Post-Arrest Care:
Strengthening the Chain of Survival

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Induced Hypothermia: Strengthening the Chain of Survival

Why Should We Do It?

Hypothermia

Studied since ancient times

Why aren’t we doing it?

Who do we do it on?

Every one!

Induction Maintenance Rewarming

Rapid Induction Saves Brain

Rapid Induction Saves Brain

Induce with ICED Saline

Who am I?

The missing link in the chain

Clinical Trial of Induced Hypothermia to Currant Survivors of Out-Of-Hospital Cardiac Arrest

Australian Study

HACA

The New England Journal of Medicine

Hypothermia: The missing link in the chain of survival.

The missing link in the chain of survival.
Immersive Bath Systems

Induce with ICED Saline

Circulation

Place on temp monitoring

Place on Maintenance Device

Opioids/Sedation

Iced Saline

30 cc/kg

(Temp°C - 34) x 15 cc/kg

About 1 liter per ºC

100 cc/min

Max of 30 cc/kg

Probe Lag

Wait out the Probe Lag

Give More Iced Saline if Necessary

Anti-Shivering Protocol

Bedside Shivering Assessment Score

0 - None no shivering
1 - Mild neck/shorex, may be on ECST
2 - Moderate intermittent involvement of extremities + shiver
3 - Severe generalized shivering or sustained upper extremity shivering

Induction Maintenance Rewarming

32 - 34 ºC for 24 hours

Evaporative Cooling

Water Circulating Blankets

Hydrogel Devices

Tight Wrap Blankets

Intravascular Catheters

- Not studied as well as warming blankets and icy.
If you get them through the first 48 hours, things can get much better
Inclusion Criteria (Must have All)
- Post Cardiac Arrest (Any rhythm as cause of arrest is eligible)
- ROSC < 30 min from EMS/Code Team Arrival
- Time now <6 hrs from ROSC
- Comatose (Does not follow commands)
- MAP > 65 on no more than one vasopressor

Exclusion Criteria
- Pt has DNR, poor baseline status, or terminal disease
- Active or Intracranial Bleeding
- Traumatic etiology for arrest
- Cryoglobulinemia
- Pregnancy (Relative-Consider OB/Gyn consult)
- Recent Major Surgery (Relative)
- Sepsis as cause of Arrest (Relative)

Eye Opening
- Spontaneous

Voice
- Confused
- Inappropriate

Pain
- None

Motor
- Obey
- Localizes
- Withdraws
- Decorticate
- Decerebrate
- Intubated

Brainstem
- Pupils React
- Corneal
- Spontaneous
- Respiration
- Doll’s Eyes

Intubated
- None

Neurologic Exam

DTRs:
- Bicep
- Knee
- Toes

List any Sedatives or Paralytics On-Board at time of Exam:

If any Starred (*) Item is checked off on the neuro exam, the patient is ineligible for the protocol.

Protocol

• Discuss Case with ICU Fellow or Attending (They must agree with the plan for hypothermia and an ICU bed must be available in next few hours)

• Time of Discussion: If pt is deemed ineligible by ICU, list reason:

• Send blood for: CMP, LFTs, Superstat I, Lactate, CBC, PT/PTT, CK/MB/Troponin, Lipase/Amylase

• Place Foley catheter and monitor urine output.

• Completely expose patient and place cooling blanket above and below with nothing between blanket & skin.

• Place temp probe in esophagus (38-42 cm); if unable to place in esophagus, probe can be placed rectally (5 cm)

• Hook both cooling blankets and the probe to the same blanketrol machine.

• Set temperature to 33º C and Set the machine to “Auto Control”.

• List time Now: List Initial Patient Temperature:

• If initial temperature is < 34º C, allow patient to warm to 33º C.

• Begin opioids & sedation. Titrate to Ramsay Score 4/5.

• Infuse refrigerated crystalloid preferably through large bore, peripheral IV.

  Amount of crystalloid is (Initial Temp °C - 34 = liters of iced saline) Maximum initial infusion is 30 cc/kg. Administer at ~100 ml per minute using pressure bags.

• Administer Tylenol 650 mg GT Q 6 hours and Buspirone 30 mg GT Q 8 hours unless pt has allergy or on MAO inhibitor.

• If during induction, pt has shivering unrelieved by the above meds, Vecuronium 0.1 mg/kg x1 can be used

• The goal temperature is 34º C; after initial infusion is completed, wait 15 minutes. If temp > 34º C, infuse 250 cc boluses of cold crystalloid Q 10 min until <34.5º C

• Total Cold Crystalloid Infused: Time that Pt reaches 34º C:

• If patient’s temperature rises above 34.5º C, infuse 250 cc boluses of cold crystalloid Q 10 min until <34.5º C.

• Assess for shivering Q 15 minutes. If any signs of shivering, see the protocol on page 2.

• Maintain temperature 32-34º C for 24 hours (ideal temperature is 33º C).

• If significant bleeding or severe hemodynamic instability, consider rewarming. See ehced.org for protocol.

• Time of Rewarming: Reason Necessary:

• Maintain MAP>80: Pressors and/or Dobutamine may be used during protocol, if fluid loading ineffective.

8/2/08
Induction of Hypothermia

See First Page

Procedures

- Full sterile neck line with CVP monitoring
- Full sterile femoral arterial line (Axillary if femoral contraindicated/unsuccessful)
- Foley Catheter with hourly urine monitoring
- Orogastric Tube on suction

Ventilation

- Send an ABG, **DO NOT INDICATE THE PATIENT’S TEMPERATURE ON THE ABG ORDER**
- Place patient on AC Mode
- Set Vt to 8 ml/kg IBW (see last page)
- Set IFR to 60 lpm
- Set Initial rate to 18 bpm
- Set Initial O2 to 50%
- Titrate FiO2/PEEP to achieve corrected ABG PaO2 > 60. To correct ABG O2 for temperature: Subtract 5 mm Hg for every 1 C below 37°C.
- Often pulse ox will not read well due to peripheral vasoconstriction

Hemodynamic Goals

- **Ensure Adequate Preload**
  Assess by passive leg raise, pulse pressure variation, and echo. CVP may provide some indication if very low. Use normal saline or lactated ringers boluses. Use room temperature fluid if patient at goal temperature. Replace patient’s urine losses 1:1
- **MAP > 65** at all times, MAP > 80 is preferred to augment cerebral perfusion
  Preferred initial pressor is norepinephrine, may add vasopressin if necessary
  If MAP is < 80 and CVP > 10 perform passive straight leg raise to assess fluid responsiveness.
  If MAP > 100, start nitroglycerin infusion
- **Corrected ScvO2 > 70**
  Can be measured by PreSEP catheter or corrected central venous O2 saturation (send blood gas as mixed venous WITH PATIENT’S TEMPERATURE ON THE ORDER)
  If ScvO2 < 70 and HB < 7 (some would advocate <10 as trigger), transfuse patient
  If HB > 7, evaluate echocardiogram and consider inotropes vs. balloon pump/revascularization
- **Lactate**
  Hypothermia will raise lactate levels and post-arrest patients will have high lactate. Send a baseline level after the patient achieves goal temperature. From this point on, the lactate should stay the same or drop. If lactate is increasing, the patient is under-resuscitated or seizing

Sedation

- To gain the full benefits of hypothermia, it is imperative that the patient is adequately sedated
- Optimize fentanyl infusion rate first
- Add on propofol if necessary
- Titrate to Ramsay Score of 4/5 (see last page)
**EHC ED Critical Care**

**Post-ROSC Care Package**

**Labs & Electrolytes**
- Send Superstat I (ABG with Electrolytes) and Lactate Q 1 hour for first 4 hours, then Q 4 hours
- On arrival, send CMP, CBC, Lytes, PT/PTT, Lipase, Cardiac Enzymes, Type and Hold, Pan-Cultures
- Send CMP (complete metabolic panel) and CBC Q 4 hours
- Send Cardiac Enzymes Q 8 hours
- Keep Magnesium at high-normal at all times with aggressive IV repletion
- Replete Potassium if < 3.4 with IV KCl
- Keep iCal at high normal at all times
- Keep Sodium at least 140 at all times; 150 is preferable
- Keep Glucose < 150 with subcutaneous or Drip Insulin

**Cardiac Testing**
- Get EKG immediately upon arrival; at the start of hypothermia induction; and Q 1 hour for the first 4 hours
- If possible, get a bedside transthoracic echo at the start of induction. In the ED, this should be performed by the emergency physician or cardiology. Look specifically for qualitative LV function, RV function, pericardial effusion/tamponade, & gross valve function

**DVT Prophylaxis**
- If no contraindication, Heparin 5000 units subcutaneous Q 8 hours

**Stress Ulcer Prophylaxis**
- Nexium 40 mg IVSS

**VAP Prophylaxis**
- Head of bed to 30°
- Place in-line closed suction and perform aggressive pulmonary toilet

**Additional Testing**
- Consider Head CT if possible neurologic cause to arrest. Note: even an intracranial bleed is not a contra-indication to continuation of induced hypothermia. Consider letting the patient drift to 34°C and administration of dDAVP.
- Consider CTA if strong suspicion of PE as the cause of arrest. Bedside dopplers by EP or sono technician may be good first step
- EEG if seizures (convulsive or non-convulsive) are suspected

**Revascularization for STEMI**
- PCI is preferred, consult with CPORT fellow/attending and CCU fellow. Hypothermia does not need to be discontinued for PCI
- If PCI is not available or will be delayed, thrombolysis should be administered. Thrombolysis can be given during hypothermia. CPR performed prior to ROSC should not stop reperfusion therapy. Use standard doses of Retevase. Consult with CPORT fellow/attending.

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This package outlines suggestions for the care of the Post-Arrest patient. It does not set a standard of care and individual patient circumstances should always be taken into account when making treatment decisions.
Ramsay Sedation Scale
1. Patient is anxious and agitated or restless, or both
2. Patient is cooperative, oriented, and tranquil
3. Patient responds to commands only
4. Patient exhibits brisk response to light glabellar tap or loud auditory stimulus
5. Patient exhibits a sluggish response to light glabellar tap or loud auditory stimulus
6. Patient exhibits no response

Shivering Protocol After Induction
Bedside Shivering Assessment (BSAS) (Neurocrit Care 2007;6:213)
0-None, no shivering. Must not have shivering on EKG or palpation.
1-Mild-localized to neck/thorax. May only be noticed on palpation or EKG.
2-Moderate-intermittent involvement of upper extremities +/- thorax
3-Severe-generalized shivering or sustained upper extremity shivering

• All patients receive
  Acetaminophen 650 mg GT Q 6 hours unless allergic and
  Buspirone 30 mg GT Q 8 hours unless allergic or on MAO Inhibitors

• If BSAS > 1, add Fentanyl Drip (titrate as per EHCED drip sheet)
• If BSAS still > 1, add Propofol Drip (titrate as per EHCED drip sheet)
• If BSAS still > 1 after titration of sedation/opioid, add Nimbutal 0.15 mg/kg IV Q 1 hour PRN
Paraesthesia should only be necessary under extraordinary circumstances!

ARDSNet Vent Protocol

INCLUSION CRITERIA: Acute onset of
1. PaO₂/FIO₂ ≤ 300 (corrected for altitude)
2. Bilateral (patchy, diffuse, or homogeneous) infiltrates consistent with pulmonary edema
3. No clinical evidence of left atrial hypertension

PART I: VENTILATOR SETUP AND ADJUSTMENT
1. Calculate predicted body weight (PBW)
   Males = 50 + 2.3 [height (inches) - 60]
   Females = 45.5 + 2.3 [height (inches) - 60]
2. Select Assist Control Mode
3. Set initial TV to 8 ml/kg PBW
4. Reduce TV by 1 ml/kg at intervals ≤ 2 hours until TV = 6 ml/kg PBW.
5. Set initial rate to approximate baseline VE (not > 35 bpm).
6. Adjust TV and RR to achieve pH and plateau pressure goals below.
7. Set inspiratory flow rate above patient demand (usually > 80L/min)

OXYGENATION GOAL: PaO₂ 55-80 mmHg or SpO₂ 88-95%
Use incremental FIO₂/PEEP combinations below to achieve goal

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PLATEAU PRESSURE GOAL: ≤ 30 cm H₂O
Check Pplat (0.5 second inspiratory pause), SpO₂, Total RR, TV and pH (if available) at least q 4h and after each change in PEEP or TV.

If Pplat > 30 cm H₂O: decrease TV by 1 ml/kg steps (minimum = 4 ml/kg).
If Pplat < 25 cm H₂O: TV < 6 ml/kg, increase TV by 1 ml/kg until Pplat > 25 cm H₂O or TV = 6 ml/kg.
If Pplat < 30 and breath stacking occurs: may increase TV in 1 ml/kg increments (maximum = 8 ml/kg).

pH GOAL: 7.30-7.45
Acidosis Management: (pH < 7.30)
- If pH 7.15-7.30: Increase RR until pH > 7.30 or PaCO₂ < 25 (maximum RR = 35).
- If RR = 35 and PaCO₂ < 25, may give NaHCO₃.

If pH < 7.15: Increase RR to 35.
If pH remains < 7.15 and NaHCO₃ considered or infused, TV may be increased in 1 ml/kg steps until pH > 7.15 (Pplat target may be exceeded).

Alkalosis Management: (pH > 7.45) Decrease vent rate if possible.
The Evidence


Who Gets It?
Patient should either be made palliative or get the full post-rosc package. Consider a trial of critical care: 48-72 hours, and then withdraw care.

Induce with Iced Saline
I recommend iced saline even with endo-vascular cooling (Resuscitation 2005;64(3):347-351)


Post-arrest patients are vasodilated from SIRS response; they need volume. (Circ 2002;106;562-568)

Until prospective validation, I would still would give a maximum of 30 cc/kg and then wait until temperature equilibration, before giving more.

Ventilator
6-8 cc/kg
Plateau Pressure <30
Titrate PEEP/FiO2 to achieve O2 Sat>90%

ABGs
Send ABG without indicating patient temperature. (Alpha-stat management)
Pulse ox will likely be inaccurate, use ABG PaO2corrected by subtracting 5 mm HG for every degree below 37.

Bleeding Effects
No coagulopathy until <33.5.
Mild platelet effects below
35; the latter may be reversed by dDAVP (Resuscitation 2008;76:129)

**Cardiac Stunning and Dobutamine**

**Thrombolysis after Cardiac Arrest/CPR**