Targeted Temperature Management: Normothermia after Cardiac Arrest (NACA)

I. Rationale

Hyperthermia in the setting of cardiac arrest is associated with worse neurological outcomes (Zeiner, 2001). Increased brain metabolism secondary to fever can exacerbate neuronal damage due inflammatory changes and biochemical cascades that develop following ischemia and reperfusion injury associated with cardiac arrest (Polderman, 2004). Evidence on temperature management in cardiac arrest is limited, and the ideal temperature goal has not been determined (Nielsen, 2013).

This guideline section provides a therapeutic alternative to hypothermia after cardiac arrest (HACA) which has a goal temperature of 33°C. Targeted temperature management with goal temperature of 36°C may be considered an alternative to HACA in the unresponsive post-cardiac arrest patients in which return of spontaneous circulation (ROSC) is achieved (Nielsen, 2013). Currently, there is uncertainty about whether certain patients may benefit from one more than the other, and the decision for which temperature target to set should be made on an individual basis.

Differences between NACA and HACA

<table>
<thead>
<tr>
<th></th>
<th>NACA</th>
<th>HACA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Target Temperature</td>
<td>36°C</td>
<td>33°C</td>
</tr>
<tr>
<td>Paralytics</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>Sedation</td>
<td>+</td>
<td>++</td>
</tr>
<tr>
<td>Shivering</td>
<td>++</td>
<td>-</td>
</tr>
<tr>
<td>Duration of normothermia after the initial 24 hours</td>
<td>48 hrs*</td>
<td>24-48 hrs*</td>
</tr>
</tbody>
</table>

* Refer to TTM: Normothermia for Neuroprotection guideline for further details

Normothermia after cardiac arrest typically avoids the use of paralytics, although some patients may require medications for shivering suppression. Sedation requirements are lower for NACA. However, NACA also requires experience and knowledge in the identification and pharmacologic management of shivering, including micro-shivering. The duration of HACA is generally a period of 24 hours at 33°C, followed by normothermia maintenance at 37°C for 24-48 hrs. In contrast the NACA target of 36°C should be followed for 48 hours of normothermia at 37°C and then guided by the TTM normothermia for neuroprotection guideline for discontinuation determination.

General approach and intensity of therapy

Once a goal temperature is determined by the treating team, a graded intensity of therapy should be determined. An intravenous cold saline bolus administered through a peripheral IV catheter
can be considered as a following step, and a bladder temperature catheter may be used for continuous temperature measurement until a TTM cooling device is initiated.

II. Patient eligibility

1. In- or out-of-hospital VF, asystole, or PEA cardiac arrest requiring CPR and with return of spontaneous circulation (ROSC).
2. Comatose, defined as Glasgow Coma Score (GCS) < 8.
3. Adults age ≥18 years old. For pediatric patients, please see Pediatric ICU guideline for therapeutic hypothermia.
4. The Stroke/ICU consult Service should be consulted to assess and document the comatose state prior to or immediately after the initiation of TTM. Page the Stroke/ICU consult Service (beeper 20202) for the initial consult.

III. Relative Exclusion Criteria

1. Contraindications to induced temperature reduction, such as patients with known hematological dyscrasias which affect thrombosis, (cryoglobulinemia, sickle cell disease, serum cold agglutinins), or known deep venous thrombosis (for femoral catheter approach only)
2. Peripheral vasospastic disorders
3. Contraindication for central venous catheter placement (for catheter-based approach only)
4. Known or suspected diagnosis of heparin induced thrombocytopenia (for catheter-based approach only).
5. Extensive skin defects (for cooling vest approach only)
6. Diagnosis of sepsis syndrome

IV. Procedure for Normothermia for cardiac arrest

Targeted temperature management at 36°C after cardiac arrest is a time targeted procedure unlike other normothermia strategies. It requires a change in target temperature after 24 hours.

1. All patients started on the NACA protocol will have a bladder or esophageal temperature probe will be placed.
2. Hemodynamics: MAP range of >70 mmHg is preferred for cerebral perfusion, using inotropes as needed. However, TTM should not be terminated if a MAP >70 mmHg cannot be achieved. Clinicians should take into consideration the context of individual patients with the amount of pressor needed to meet MAP >70 mmHg.
3. **The target temperature for NACA is 36.0 ± 0.5°C (95.5-97.5°F) for the first 24 hours, followed by 37.0 ± 0.5°C (97.5-99.5°F) for at least 48 hours.**
4. After the initial 24 hrs of targeted temperature at 36°C, set the console to rewarm to 37°C (98.6°F) at a rate of no more than 0.5°C per hour. The Arctic Sun device is used in automatic mode only to maintain safe rewarming.
5. Electrolyte disturbances may occur and infection may develop and be difficult to detect through ordinary measures. Therefore, use clinical judgment to determine the frequency
of checking electrolyte panel, CBC, and blood cultures. A typical frequency may be every 12 hours for the first 24 hours.

6. Use of muscle paralysis is not routinely used in NACA unless indicated for shivering management.

7. Methods for induction and management are similar for all normothermia targeted temperature management strategies.

8. EEG monitoring: Continuous EEG may be considered for prognostic purposes. Please see the associated Neurological Prognosis After Cardiac Arrest guideline for the indication and interpretation of EEG monitoring.

V. Methods

A. Cold Saline Induction (optional)

Cold saline chilled to 4°C has been used to lower temperature during TTM therapy. At the discretion of the treating team, it may also be useful in “breaking” high fever in neurologically impaired patients. However, the administration via an internal jugular or subclavian venous catheter is unsafe due to the risk of dysrhythmia and contraindicated if a TTM device is in use.

Materials needed:
1. Foley catheter temperature device or esophageal temperature device and temporal artery thermometer
2. Chilled 0.9% Normal Saline at 4°C from medication refrigerator.
3. Patient weight determines the amount of saline delivered:
   a. Calculation is 30cc/kg infused intravenously over 30-45 minutes up to a maximum of volume of 2L.
   b. Careful clinical consideration is advised in cases of cardiogenic shock or left ventricle failure.
4. Peripheral IV access recommended. Cold Saline should be delivered through a peripheral line. There are case reports of chilled saline through a subclavian and internal jugular central venous catheter causing life-threatening arrhythmia. Delivery by a femoral venous line may be acceptable if no peripheral access is available.

Procedure:
1. Place catheter and record the temporal artery thermometer and/or bladder/esophageal temperature on the flow sheet.
2. Set up first liter of Normal Saline on large bore tubing and into a pressure bag for delivery into a peripheral I.V. Total cold normal saline fluid volume is calculated as 30cc/kg, run over 30-45 minutes.
3. Cold Saline should be given via a peripheral line.
4. Record temperature every 10 minutes during infusion and up to 30 minutes after.

B. Maintenance Cooling with an external cooling pad device:
1. Eligibility confirmed and materials gathered.
2. Place continuous temperature device and place cooling pads on patient. Pad size is determined by weight and height.
3. After applying pads, set target goal for **36.0 ± 0.5°C (95.5-97.5°F)** for the first 24 hours, followed by **37.0 ± 0.5°C (97.5-99.5°F)** for at least 48 hours thereafter.
   a. These pads may be used with external pacing pads. Place the external pacing pads on the chest and cover with Arctic sun pads.

4. Place Bair Hugger over patient and set on low.

5. To suppress shivering, start magnesium sulfate IV bolus (2g over 30 minutes) for a goal level of 3.0 - 4.5 mEq/dL, followed by a Magnesium sulfate infusion (initial maintenance rate: 1g/hr which is equivalent to 25mL/hr).

6. Record temporal artery temperature, patient temperature from continuous device and water temperature of the device q1-2hrs.

7. Assess for shivering and treat aggressively with counter measures and/or medication.


9. Follow and document fever burden (how many times patient had fever for 24 hour period)

10. Change goal temperature after 24 hours to **37.0 ± 0.5°C (97.5-99.5°F)** for at least 48 hours and refer to **Normothermia for Neuroprotection** guideline for further management if needed.

11. Determine discontinuation based on fever burden.

C. **Shivering management:**

Shivering may be encountered while maintaining normothermia, increasing metabolism and counteracting the benefit of targeted temperature management significantly. Shivering is evident on exam or should be suspected when water temperature of the device drops and remains low for a period over two hours. The shivering scale is a 5-step score ranging from no shivering to refractory shivering (see below).

**Shivering scale and recommended interventions:**

1. **No shivering:**
   - Begin standing acetaminophen
   - Forced air convection warmer (Bair Hugger) on low setting
   - Begin magnesium sulfate IV bolus (2g) over 30 minutes for a goal level of 3-4.5 mEq/dL followed by a Magnesium sulfate infusion (Initial Maintenance Rate: 1g/hr which is equivalent to 25mL/hr).
   - Magnesium sulfate is contraindicated in cases of renal insufficiency (calculated creatinine clearance rate < 30ml/min), neuromuscular junction disorders, second or third degree heart block, hyperkalemia (K >6mmol/L) or hypocalcemia (Ca <1.1 mmol/L).

2. **Shivering <5 min:**
   - Forced air convection warmer (Bair Hugger) on high setting
   - Meperidine intermittent IV push 12.5-50 mg as needed not to exceed 100mg every 6 hours. Contraindicated in the setting of renal insufficiency (serum creatinine ≥ 1.5) or with the concomitant use of monoamine oxidase inhibitors MAOI within the past 2 weeks.
• Buspirone 5 mg ORALLY 2-3 times a day OR 7.5 mg ORALLY twice a day; may increase the dosage by 5 mg/day every 2-3 days as needed (usual dose 20-30 mg/day 2-3 divided doses, MAX dose 60 mg/day)

3. Shivering sustained for >5 min after above interventions attempted:
   • Meperidine infusion 12.5-50 mg/hr
   • Propofol infusion at 10-300 mg/hr

4. Breakthrough shivering:
   • Consider infusion of dexmedetomidine 1 mcg/kg over 10 min. Maintenance infusion dose range is 0.2-0.7 mcg/kg/hr
   • Dantrolene. 50mg ORALLY 2-3 times a day; may increase the dosage by 25-75 mg/day every 2-3 days as needed; maximum dose 400mg a day.

5. Refractory shivering:
   • Neuromuscular paralysis with cisatricurium, vecuronium or discontinue TTM.

D. Discontinuation of normothermia after cardiac arrest:
After the first 24 hours with the goal temperature set as 36.0 ± 0.5°C (95.5-97.5°F), the guideline for normothermia for neuroprotection with a goal of 37.0 ± 0.5°C (97.5-99.5°F) should be implemented for at least 48 hours. Fever burden may be used to evaluate the continued need for targeted temperature management. Other considerations for discontinuation of normothermia therapy include risk-benefit ratio specific to the individual patient.

VI. References


VII. Authoring Information

Reviewed/Approved by:
   Critical Care Cooling Committee: 05/04/2015
Last updated: 05/04/2015
Targeted temperature management: Normothermia for cardiac arrest

- **Cold saline or TTM Device**
  - Intravenous cold saline infusion (if device not available)
  - Cooling pads applied, goal set to 36.°C.
  - Bair Hugger on low
  - Magnesium drip instituted

- **Maintenance**
  - Fever burden assessment
  - Continued shivering assessment and management
  - Surveillance cultures will be sent if there is clinical concern for infection

- **Shivering management**
  - Shivering assessment and scale
  - Counter measures and medications employed as needed.

- **Discontinuation of normothermia**
  - Once active normothermia not required to control fever
  - Risk/benefit of normothermia/shivering management
Targeted temperature management for Normothermia Cardiac Arrest Algorithm

NACA

Infection Rule Out
- Blood cultures if WBC increases

Cold Saline Challenge
- 4°C at 30cc/kg if TTM device not employed

Bladder catheter or esophageal temperature probe insertion

TTM device with target of 36°C for 24 hrs followed by 37°C for at least 48 hrs

Bair Hugger
- Magnesium sulfate
- Shivering algorithm

Shivering Management using shivering algorithm

Discontinuation of normothermia

Management steps for Shivering
0: No shivering
- **Tylenol** lowers hypothalamic set point
- **Magnesium** promotes vasodilatation/causes hypotension
- **Bair hugger** - forced air-warming increases surface temperature without significant changes in core temperature

1: <5 min shivering
- **Demerol** – lowers shivering threshold/ decreases seizure threshold
- **Buspirone** lowers shivering threshold/ works more effectively in conjunction with other meds.

2: >5 min shivering
- **Demerol infusion**
- **Propofol**- promotes mild vasoconstriction/ causes hypotension

3: >5 min breakthrough shivering
- **Dexmedetomidine** - manages vasoconstriction and shivering/ causes bradycardia
- **Dantrolene** - decreases muscle catabolism /flushing, AV block, drowsiness

4: Refractory shivering
- **Paralytics**- muscle relaxant, loss of exam, increased pneumonia rates
Shivering Scale and Management

No Shivering

- (0) Tylenol ATC
- Bair Hugger on low Magnesium infusion

< 5 minutes

- (1) Bair Hugger on high
- Meperidine bolus
- Buspirone

> 5 minutes

- (2) Meperidine or Propofol infusion

Breakthrough Shiver > 5 minutes

- (3) Dexmedetomidine
- Dantrolene

Refractory shivering

- (4) Cisatracurium or Vecuronium