phases of Hypothermia

- **Induction**
 - Rapid cooling, target temp within 1 hour
- **Maintenance**
 - Precise temperature control 32° to 34° C
- **Rewarming**
 - Slowly, 0.1 - 0.5° C per hour
 - At 36° C allow passive rewarming
- **Normothermia**
 - Maintain normothermia



Complications of Therapeutic Hypothermia

- Hemorrhage
- Hyperkalemia (clinically significant)
- Hyperglycemia
- Pharmacokinetics
- Infection including pneumonia (up to 50%)
 - Probably related to aspiration
- Sepsis (no statistical significance)
- Skin breakdown (no bathing until re-warmed)
- Seizures
- Shivering



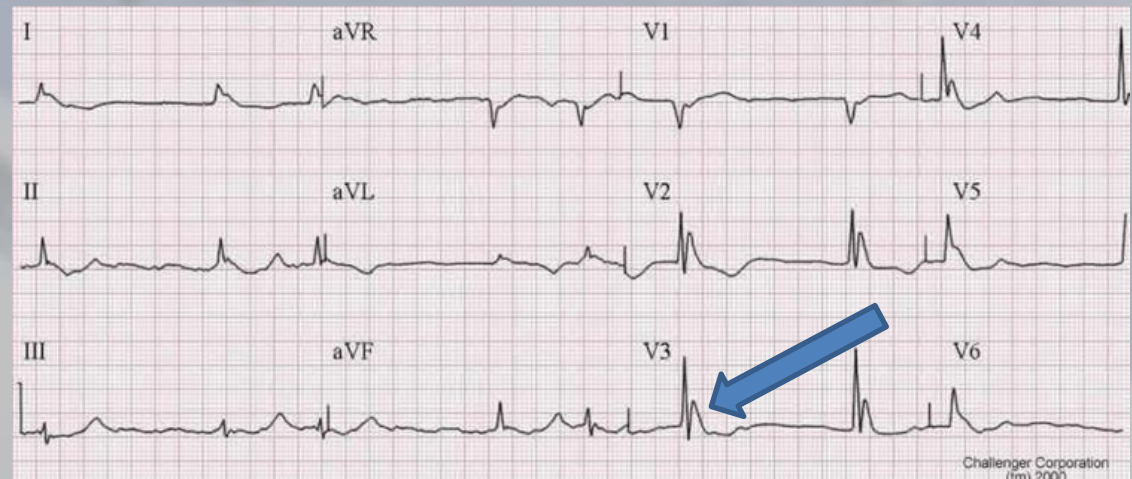
Control of Shivering

- Hyperthermia expected and bad
- Demerol decreases shivering threshold
- Fentanyl more commonly used
- Benzodiazepines
- Anesthetics
- Magnesium
- Neuromuscular blockade

Arrhythmia Complications

- **EKG Changes**

- “Normal” HR at 32°C is 40 beats per minute
- Prolonged PR interval, widening of the QRS complex, increased QT interval, Osborn waves
- Artificially increasing the HR is rarely necessary and can decrease myocardial contractility
- Mixed venous or lactic acid level to determine if patient is tolerating HR



Complications of Rewarming

- Allowing too rapid warming process
- Hyperthermia
- Hyperkalemia
- Diuresis
- Shivering

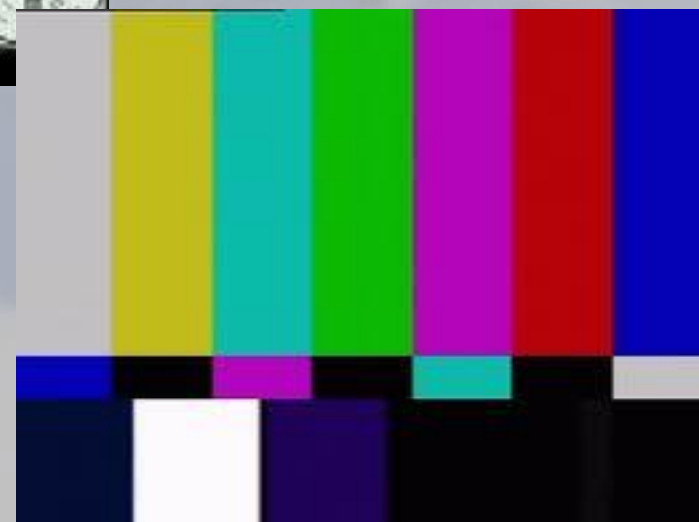
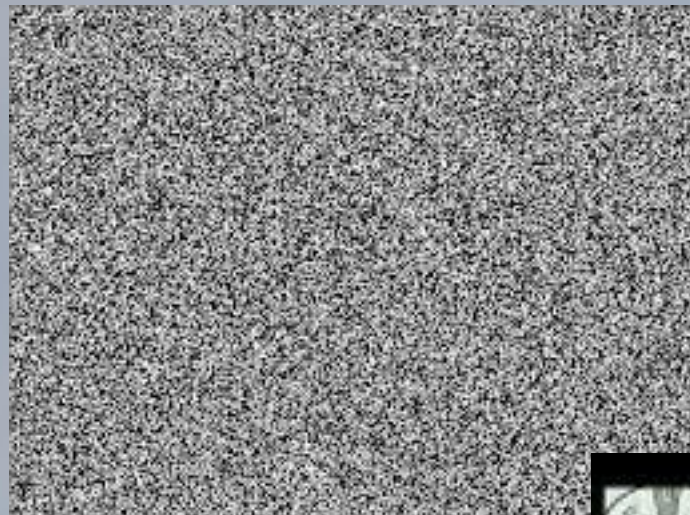


Is Therapeutic Hypothermia Really Safe?

- YES
- Meta-analysis February 2013
- 63 studies
 - Mainly VT patients
 - ROSC and minimal neurological recovery
 - NNT 5 - 7
- Arrhythmia and hypokalemia most common
 - Xiao G et al. Safety profile and outcome of mild therapeutic hypothermia in patients following cardiac arrest: Systematic review and meta-analysis. Emerg Med J 2013 Feb; 30:91.

SUMMARY

- Should I begin therapeutic hypothermia in my EMS system?
- YES....but
 - Only if you have high-quality CPR
 - Early defibrillation
 - Team focused CPR
 - EMD aggressively instructing CPR
 - Maximized all other interventions first



Local Case Study

- 47 y/o caucasion male
- Typical Friday evening with his family
- Sudden Cardiac Arrest
- Bystander CPR by spouse
- 9 y/o daughter called 911
- First Responders / FD defibrillated with AED
- ROSC after about 15 minutes

Local Case Study

- Remained unresponsive with no respiratory effort and with fixed and dilated pupils
- Hypothermia induced with IV fluids and cold packs to neck, axilla and groin
- Arrived at FMC with Arctic Sun continued
- Therapeutic hypothermia for 24 hours
- Tuesday pupillary reaction noted with spontaneous respirations
- Wednesday awake on ventilator

Local Case Study

- Wednesday recognizing family and friends at bedside
- Thursday extubated
- Friday sitting in chair eating in CICU
- 11 days after arrest discharged home with only mild short term memory loss
- Returning to work as a High School teacher





Therapeutic Hypothermia Whole Story in an Ice Cube



- Benefits of hypothermia known since antiquity
- Relatively cheap and easy to utilize
- Neurological outcomes improved
- ***Requires Multidisciplinary care***
- Recommended since 2003 by AHA but continues to have poor utilization among physicians

- http://iconnect.novanthealth.org/Forsyth/POCOrderSets/POC_Documents/CriticalCareHypothermiaPostCardiacArrestOrders.pdf