Therapeutic Hypothermia After Cardiac Arrest (Catheter Cooling) Guideline
ProHealth Care

Goals:
The aim of this therapy is to suppress the chemical reactions that occur when vital signs have been absent and reperfusion has occurred after cardiac arrest. To initiate current evidence based research and best practice guidelines to the caregiver, which has been shown to improve patient neurologic outcomes post cardiac arrest, where resuscitation has been delayed or prolonged. Induction of mild hypothermia post cardiac arrest will slow bodily processes thereby decreasing the effects of hypoxia after the cardiac event.

Zoll / Alsius Cooling Catheter:
The cooling catheter should be placed in the femoral vein and functions as a closed loop interval cooling circuit, which cools the blood as it circulates past the catheter. The catheter is attached to the Zoll/Alsius thermal regulation system, which monitors catheter performance and measures temperature via a connection to the internal thermometer probe. The machine should ideally be plugged in 20 minutes prior to use and set to maximal cooling with a target temperature of 33°C for 24 hrs. ICY Cath for shorter patients, Quatro for taller patients.

Equipment:
1) CVP/PA or Esophageal, and bladder catheter temperature probe
2) One cooling blanket devices
3) Two liters of 4°C .09% Saline
4) Cooling Catheter

Inclusion criteria:
- Hypothermia should be initiated as soon as possible after the of return of spontaneous circulation (ROSC)
- Must include the following:
  o Post cardiac arrest (does not need to be witnessed) : defined as absence of pulse requiring chest compressions, regardless of location of collapse, or initial rhythm, with subsequent ROSC.
  o Comatose with Glasgow Motor Score (GMS) Less than 6
    ▪ 6 – Obeys commands
    ▪ 5 – Localizes painful stimuli
    ▪ 4 – Flexion/Withdrawal to painful stimuli
    ▪ 3 – Abnormal flexion to painful stimuli (decorticate response)
    ▪ 2 – Abnormal extension to painful stimuli (decerebrate response)
    ▪ 1 – Makes no movement to painful stimuli

Exclusion Criteria:
- Patient is under18 years of age (for younger patients coordinate care plan with Children’s Hospital of Wisconsin).
- Active DNR (Do Not Resuscitate) order
- Presence of severe pre-arrest cognitive impairment (ie. Nonverbal and bed bound)
- Time is greater than 12 hours from ROSC
- Uncontrolled Bleeding
- Evidence of Trauma – ie: Trauma as possible cause of cardiac arrest (because of active bleeding) {note: hanging typically results in an anoxic arrest and therefore is not a contraindication based on mechanism alone}
- Presence of other etiology for coma (ie. Head Trauma, Hemorrhagic Stroke, Status Epilepticus, etc..) {note: narcotic overdose completely reversed with Narcan is not an exclusion criteria}
- Pre-existing multi-organ dysfunction syndrome or severe sepsis
- Comorbidities with minimal chance of meaningful survival independent of neurologic status
- Cardiac instability
  - Refractory or recurrent life threatening dysrhythmia
  - Hypotension is not a contraindication unless caused by persistent dysrhythmia
- Note: Respiratory arrest leading to cardiac arrest is not a contraindication to cooling.

Relative Exclusion Criteria:
- Environmental hypothermia exposure (warm patient to 32-34° C and continue protocol)
- History of Bleeding disorder or current coagulopathy (Coumadin, Lovenox, Aspirin, etc.. are not contraindications) {note: target temp of 36° C does not affect coagulation – consider this option}
- Controlled bleeding : target temp of 36° C does not affect coagulation – consider this option
- Overdose : If ROSC, and sedative effect of overdose has been reversed, and patient remains altered with GMS less than 6, and there is concern for anoxic injury, patient is a candidate for cooling. If patient remains comatose and there is a persistent pharmacologic reason for their mental status, they are not a candidate for cooling.
- Pregnancy: as per one case report, cooling can be performed safely on pregnant patients.

For patients meeting criteria for 36° C target temperature, see appendix A below.
Pre-induction phase:
- Start 2 IVs each 20 ga or larger
- Continuous ECG monitoring
- Continuous \( \text{SpO}_2 \) monitoring
- Hyperoxia is harmful in ROSC. Titrate \( \text{FiO}_2 \) to hold \( \text{SpO}_2 \) between 92 – 96%
- Insert Temp Probe Foley Catheter
- Urine HCG on females of child bearing age
- Order ABG, CBC, BMP, INR, LFT's, Troponin, CPK with MB, Lactate, Mg, PO_4
- Order PCXR post intubation
- Order Head CT to rule out intracranial bleed (Should be done at a convenient time before the “monitoring phase”. Should not delay cardiac cath unless there is a high suspicion of intracranial bleed)
- Insert nasogastric or oral gastric tube
- Document baseline vitals at a minimum of every 15 minutes
- Assess and document baseline skin condition
- Insert an arterial line
- Insert two core temperature monitoring devices (CVP/PA cath or Esophageal temp probe) {connected to temp port #1 on Zoll machine} and (bladder or rectal probe) {connected to temp port #2 on Zoll machine} The second core temperature monitoring device should be placed as soon as possible to allow complementary core temperature readings.
- Place Cooling Catheter {Set target temp to 33°C} (catheter may be placed in cardiac cath lab)
- Order KUB x-ray to confirm location of catheter tip (may be done with fluoroscopy as well)
- Anticipate need for vasopressor support
- Position cooling blanket under patient with sheet between blanket and patient if delay in placing cooling cath {preferred to place cooling blanket on bed prior to patient arrival}
- Intubate patient with ETT
- Sedate patient (consider Propofol 5-10 mcg/kg/min or Versed drip) and/or (Fentanyl 50-100mcg bolus and 50mcg/hr drip) {narcotics are important to control shivering and treat pain}
- If monitoring sedation with Bispectral Index Monitoring (BIS), titrate to goal : 40-60
- Paralyze patient with neuromuscular blocking agents as needed for shivering (consider drip)
- Wrap hands and feet in towels to prevent frost bite and decrease shivering stimulus

Induction Phase:
- Hypothermia procedures should not delay interventional cardiology
- Place cloth protected ice packs in groin and axilla – will be removed when temp is 34°C
- Infuse 30ml/kg of 4°C saline rapid bolus via pressure bag (max of 2 liters) if {the patient is not already at target temperature, additional fluid is not contraindicated, a cold fluid bolus has not already been administered}
- Do not administer cold saline bolus if obvious pulmonary edema is present
- Place second cooling blanket on top of patient with sheet between blanket and sheet (if delay in placing cooling cath)
- The cooling blankets should not make direct contact with the patient’s skin
- Turn on the cooling blankets in manual mode and set temperature at 4°C (Gaymar flat blanket style)
- Cooling blankets can be removed once cooling catheter has been placed.
- Automated cooling devices (Zoll / Alsius) should be set with a target temp or (set point) of 33°C.
- The patient’s temperature should be kept between 32°C and 34°C for 24 hrs from the time target temperature is reached
- The patient should be cooled as fast as possible until target is reached
- The temperature should not go below 32°C
Document core temperature every 15 min during cooling and rewarming.
- Be aware of subclinical shivering (see appendix B below)
- Consider continuous EEG monitoring for 48 hrs due to 10-15% incidence of seizures
- Once catheter location confirmed, initiate max cool algorithm on Zoll / Alsius device (set point 33°C)

Monitoring/Maintenance Phase:
- Document core temperature every hour during maintenance.
- Continue to assess patients skin every 2 hrs
- Continuous ECG monitoring (bradycardic rhythms are common)
- Keep Head of Bed elevated at 30°
- Reposition patient q 2° and PRN
- Do not perform invasive thoracic procedures or reposition the patient if temp is < 32°C
- Monitor vital signs per ICU routine
- Mean Arterial Pressure (MAP) goal (90-100 mmHg) or BPs 120.
- Use vasopressor support as needed
- Insulin drip as ordered for glucose management
- Maintain CVP between 8-12 mmHg (euvoolemia, unless other concerns, ie: CHF)
- Monitor blood glucose every 4 hrs or as ordered per glucose management protocol
- Be sure to avoid heated humidified oxygen on the ventilator
- NG or OG to low intermittent suction
- Avoid maintenance fluid containing dextrose
- Constant assessment for shivering
- Pepcid 20mg IVP q 12°
- Tylenol 650mg NG or PR q6° x 24°
- Avoid bed bath during administration of hypothermia
- Often continuous neuromuscular blockade may be stopped during this phase and used only as needed for shivering. Be aware of subclinical shivering (see appendix B below)
- Blood glucose should be maintained between 125-175 mg/dl
- Once the temperature has reached the machine’s set point, record, and monitor the location of the cooling “power” indicator on the machine.

Re-Warming Phase:
- Consider increasing CVP to 15 mmHg just prior to warming, unless CHF as patient will vasodilate with warming
- Automatically re-warm the patient after 24 hr hypothermic period complete with Zoll / Alsius cooling cath algorithm pre-programmed in machine. (target temp 37°C)
  o Hypothermic period starts once target temperature is reached
  o The patient should be re-warmed at a rate no faster then 0.25°C per hour
- Neuromuscular blocking agents may be needed during re-warming phase to prevent shivering but should no longer be needed once 36°C is reached.
- Once warmed, patients may become hyperthermic.
  o Screen for sources of infection (ie. Blood cultures x 2, UA with culture, pCXR, etc.)
  o Tylenol 1000mg PO or PR q 6°PRN Temp > 37.5°C.
  o Consider using active cooling/warming to maintain normothermia for 48 hrs.
- Anticipate increased CO₂ production during rewarming and possible need for ventilator adjustment
- Stop Potassium containing solutions unless hypokalemic (potassium will increase during rewarming)
Special Considerations:
- Rectal temperature monitoring is the least accurate and is not preferred.
- Avoid IV solutions containing dextrose unless hypoglycemia has developed.
- Watch for clinical symptoms of seizure in paralyzed patient (unexplained tachycardia)
- Avoid hyperventilation
- Perform routine neuro assessment q 4° once rewarming is complete
- Obtain Neuropsychology consultation prior to discharge

Reasons to Abort Cooling:
- Significant hemorrhage
- Severe and persistent arrhythmia causing hypotension
- Decision to withdraw care or palliative care
- Ethical reasons: ie. Previously unknown end-stage cancer or refractory shock with end-stage multiorgan failure

Do not Abort Cooling if:
- Cardiac arrest – perform ACLS as if patient was normothermic
  - If regain ROSC, restart 24hr hypothermic monitoring phase at time of new ROSC

Diagnostic Studies (Laboratory/Radiology – if not already done)
- ABG, CBC, CMP, Mg, PO₄, INR, PTT, Lactate q 6° x4
- CPK, CPK-MB q8° x 3
- Troponin q8° x3
- Potassium q2° during re-warming phase until Temp ≥ 36°C
- LABS: Include patient’s body temperature in order and on label if < 37°C
- Blood sugar per protocol
- PCXR – re: ETT placement, R/O aspiration
- 12 lead EKG q 12° x 2
Neuroprognostication:

- Standard prognostication techniques were developed prior to therapeutic hypothermia
- Neurologic evaluation for ROSC patients based on:
  - Clinical neurological examination {including but not limited to: GCS, pupillary and corneal reflexes, N20-peak on median nerve somatosensory evoked potentials (SSEP), and EEG}.
- Recommend waiting 72hrs after rewarmed to 37°C before determining prognosis
- Findings allowing for discontinuation of active intensive care:
  - Brain Death due to cerebral herniation
  - Severe myoclonus status in the first 24 hrs after admission and a bilateral absence of N20-peak on median nerve SSEP
  - Minimum of 72 hrs after warmed: persisting coma with GMS 1-2 and bilateral absence of N20-peak on median nerve SSEP
  - Minimum of 72 hrs after warmed: persisting coma with GMS 1-2 and a treatment refractory status epilepticus
- Patients with GMS 1-2, 72 hrs after warmed with retained N20-peak on the SSEP or if SSEP not available:
  - Re-examination daily
  - Consider withdrawal of intensive care if: No improvement in GMS and metabolic and pharmacological affection is ruled out
Appendix A: Therapeutic Hypothermia with Target Temperature of 36°C

On Nov 17th, 2013, Nielsen published an article in the NEJM that allows the option to cool patients to a target temp of 36°C instead of 32-34°C. There are many advantages to using a target temp of 36°C. At this temperature, pharmacologic, electrolyte, metabolic, sedative, hemodynamic, coagulopathic, and shivering challenges are avoided. A potential limitation to this study is that 70% of the patients had bystander CPR. This could decrease the relative severity of the brain injury sustained by these patients, and therefore, may not accurately reflect the patient population in every area. Data is still lacking to demonstrate that 36°C is therapeutically equivalent to 33°C for patients with moderate and severe brain injury. Since the severity of brain injury can not be accurately predicted prior initiating cooling, a target temp of 32-34°C is still recommended for most patients. If for clinical reasons, a provider feels that cooling a patient to a target temperature of 33°C carries too much risk (perhaps due to cardiac instability or risk of bleeding), there is good evidence to allow cooling to a target temperature of 36°C. The remainder of the protocol is unchanged however management can be more consistent of a typical intensive care patient since rewarming, drug metabolism, electrolyte, and shivering problems are much less likely. It is possible that in the future, the target temperature of 33°C will be abandoned for a target temp of 36°C on all patients.

Appendix B: Subclinical Shivering

Shivering can be either visible or invisible. The first indication of shivering may be labored breathing, a fall in mixed venous O2 saturation, and heightened muscular tone. Visible shivering may be as subtle as involuntary facial and neck muscle contractions or trembling on palpation of the thorax. Shivering can triple oxygen consumption, causing hypoxemia, and organ ischemia. It will also increase intracranial pressure. Therefore shivering is undesirable in critically ill patients and in post cardiac arrest patients. Shivering is most likely to occur between 34 and 36°C. Therefore, either cooling patients to 36°C or rapidly cooling patients beyond 34°C is ideal. Shivering is common with surface cooling techniques but only occurs in 3.7% of patients cooled intravascularly. Make note of cooling power indicator on cooling machine throughout maintenance phase. If the cooling machine suddenly has to put more power into keeping the patient cool, they are likely shivering.

Signs of subclinical shivering:
- Increase heart rate without other cause
- Patient’s rate of cooling is slow or has slowed
- Cooling machine moves to colder mode vs previous baseline
- Evidence of shivering on EEG

Consider temporary neuromuscular blockade

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