Targeted Temperature Management in Post Cardiac Arrest Patients

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Continuing Education Presentation
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Objectives

- Explain the rationale behind the process of post cardiac arrest Targeted Temperature Management (TTM)
- Explain the evidence-based recommendations for the use of medications during the TTM process
- List the major side effects of each medication recommended for use in post cardiac arrest TTM

Post Cardiac Arrest Care

American Heart Association:

- All comatose adult patients who attain return of spontaneous circulation (ROSC) undergo targeted temperature management (TTM)
- Cerebral perfusion scores significantly improved in patients who underwent TTM

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American Heart Association. Web-based Integrated Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care – Part 8: Post-Cardiac Arrest Care. ECCguidelines.heart.org.

Post Cardiac Arrest Care

2015 Recommendations- Highlights

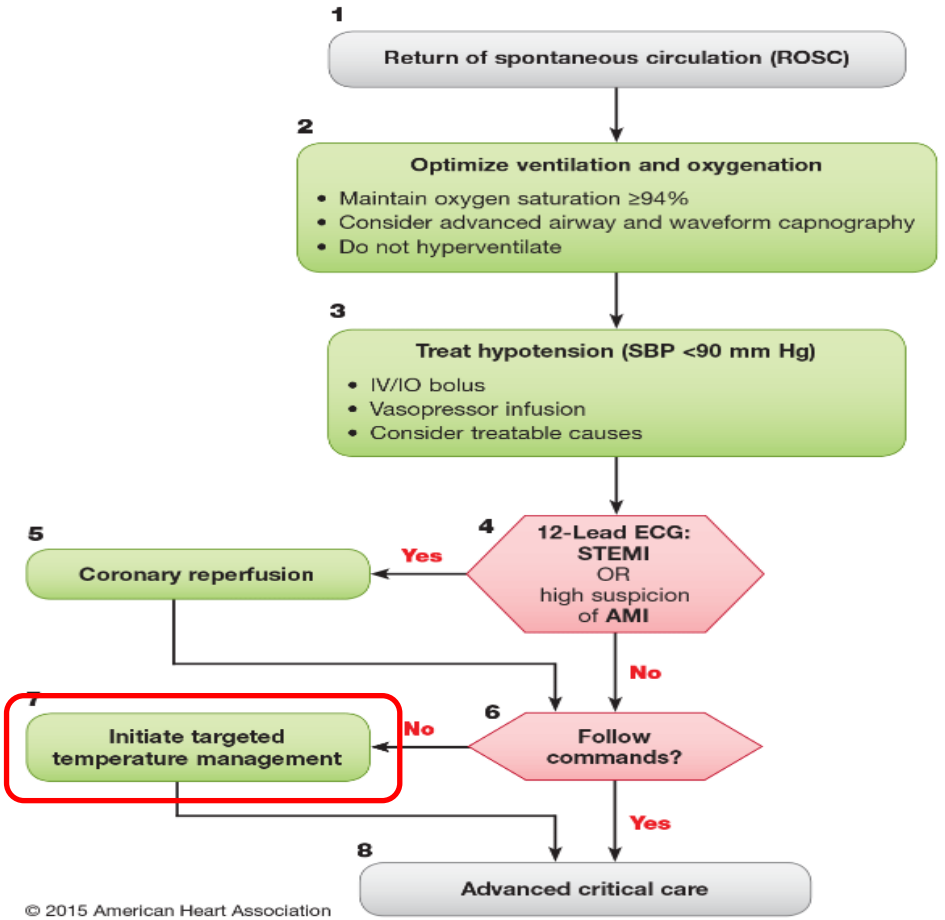
- Comatose adult patients with ROSC after out-of-hospital ventricular fibrillation (*VF)* or ventricular tachycardia (*VT)* cardiac arrest should be cooled to 32°C to 36°C
  - Class I, (LOE B-R)

- Comatose adult patients with ROSC after out-of-hospital *with non VF/VT (non shockable)* cardiac arrest or in hospital cardiac arrest should be cooled to 32°C to 36°C
  - Class I, (LOE C-EO)

LOE= Level of evidence
R= based on randomized studies
EO= based on consensus of expert opinions

Overview

Adult Immediate Post–Cardiac Arrest Care Algorithm—2015 Update



Doses/Details

Ventilation/oxygenation: Avoid excessive ventilation. Start at 10 breaths/min and titrate to target P_{ETCO_2} of 35-40 mm Hg. When feasible, titrate F_{IO_2} to minimum necessary to achieve Spo_2 ≥94%.

IV bolus: Approximately 1-2 L normal saline or lactated Ringer's

Epinephrine IV infusion: 0.1-0.5 mcg/kg per minute (in 70-kg adult: 7-35 mcg per minute)

Dopamine IV infusion: 5-10 mcg/kg per minute

Norepinephrine IV infusion: 0.1-0.5 mcg/kg per minute (in 70-kg adult: 7-35 mcg per minute)

Reversible Causes

- **H**ypovolemia
- **H**ypoxia
- **H**ydrogen ion (acidosis)
- **H**ypo-/hyperkalemia
- **H**ypothermia
- **T**ension pneumothorax
- **T**amponade, cardiac
- **T**oxins
- **T**hrombosis, pulmonary
- **T**hrombosis, coronary

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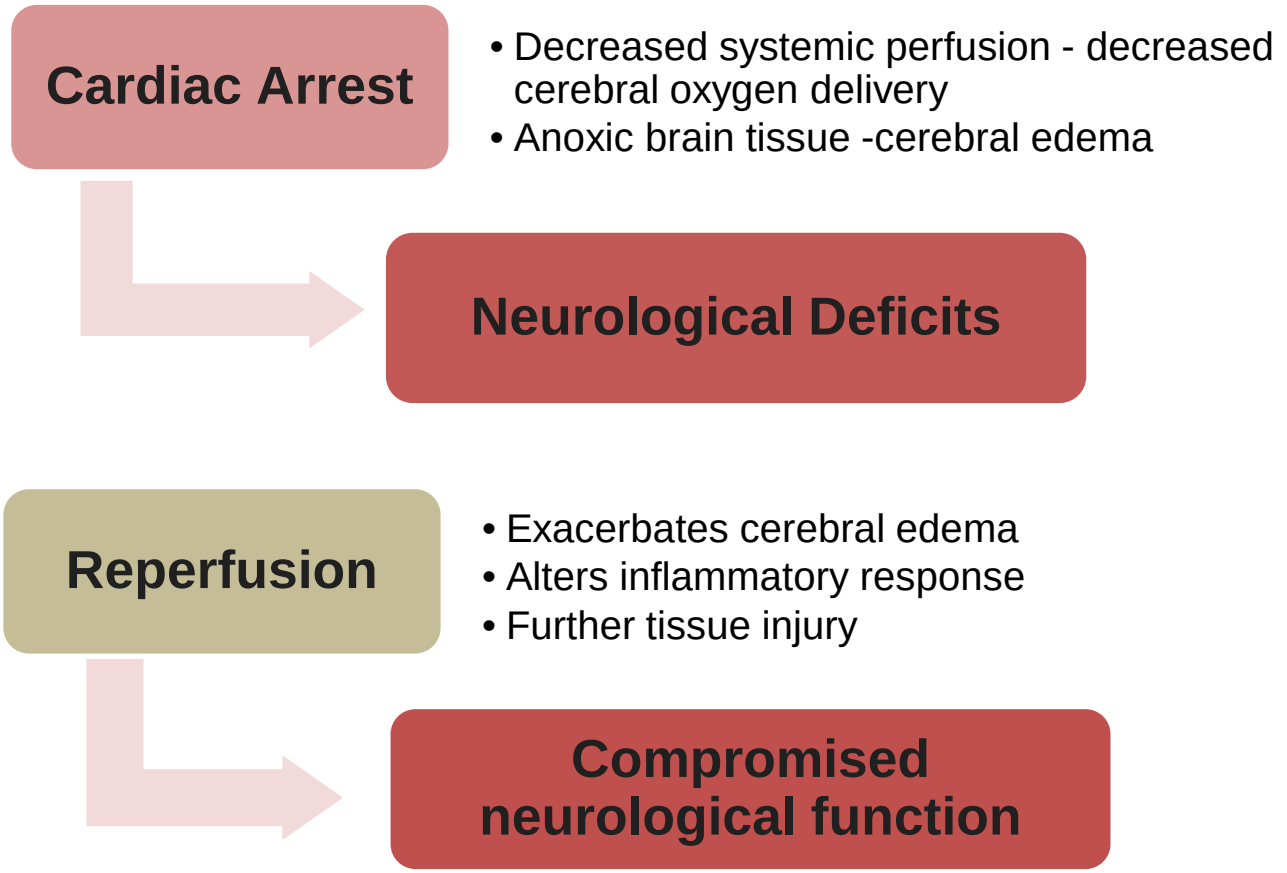
Post Cardiac Arrest Care



Opie LH. Reperfusion injury and its pharmacologic modification. Circulation. 1989;80:1049 –1062.
White BC, Grossman LI, Krause GS. Brain injury by global ischemia and reperfusion: a theoretical perspective on membrane damage and repair. Neurology. 1993;43:1656 – 1665.

Targeted Temperature Management (TTM)

Targeted temperature management previously known as *therapeutic hypothermia*

- Active treatment to achieve and maintain a specific temperature (between 32ºC and 36ºC)
- Goal to preserve neurological function

Mechanism of TTM

Targeted Temperature Management

- Slows cerebral metabolism
- Decreases oxygen consumption
- Lessens cerebral edema

Perman S, Goyal M et al. Clinical Applications of Targeted Temperature Management. Chest. 2014 Feb; 145(2): 386–393..

Landmark Trials

- Improved neurological outcomes and mortality in comatose patients with out-of-hospital cardiac arrest

Trial	Design	Outcome	Summary
Bernard S et al 2002	n=77; RCT, un-blinded trial	Survival to discharge with good neurological outcome 49% vs 26% (p=0.046, NNT=4)	Improved the incidence of favorable discharge disposition
Holzer M et al *(HACA Trial) 2002*	n=136; RCT, multicenter	Favorable neurologic outcome within 6 months 55% vs. 39% (RR 1.40; 95% CI 1.08-1.81; p=0.009)	Therapeutic mild hypothermia increased rate of favorable outcome.

RCT=Randomized Controlled Trial
NNT=Number needed to treat
CI=Confidence Interval
RR=Relative Risk

Bernard SA, Gray TW, Buist MD, et al. Treatment of comatose survivors of out-of-hospital cardiac arrest with induced hypothermia. N Engl J Med. 2002;346:557–63..
Holzer M, et al. "Mild Therapeutic Hypothermia to Improve the Neurologic Outcome After Cardiac Arrest". The New England Journal of Medicine. 2002. 346(8):549-556.

Landmark Trials

Nielsen N et al (*TTM trial*) 2013

- TTM at 33ºC vs 36ºC for 24 hours

Outcome	33°C Group	36°C Group	Hazard Ratio or Risk Ratio (95% CI)*	P Value
	no./total no. (%)			
Primary outcome: deaths at end of trial	235/473 (50)	225/466 (48)	1.06 (0.89–1.28)	0.51
Secondary outcomes				
Neurologic function at follow-up†				
CPC of 3–5	251/469 (54)	242/464 (52)	1.02 (0.88–1.16)	0.78
Modified Rankin scale score of 4–6	245/469 (52)	239/464 (52)	1.01 (0.89–1.14)	0.87
Deaths at 180 days	226/473 (48)	220/466 (47)	1.01 (0.87–1.15)	0.92

- Cooling to 33ºC vs 36ºC did not provide any additional benefit

Nielsen N, et al. "Target Temperature Management 33°C vs. 36°C after Out-of Hospital Cardiac Arrest". The New England Journal of Medicine. 2013. 369(23):2197-2206

Landmark Trials

Common misconception

- '*TTM trial showed no benefit with TTM*'

TTM trial

- Both groups received active cooling
- Comparison between two target temperatures (33ºC vs 36ºC)
- High bystander CPR (shorter "no flow" time)

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Nielsen N, Wetterslev J, Cronberg T, et al. Targeted temperature management at 33 °C versus 36 °C after cardiac arrest. N Engl J Med. 2013;369:2197–006. doi: 10.1056/NEJMoa1310519

Pop Quiz!

- Patients undergoing targeted temperature management post cardiac arrest are recommended to be cooled to:

  a. 30ºC
  b. 32ºC - 36ºC
  c. 25ºC - 30ºC
  d. All of the above
  e. None of the above

Pop Quiz!

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c. 25ºC - 30ºC
d. All of the above
e. None of the above

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Ideal Temperature Target

Nielsen et al

- 33ºC vs 36ºC offered no additional benefit
- Did not show any additional adverse effects when cooled to 33ºC
  - Any adverse events (93% vs 90%; p=0.86)
- No clinical or statistically significant differences in patient outcomes

➢ ***Due to lack of significant data, either temperature goal (33ºC or 36ºC) seem reasonable.***

- ***Patient specific temperature targets***

Nielsen N, Wetterslev J, Cronberg T, et al. Targeted temperature management at 33 °C versus 36 °C after cardiac arrest. N Engl J Med. 2013;369:2197–006. doi: 10.1056/NEJMoa1310519

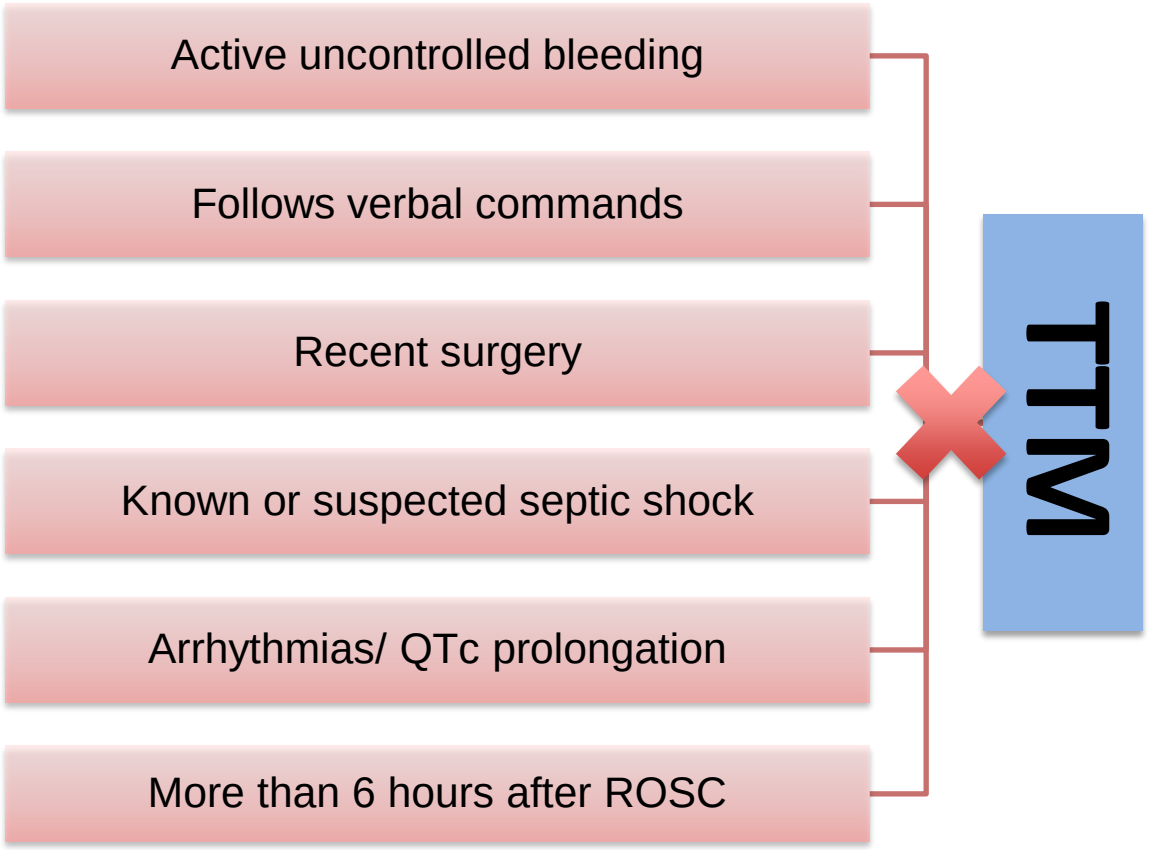
Initiation of TTM: Optimal time

Trial	Design	Outcome	Summary
Mooney et al *2011*	n=140; case review, multicenter	Survival to elapsed time from ROSC to imitation of cooling *Relative hazard estimate: 1.20 (95% CI 1.04-1.39)*	For every hour delay in cooling risk of death increases by 20%

- ***TTM is a medical emergency!***

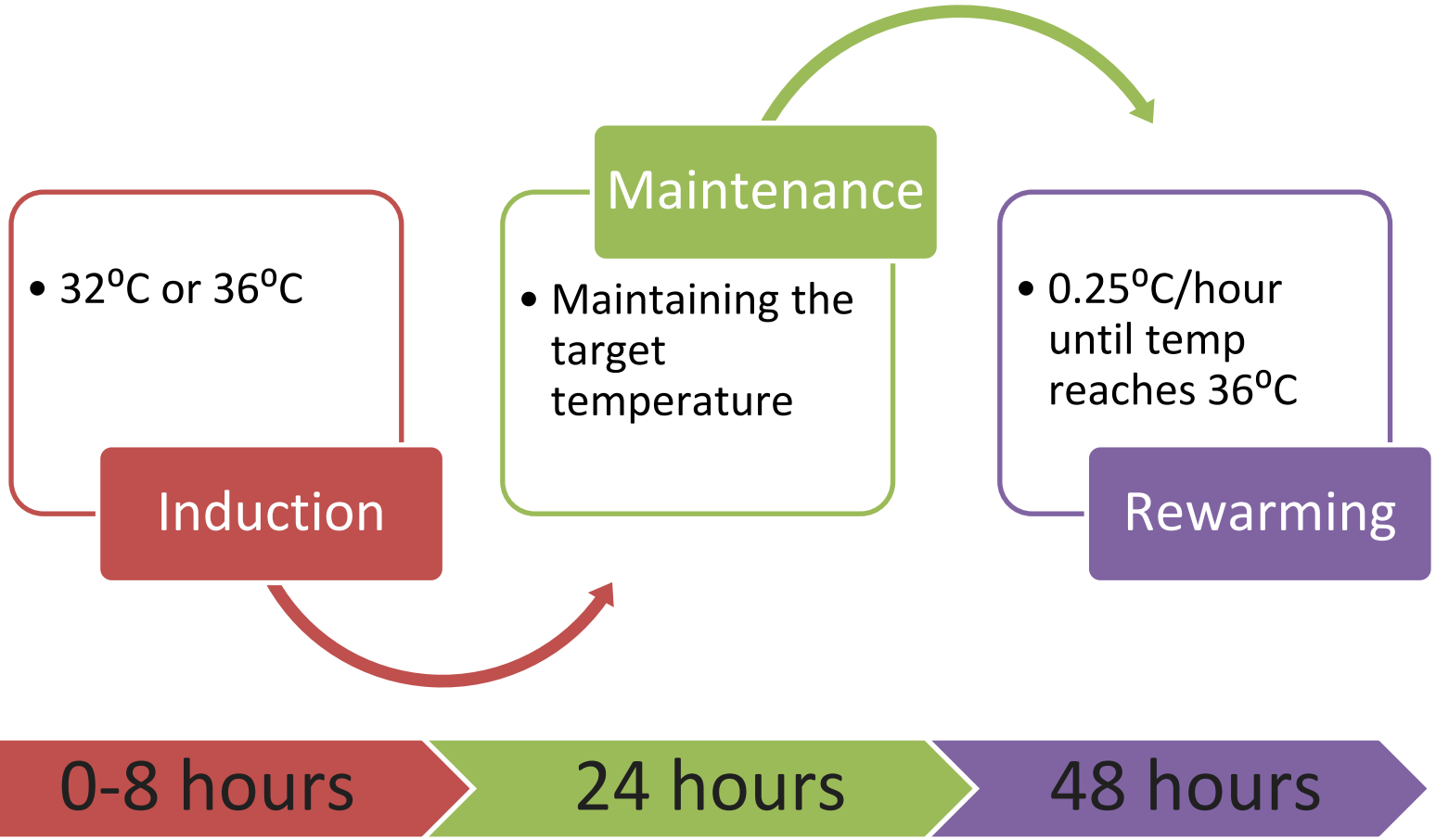
15 Mooney MR, Unger BT, Boland LL, et al. Therapeutic hypothermia after out-of-hospital cardiac arrest: evaluation of a regional system to increase access to cooling. *Circulation*. 2011;124(2):206–214.

Relative Contraindications of TTM



So H. Therapeutic hypothermia.Korean J Anesthesiol. 2010 Nov; 59(5): 299–304

Temperature Management Overview



American Heart Association. Web-based Integrated Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care – Part 8: Post-Cardiac Arrest Care. ECCguidelines.heart.org.

Pop Quiz!

- Targeted temperature is achieved by which of the following ways
  a. Cooling blanket
  b. Infusing cold 0.9% sodium chloride
  c. Keeping the patient in a refrigerator
  d. A & B
  e. All of the above

Pop Quiz!

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  a. Cooling blanket
  b. Infusing cold 0.9% sodium chloride
  c. Keeping the patient in a refrigerator
  d. A & B
  e. All of the above

Methods to Institute TTM

Conventional cooling techniques

- Cold saline, crushed ice or ice bags

Surface cooling systems

- Moving cold fluid or cold air through blanket of pads wrapped around the patient.
- Cooling blankets and surface pads

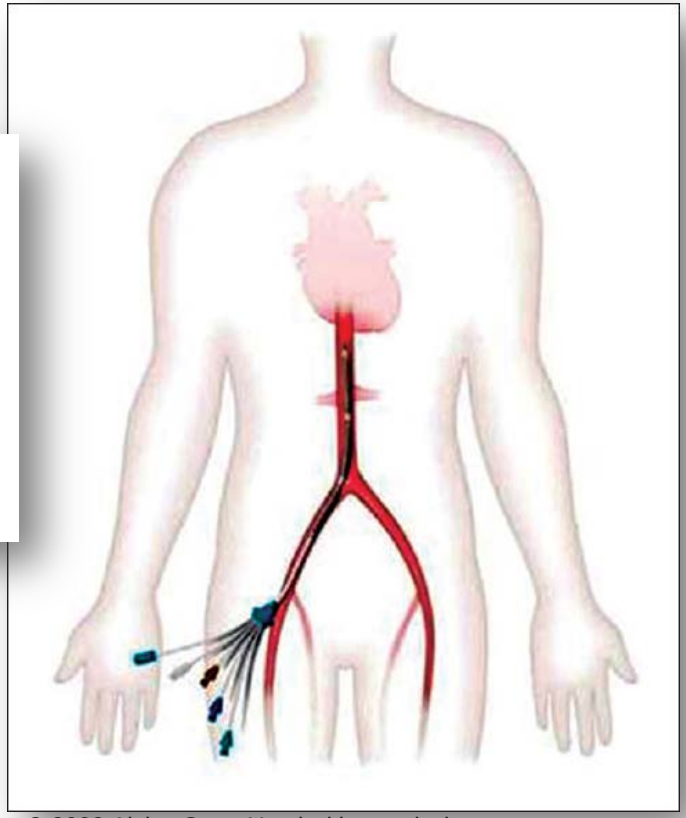
Intravascular cooling systems

- Circulating cool or warm saline in a closed loop through a catheter's balloon
- Catheter balloons: Femoral, jugular, subclavian

Vaity et al. Cooling techniques for targeted temperature management post-cardiac arrest. Crit Care. 2015; 19(1): 103.

Methods to Institute TTM

Surface vs Intravascular cooling



Methods to Institute TTM

Gillies M et al.

- *Objective:* Surface vs Endovascular cooling
- *Study design:* Retrospective cohort study, n= 83
- *Outcomes:*
  - Less temperature variation in endovascular group
    - Between 10 hour and 20 hour of cooling (1.0 vs 1.7; p=0.003)
  - No difference in outcomes:
    - Hospital mortality (54.2% vs 50.0%; p=0.51)
    - Poor neurological outcomes (59% vs 57.1%; p=0.82)

Gillies M, Pratt R, Whiteley C, et al. Therapeutic hypothermia after cardiac arrest: a retrospective comparison of surface and endovascular cooling techniques. Resuscitation. 2010;81:1117–22.

Induction Phase

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Induction Phase

Hemodynamic Stability

- No specific MAP or SBP targets
  - Published protocols recommend to maintain MAP at 65 mmHg or SBP above 80 mmHg
  - SBP <80 mmHg
    - Norepinephrine
      - 0.1–0.5 mcg/kg/min (In a 70 kg adult, 7–35 mcg/min)
  - Symptomatic Bradycardia
    - Dopamine
      - 5–10 mcg/kg/min
    - May tolerate HR 30-40 bpm!!!
    - Overstimulation of heart rate can decrease myocardial contractility

SBP: Systolic blood pressure
MAP: Mean arterial pressure

American Heart Association. Web-based Integrated Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care – Part 8: Post-Cardiac Arrest Care. ECCguidelines.heart.org. © Copyright 2015 American Heart Association, Inc.
Lewis ME et al: The effects of hypothermia on human left ventricular contractile function during cardiac surgery. J Am Coll Cardiol 2002; 39:102–108

Induction Phase

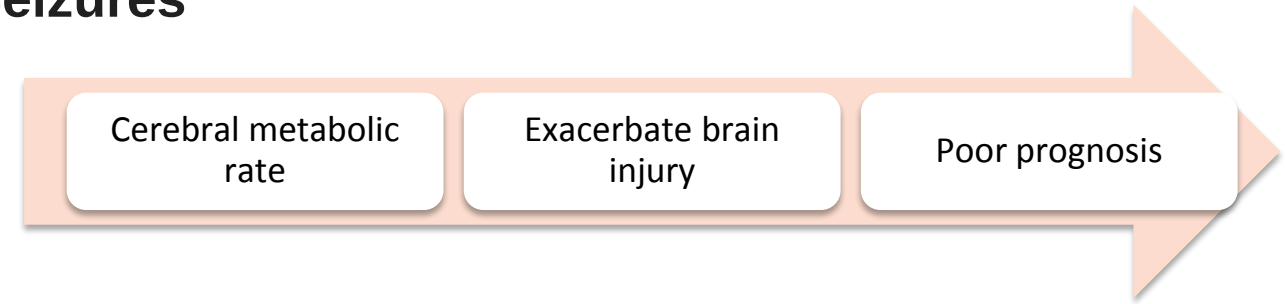
Goals

- Monitor for seizures
- Optimize analgosedation
- Minimize metabolic demand
  - Paralytics
  - Shivering prevention

Polderman KH. Mechanisms of action, physiological effects, and complications of hypothermia. Crit Care Med. 2009;37(suppl):S186–S202.

Induction Phase

Seizures



- Common, occurs in one-third of the patients post cardiac arrest
- Routine seizure prophylaxis in post cardiac arrest patients
  - Not recommended
  - Increased risk of side effects

- *Monitoring may include continuous/intermittent Electroencephalography(EEG) or Bispectral Index (BIS)*

Ingvar M. Cerebral blood flow and metabolic rate during seizures. Relationship to epileptic brain damage. Annals of the New York Academy of Sciences 1986;462:194-206

Sedation and Analgesia

Animal studies have shown:

- Inadequate sedation leads to partial or complete loss of protective effects of TTM

Goals:

- Optimize angalgosedation
  - Prior to initiation of pharmacologic paralytic
- Minimize doses of sedatives and analgesia
  - Hypothermia reduces clearance
- Select agents with short half-life
  - Enables early prognostication

Thoresen M, Satas S, Løberg EM, Whitelaw A, Acolet D, Lindgren C, Penrice J, Robertson N, Haug E, Steen PA. Twenty-four hours of mild hypothermia in unsedated newborn pigs starting after a severe global hypoxic-ischemic insultis not neuroprotective. Pediatr Res 2001;50:405–11

Sedation and Analgesia

Fentanyl IV

- Opioid analgesic; provides sedation and analgesia
- 100 x potent than morphine, fast onset of action (0-2 seconds)

- Metabolized by liver; decrease in hepatic blood flow
- Adverse effects
  - Respiratory depression
  - Chest wall rigidity with bolus administration
  - Ileus

Fritz H et al & Zhou et al

- Hypothermia decreases systemic clearance

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Fritz H et al. The effect of mild hypothermia on plasma fentanyl concentration and biotransformation in juvenile pigs. Anesth Analg. 2005 Apr;100(4):996-1002
Zhou et al. The effect of therapeutic hypothermia on drug metabolism and drug response: cellular mechanisms to organ function. Expert Opin Drug Metab Toxicol. 2011 Jul; 7(7): 803–816.

Sedation and Analgesia

Propofol

- Sedative
- Fast onset (10 seconds) and offset of action (3-10 minutes)
- Decreases
  - Cerebral metabolic oxygen demand
  - Shivering threshold

- Adverse effects: Hypotension, bradycardia, propofol infusion syndrome, hypertriglyceridemia

Zhou et al

- Clearance of propofol decreased by 25% compared to normothermia conditions
  - 0.59 (95% CI: 0.24–1.38) L/min vs 0.79 (0.58–1.08) L/min

Zhou et al. The effect of therapeutic hypothermia on drug metabolism and drug response: cellular mechanisms to organ function. Expert Opin Drug Metab Toxicol. 2011 Jul; 7(7): 803–816.

Sedation and Analgesia

Midazolam

- Benzodiazepine; provides sedation and amnesia
- Sedative impact on brain provides shiver control
- Onset of action (15 minutes); duration of action (<2 hours)
- Active metabolite: 1-hydroxymidazolam

▪ Adverse effects: Respiratory depression, bradypnea

➢ Accumulation of active metabolite in renal impairment; prolonged sedation

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Midazolam. Micromedex Solutions. Truven Health Analytics, Inc. Ann Arbor, MI. Available at: http://www.micromedexsolutions.com. Accessed June 5, 2017

Pop Quiz!

- A 50 year old post cardiac arrest patient is ordered cisatracurium while being started on external cooling pads to attain a temperature of 33ºC. What sedative would you recommend in this hemodynamically stable patient based on pharmacokinetic data available in patients undergoing TTM?

a. Propofol
b. Pentobarbital
c. Dexmedetomidine
d. Midazolam
e. None of the above

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d. Midazolam
e. None of the above

Neuromuscular blockers (NMB)

- Achieve target temperature quicker
- Quickest method to cease shivering
  - Useful in hemodynamically unstable patients

Caveats to Use

- Train-of-four (TOF) unreliable
  - Decreased peripheral nerve conduction
- Mask seizures
  - Continuous EEG monitoring is recommended

33 Lascarrou J, et al Neuromuscular blockade during therapeutic hypothermia after cardiac arrest: observational study of neurological and infectious outcomes. Resuscitation. 2014 Sep;85(9):1257-62
Murray MJ et al. Clinical practice guidelines for sustained neuromuscular blockade in the adult critically ill patient. 2016 Crit Care Med 44(11):2079–2103

Neuromuscular blockers (NMB)

2016 Critical care guideline recommendations:

- No recommendation for routine use in TTM
- Suggest NMBs can be used to manage overt shivering during TTM

Task force good practice statement:

- Assessment of degree of blockade
  - Peripheral nerve stimulation + clinical assessment (ventilator triggering, degree of shivering)
- Protocol guided NMB use in patients undergoing therapeutic hypothermia
- Adequate analgesia and sedation prior to and during neuromuscular blockade.

Murray MJ et al (2016) Clinical practice guidelines for sustained neuromuscular blockade in the adult critically ill patient. Crit Care Med 44(11):2079–2103

Neuromuscular blockers (NMB)

- Salciccioli et al
  - *Objective:* Continuous NMB for 24 hours and outcomes in OHCA
  - *Study design:* n=111, A post hoc analysis, prospective observation study
  - *Outcomes:*
    - Increase in crude survival rate with continuous NMB use
      - 78% vs 41%; p = 0.004
    - Post multivariate adjustment
      - OR: 7.23, 95% CI: 1.56-33.38
    - Showed improved lactate clearance

OR: Odds ratio
CI: Confidence interval
OHCA: Out of hospital cardiac arrest

Salciccioli J, et al Continuous neuromuscular blockade is associated with decreased mortality in post-cardiac arrest patients. Resuscitation. 2013 Dec;84(12):1728-33

Neuromuscular blockers (NMB)

- Lascarrou et al.
  - *Objective:* Effect of NMB on neurological outcomes and incidence of pneumonia
  - *Study design:* Observational retrospective study, n= 144
  - *Outcomes:*
    - No statistically significant difference in neurological outcomes after 3 months in NMB group
      - 42% vs. 36%, p = 0.26
    - Early-onset pneumonia higher in NMB group
      - 64% vs. 33%; p = 0.005; a*fter adjustment for propensity scores; no difference*

Lascarrou J, et al Neuromuscular blockade during therapeutic hypothermia after cardiac arrest: observational study of neurological and infectious outcomes. Resuscitation. 2014 Sep;85(9):1257-62

Neuromuscular blockers (NMB)

Cisatracurium

- Neuromuscular blocker; given only after sedation
- Eliminated through urine
  - Accumulation with renal impairment

Adverse effects:

- May mask insufficient sedation and/or seizures
- Neuropathy and prolonged weakness

Alternative Agent:

Vecuronium

- Active metabolite: 3-desacetyl vecuronium
- Rate of elimination decreased in hepatic dysfunction
  - Significant increase in duration of action

Cisatracurium..Micromedex Solutions. Truven Health Analytics, Inc. Ann Arbor, MI. Available at: http://www.micromedexsolutions.com. Accessed June 5, 2017
Vecuronium. Micromedex Solutions. Truven Health Analytics, Inc. Ann Arbor, MI. Available at: http://www.micromedexsolutions.com. Accessed June 5, 2017

Maintenance Phase

Post Cardiac Arrest Care

2015 Recommendations- Highlights

- Hypothermia (TTM) post cardiac arrest *should be maintained* for at least 24 hours after achieving target temperature.
  - Class IIa, (LOE C-EO)
- Reasonable to actively prevent fever in comatose patients after TTM.
  - (Class IIb, LOE C-LD)

LOE= Level of evidence
EO= based on consensus of expert opinions

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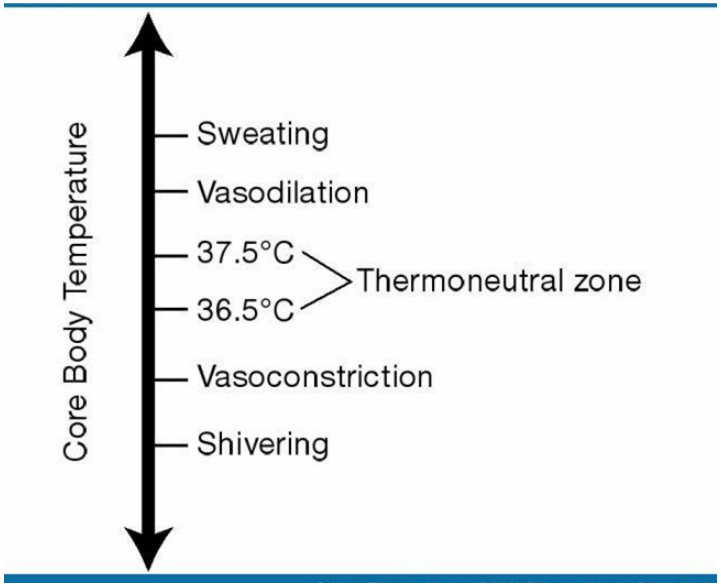
Shivering Pathophysiology

- Human body maintains a core temperature: 36.4ºC +/- 0.4ºC
- Shivering:
  - Involuntary response to enhance heat production
  - Resulting in an increase in oxygen consumption



Weant KA et al. Pharmacologic options for reducing the shivering response to therapeutic hypothermia. Pharmacotherapy Aug 2010.30:830–41.

Bedside Shivering Assessment Scale

- Bedside Shivering Assessment Scale (BSAS)
  - Quick assessment to identify shivering in patients

Table Bedside Shivering Assessment Scale[a]

Score	Type of shivering	Location
0	None	No shivering is detected on palpation of the masseter, neck, or chest muscles
1	Mild	Shivering localized to the neck and thorax only
2	Moderate	Shivering involves gross movement of the upper extremities (in addition to neck and thorax)
3	Severe	Shivering involves gross movements of the trunk and upper and lower extremities

[a] Data from Badjatia et al.[16]

- Frequent shivering assessment is required in the induction phase

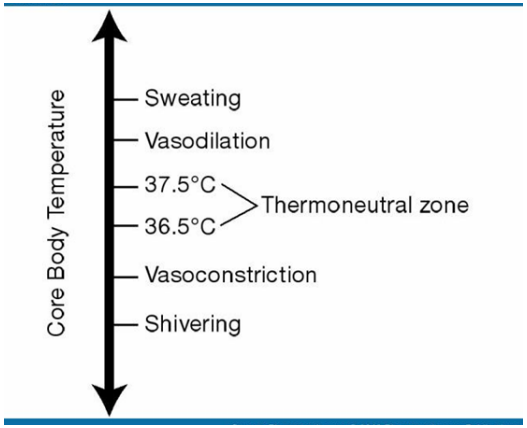
Badjatia N, Strongilis E, Gordon E, et al. Metabolic impact of shivering during therapeutic temperature modulation: the Bedside Shivering Assessment Scale. Stroke. 2008; 39(12):3232–3247.

Pharmacologic Management

Widen interthreshold range

- Lowering vasoconstriction and shivering threshold
- Raising vasodilation and sweating thresholds

- Pharmacologic agents:
  - Acetaminophen
  - Buspirone
  - Dexmedetomidine
  - Meperidine
  - Magnesium



Weant KA et al. Pharmacologic options for reducing the shivering response to therapeutic hypothermia. Pharmacotherapy Aug 2010.30:830–41.

Pharmacologic Management

Acetaminophen

- Inhibition of cyclooxygenase-mediated prostaglandin synthesis
- Lowers hypothalamic set-point
- Provides analgesia

Studies showed high dose acetaminophen (4-6 g /day) decreased body temperature by 0.3ºC – 0.4ºC

Adverse effects: Liver toxicity

Note: Dose reduction or discontinuation in hepatic impairment patients

43 Dippel DW, van Breda EJ, van Gemert HM, et al: Effect of paracetamol (acetaminophen) on body temperature in acute ischemic stroke: A double-blind, randomized phase II clinical trial. *Stroke* 2001; 32: 1607–1612

Pharmacologic Management

Buspirone

- Acts centrally as 5 HT1 receptor agonist to decrease shivering threshold

Mokhtarani et al showed that combination of buspirone and meperidine caused little sedation or respiratory adverse effects

- Shivering thresholds:

Buspirone 60mg	Buspirone 30mg + low dose Meperidine (serum conc 0.4mcg/mL)	High dose Meperidine (Serum conc 0.8mcg/mL)
35ºC +/- 0.8ºC	33.4ºC +/- 0.7ºC	33.4ºC +/- 0.7ºC

Adverse effects: Hypotension, nausea

Mokhtarani M, Mahgoub AN, Morioka N, et al. Buspirone and meperidine synergistically reduce the shivering threshold. *Anesth Analg.* 2001;93:1233-1239.

Pharmacologic Management

Buspirone and Dexmedetomidine

- Buspirone (5 HT1 receptor agonist), Dexmedetomidine (α2-agonist)

Lenhardt R et al showed buspirone and dexmedetomidine synergistically reduced shivering threshold.

- Shivering thresholds: ($p<0.01$)
  - Control: 36.4ºC +/- 0.5ºC
  - Buspirone only: 34.9ºC +/-0.6ºC
  - Dexmedetomidine only: 36.1ºC +/- 0.6ºC
  - Combination: 34.2ºC +/- 0.5ºC

Lenhardt R et al. Buspirone and dexmedetomidine synergistically reduce the shivering threshold in humans. Critical Care200711(Suppl 2):P334

Pharmacologic Management

Meperidine IV

- K-opioid receptors and α2 adrenergic receptors

Kurz A et al showed

- Reduced shivering threshold nearly twice as much as the vasoconstriction threshold
  - (6.1ºC +/- 3.0ºC and 3.3ºC +/- 1.5ºC, *p = 0.001*)

Adverse effects: Somnolence, seizures, hypotension, seizures

Kurz A et al Meperidine Decreases the Shivering Threshold Twice as Much as the Vasoconstriction Threshold Anesthesiology 5 1997, Vol.86, 1046-1054

Pharmacologic Management

Magnesium Sulfate

- Peripheral vasodilation – decrease time to goal temperature

Zwelfler et al

- Magnesium + Meperidine vs Meperidine containing other regimens in healthy patients cooled to 31ºC
- Showed that the magnesium group
  - » Higher comfort scores ($p < 0.001$)
  - » No adverse events associated with addition of magnesium
  - » Vasodilation: 88% vs 29% ($p = 0.02$)

Adverse effects : Hypotension, heart block, CNS depression

Zwelfler et al.Magnesium sulfate increases the rate of hypothermia via surface cooling and improves comfort.Stroke. 2004 Oct;35(10):2331-4

Pop Quiz!

- What is the major side effect we need to monitor for a patient receiving meperidine during TTM?

  a. Seizure
  b. Shivering
  c. Hypertension
  d. None of the above

Pop Quiz!

- What is the major side effect we need to monitor for a patient receiving meperidine during TTM?

  a. Seizure
  b. Shivering
  c. Hypertension
  d. None of the above

Rewarming Phase

Post Cardiac Arrest Care

2015 Recommendations- Highlights

- Reasonable to actively prevent fever in comatose patients after TTM
  - (Class IIb, LOE C-LD)

24 hours after TTM start time

- Goal:
  - Rewarm to 36.5ºC at a rate of 0.25ºC/hour
  - Actively maintain temperature at 36.5ºC for 24 hours
  - Passively maintain normothermia for next 48 hours

LOE=Level of evidence
EO= based on consensus of expert opinions

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Rewarming Phase

Post–cooling Fever

Bro-Jeppesen et al

- *Objective:* 30 day mortality in patients with post-cooling fever vs no fever
- *Study design:* Prospective, observational, cohort study, n = 270
- *Outcomes:*
  - 30 day mortality
    - Adjusted hazard rate (HR):1.8 (95% CI: 1.1-2.7, *p=0.02*)
  - Good neurological outcomes
    - (61% vs 75%, *p=0.02)*

Bro-Jeppesen et al Post-hypothermia fever is associated with increased mortality after out-of-hospital cardiac arrest. Resuscitation. 2013 Dec;84(12):1734-40

ICU Management

Electrolyte management

- Monitor levels:
  - Magnesium, potassium, calcium and phosphorus
- During TTM:
  - Dysrhythmias: low magnesium and potassium
  - Replace potassium: <3.5mEq/L
- Post TTM:
  - Elevation in electrolyte levels due to shifting of electrolytes
  - Increased hyperkalemia risk

Soleimanpour H, Rahmani F et al. Main Complications of Mild Induced Hypothermia after Cardiac Arrest: A Review Article. J Cardiovasc Thorac Res. 2014; 6(1): 1–8.

ICU Management

Hyperglycemia

- Decreased insulin sensitivity and secretion
- Negative neurological outcomes seen with hyperglycemia
- Management: Initiate continuous intravenous insulin
  - Monitor glucose levels closely

Venous Thromboembolism (VTE) Prophylaxis

- Assess patients coagulation need appropriately
- Avoid SUBQ administration

Stress Ulcer Prophylaxis

- Follow institutional policy

Lee R, Asare K. Therapeutic hypothermia for out-of-hospital cardiac arrest. Am J health-Syst Pharm. 2010;67:1229-37

Pop Quiz!

- The rationale for cooling patients post cardiac arrest is:

a. To preserve neurologic function
b. To allow heart to rest and recover
c. To allow patients body to recover from shock
d. None of the above

Pop Quiz!

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Pharmacist Impact

- High risk medication classes
- Potentially uncommon medications
- Reduce delay in medication administration
- Medication education

Be competent and proactive!

Targeted Temperature Management in Post Cardiac Arrest Patients

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Continuing Education Presentation
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Atlantic Health System

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