TITLE: Therapeutic Hypothermia following Cardiac Arrest

This is a:  
✓ Guideline (recommended best practice)

OBJECTIVE:  
Reducing brain temperature during the first 24 hours following resuscitation from cardiac arrest and closely managing temperature for 48 or more hours has a significant effect on survival and neurological recovery. The use of targeted temperature management (TTM) by inducing mild therapeutic hypothermia (TH) early after ischemic insult has been shown to decrease the severity of anoxic brain damage and to improve neurological outcomes. The patients who qualify for TH have suffered from a cardiac arrest, have had a return of spontaneous circulation (ROSC), and have no purposeful movements post arrest.

PATIENT POPULATION:  
✓ Adult Critical Care  
✓ Emergency Dept

PATIENT ASSESSMENT (and DOCUMENTATION)  

Inclusion Criteria:  
1. ROSC from cardiac arrest with ability to initiate therapy within 6 hours  
2. No purposeful movements after ROSC  
3. Age >18 years  
4. Mechanically ventilated  
5. Blood pressure can be maintained at ≥90 mm Hg systolic spontaneously or with fluid and/or a maximum of two vasoactive agents

Exclusion Criteria:  
1. Alternative clinical conditions causing the patient to be comatose (i.e. drugs, sepsis, head trauma, stroke, overt status epilepticus)  
2. Major trauma or <72 hours after major surgery*  
3. Pregnancy in third trimester  
4. Temperature of <30° C following arrest  
5. Unstable blood pressure (MAP<60 mm Hg for >30 minutes on vasopressor therapy) or ventricular rhythm unresponsive to therapy. The addition of a 3rd pressor or a 2nd pressor with mechanical circulatory support is generally considered too unstable to initiate therapy.  
6. Known or preexisting coagulopathy (PTT >1.5 times upper limit of normal or active bleeding)  
7. Cryoglobulinemia  
*May consider therapy with a goal temperature of 35-36° C with attending physician approval

TREATMENT & MONITORING (and DOCUMENTATION)  

Preparation:  
1. MD/RN: Ensure use of this clinical guideline and the hypothermia order set in the EMR  
2. RN: Obtain baseline labs (per hypothermia order set): BMP, Mg, Phos, CBC, PT/PTT, lactate
3. RN: Determine availability of intravascular temperature management system (ThermoGard XP console and appropriate catheter; consoles located in CCU, MICU, and NNICU).
   MD: Determine presence of IVC filter: if none, MD to insert intravascular cooling catheter (ICY or Quattro) via femoral approach. If IVC filter is present, consider use of a shorter intravascular cooling catheter (CoolLine) via internal jugular or subclavian approach. Adjunctive cooling methods will be necessary during initiation of cooling.

4. RN/PCA: If an intravascular temperature management system is not available, obtain equipment for surface cooling per critical care nursing procedure #94C (one console and two hose sets should be ordered from the Equipment Room)

5. MD: Document post resuscitation neurologic exam in the medical record prior to patient cooling. A neurology consult should be considered, but should not delay the initiation of cooling.

6. MD: Place arterial line shortly after cooling begins in order to provide precise BP monitoring, as well as access for required frequent labs and ABGs.

Procedure: (refer to Appendix B-UVAHS Therapeutic Hypothermia Clinical Timeline)

**Phase I-Cooling:**

A. **Initiate Cooling**
   1. Initiate cooling as early as possible after ROSC.
   2. 33°C is the core temperature goal. If the patient has had major trauma or surgery less than 3 days prior to arrest, a goal temperature of 35-36°C may be considered.
   3. The goal temperature should be reached as rapidly as possible (ideally within 2 hours).
      
      RN: Convene Q2 hour team huddle until goal is reached.

<table>
<thead>
<tr>
<th>Internal Cooling Catheter (Preferred)</th>
<th>External Surface Cooling System</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Initiate cooling process using 2 liters of 4°C NS (kept in unit med refrigerator) administered rapidly (pressure bag) through either a femoral catheter or peripheral venous catheter. Not indicated if the patient has documented pulmonary edema.</td>
<td>- Pack patient in ice (groin, chest, axillae, beneath neck).</td>
</tr>
<tr>
<td>- If an intravascular temperature management system is available, follow steps in Temperature Control Using an Intravascular Cooling System (PNSO Critical Care Procedure Manual, procedure 94B).</td>
<td>- Follow Procedure for Induced Hypothermia after Cardiac Arrest Using Surface Cooling (PNSO Critical Care Procedure Manual, procedure 94C).</td>
</tr>
</tbody>
</table>

4. RRT: Warm humidification on the ventilator during the cooling period is not recommended.

5. MD/RN: Patients should **NOT** have an interruption of sedation (“sedation holiday”) for TTM duration.
University of Virginia Medical Center
Clinical Decision Tool for Therapeutic Hypothermia

6. Team: Cooling should continue for **24 hours from the initiation of therapy**. This is a guideline, and can therefore be adjusted depending on patient circumstances such as prolonged time to goal temperature or significant interruption of therapy resulting in temperature rise. “Resetting the clock” requires a team decision and attending physician approval, as well as explanation in a progress note.

B. **Medication:** Shivering Prophylaxis (refer to Appendix C)
   MD/RN: Initiate fentanyl and midazolam for synergistic shivering prophylaxis as follows:
   1. Fentanyl: 50 mcg IV bolus followed by a maintenance infusion of 25-100 mcg/hr
   2. Midazolam: 2 mg IV bolus followed by a maintenance infusion of 2 to 8 mg/hr

C. **Shivering Management:** refer to Appendix D
   Team: Regular monitoring and aggressive treatment of shivering is vital. Besides the negative effects of heat generation, uncontrolled shivering can have significant, detrimental metabolic effects. Surface counterwarming (forced warm air) should be employed as soon as any shivering is noted.

**Phase II-Rewarming/Maintenance:** (Appendix B- UVAHS Therapeutic Hypothermia Clinical Timeline)
A. Begin rewarming once 24 total hours of cooling has occurred
   1. Use a slow rewarming approach of **0.25°C/hour** until the patient reaches **36.5°C**, then...
   2. Maintain patient at **36.5°C** with the intravascular temperature management (IVTM) system for at least 24 hours, then...
   3. Discontinue active temperature maintenance (place IVTM system in “standby”) but continue monitoring temperature until stable for 48 hours. The ICY and Quattro catheters have an FDA-approved 4 day dwell time and can be used for fever management. Other physical and pharmaceutical measures may also be used to maintain normothermia.

B. Medication management (Appendix D)
   1. Discontinue neuromuscular blocking agent infusion (if used) at start of rewarming.
   2. Pharmacologic intervention may be necessary for shivering during the rewarming phase of therapy to prevent rapid rewarming and its sequelae (see Appendix D).
   3. Titrate analgesics and sedatives for patient comfort until patient is rewarmed to **36.5°C**.

**Monitoring/Documentation:**
- RN: **Continuous temperature monitoring from two sources is required for the duration of therapy, including rewarming.** Display both temperatures on the bedside monitor (via the hospital monitor interface accessor) for any patient receiving therapy with an IVTM system.
- RN: Documentation of peri-arrest information, hourly BSAS values, and therapies must be entered in the TTM flowsheet.
- MD: Obtain neurology consultation and EEG monitoring when neuromuscular blockade is utilized or if status epilepticus is suspected.
- RN: Obtain labs q4 h during active cooling and rewarming (see order set in EMR)

**Therapy Considerations:**
- Therapeutic hypothermia is an urgent treatment priority post-cardiac arrest. Therefore, the benefits of any off-unit procedure or imaging should be carefully weighed against the interruption of cooling. If warranted, CT scan should be obtained prior to transfer to ICU.
The management of electrolyte and acid base disturbances is essential. Serum potassium levels are monitored closely as the serum level will decrease during the cooling phase of management and increase during the rewarming period. A mild increase in lactic acid should also be expected.

Glucose management: hypothermia causes increased insulin resistance, leading to elevated glucose levels. Follow ICU glucose management protocols.

PATIENT & FAMILY EDUCATION (and DOCUMENTATION)
Family education is located in the UVA Repository PE 01094.

POTENTIAL COMPLICATIONS (and DOCUMENTATION)
- Electrolyte shifts are expected and must be monitored per the process set forth earlier.
- Dysrhythmias possible:
  - PR, QRS and QT interval prolongation
  - Tachycardia (expected upon initiation)
  - Bradycardia (expected as cooling progresses)
  - Atrial fibrillation
  - Very, very low risk of VT/VF with mild hypothermia (avoid overcooling)

HAND-OFF OF CARE / DISCHARGE / FOLLOW-UP CARE (and DOCUMENTATION)
- Patients will be transferred out of the ICU or discharged home dictated by clinical progression and overall health status as appropriate by clinical team
- Key information must be recorded in the EMR on the TTM flow sheet

OUTCOMES MEASURES
The goal of TTM is to discharge patients with neurological function equivalent to a CPC score of 1 or 2.

CLINICIAN EDUCATION PLAN:
* Nursing Education: New staff will attend a mandatory class presented by UVA TTM trainers. Trainers are selected by the TTM program coordinator.
* TTM nurse champions will be chosen and educated for each ICU. Those champions will serve as unit experts and provide updates to staff as new information is made available.
* Fellows-Cardiology/Pulmonary-Critical Care/Surgical/Neurosciences Education: TTM coordinator and/or TTM trainers will offer annual classes incorporating current evidence for hypothermia, clinical practice guideline and order set.
* Resident Education: Podcasts are available; in services done upon request.

ADDITIONAL INFORMATION:
DEFINITIONS:
TH: Therapeutic hypothermia is the induction and maintenance of a core body temperature between 32°-34° Celsius for the purpose of mitigating the neurologic sequelae of cardiac arrest
TTM: Therapeutic Temperature Management- collective term for several therapies, including TH
ROSC: Return of Spontaneous Circulation (ROSC)-return of perfusing rhythm following resuscitation from cardiac arrest
**RASS:** Richmond Agitation Sedation Scale-used to evaluate presence of delirium and sedation level in ICU patients.

**BSAS:** Bedside Shivering Assessment Scale-used for hypothermic patients to assess shivering intensity (Appendix C).

**CPC Scale:** Cerebral Performance Category Scale—a scale in neurological medicine that grades a patient’s functional capacity response on a scale of 1-5, 1 being a return to normal cerebral function and 5 is brain death. (Appendix B)

**REFERENCES:**


DISCLAIMER:
Protocols contain a specific, established set of actions expected to be followed by clinicians. Guidelines provide evidence-based recommendations to assist practitioners in making decisions for patient care. However, guidelines and protocols are general and cannot take into account all of the circumstances of a particular patient. Judgment regarding the propriety of using a specific protocol or guideline with a particular patient remains with the patient’s physician, nurse, or other health care professional, taking into account the individual circumstances presented by the patient. Care providers should document any deviations from protocol / guideline in the patient’s electronic medical record, including the rationale for deviation.

REVISION HISTORY

<table>
<thead>
<tr>
<th>Date</th>
<th>Version</th>
<th>Description</th>
<th>Owner(s) Name, Credentials, Title</th>
<th>Committee Approval*</th>
<th>Date of Approval</th>
</tr>
</thead>
<tbody>
<tr>
<td>12/2015</td>
<td></td>
<td></td>
<td>Mark Adams</td>
<td>Patient Care Committee</td>
<td>12/2015</td>
</tr>
</tbody>
</table>

*Adults*- Patient Care Committee approval is required if the guideline will be used in multiple areas or if the local area does not have a practice committee to approve the guideline. If approval is required through other committees (such as patient safety, infection control, etc), please list those committees and dates of approval as well.

*Pediatrics*- Children’s Hospital Clinical Practice approval is required if the guideline will be used in multiple areas or if the local area does not have a practice committee to approve the guideline. If approval is required through other committees (such as patient safety, infection control, etc), please list those committees and dates of approval as well.
APPENDIX A: Clinical Timeline

<table>
<thead>
<tr>
<th>Cooling started (by any method)</th>
<th><strong>Cooling Phase</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Shivering managed</td>
</tr>
<tr>
<td></td>
<td>Lactate monitored q4hr x4</td>
</tr>
<tr>
<td></td>
<td>(no holiday)</td>
</tr>
<tr>
<td>24 hours from start of cooling*</td>
<td>Approx. 14 hours</td>
</tr>
<tr>
<td>0:00</td>
<td>24:00:00</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Controlled rewarming phase</strong></th>
<th>**Patient reaches 36.5 **</th>
<th><strong>ThermoGard remains on</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrolytes monitored q4hr</td>
<td>to actively maintain</td>
<td>to actively maintain</td>
</tr>
<tr>
<td>Sedation maintained</td>
<td>normothermia</td>
<td>normothermia</td>
</tr>
<tr>
<td>(no holiday)</td>
<td>Stop paralytic;</td>
<td>Stop paralytic;</td>
</tr>
<tr>
<td></td>
<td>begin sedation wean</td>
<td>begin sedation wean</td>
</tr>
<tr>
<td></td>
<td>24 hours</td>
<td>12 hours +</td>
</tr>
<tr>
<td></td>
<td>62:00:00</td>
<td></td>
</tr>
</tbody>
</table>

* Cooling phase 'clock' starts with initial attempts to cool (prehospital, ED, ICU) by any method (iced NS infusion, ice bags, etc.), NOT from time the IVTM catheter is inserted or goal temperature is reached.

** Once patient is rewarmed to 36.5, **DO NOT** change anything with ThermoGard console settings for 24 hours. The patient is actively maintained for at least 24 hours at this temperature.
**APPENDIX B: SHIVERING MANAGEMENT**

**Bedside Shivering Assessment Scale (BSAS)**

<table>
<thead>
<tr>
<th>SCORE</th>
<th>TYPE OF SHIVERING</th>
<th>LOCATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>None</td>
<td>No shivering is detected on palpation of the masseter, neck, or chest muscles</td>
</tr>
<tr>
<td>1</td>
<td>Mild</td>
<td>Shivering localized to the neck and thorax only</td>
</tr>
<tr>
<td>2</td>
<td>Moderate</td>
<td>Shivering involves gross movement of the upper extremities (in addition to neck and thorax)</td>
</tr>
<tr>
<td>3</td>
<td>Severe</td>
<td>Shivering involves gross movements of the trunk and upper and lower extremities</td>
</tr>
</tbody>
</table>
# Appendix C:

## Cerebral Performance Categories Scale

**CPC Scale**

<table>
<thead>
<tr>
<th>CPC</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPC 1</td>
<td>Good cerebral performance: conscious, alert, able to work, might have mild neurologic or psychologic deficit.</td>
</tr>
<tr>
<td>CPC 2</td>
<td>Moderate cerebral disability: conscious, sufficient cerebral function for independent activities of daily life. Able to work in sheltered environment.</td>
</tr>
<tr>
<td>CPC 3</td>
<td>Severe cerebral disability: conscious, dependent on others for daily support because of impaired brain function. Ranges from ambulatory state to severe dementia or paralysis.</td>
</tr>
<tr>
<td>CPC 4</td>
<td>Coma or vegetative state: any degree of coma without the presence of all brain death criteria. Unawareness, even if appears awake (vegetative state) without interaction with environment; may have spontaneous eye opening and sleep/awake cycles. Cerebral unresponsiveness.</td>
</tr>
<tr>
<td>CPC 5</td>
<td>Brain death: apnea, areflexia, EEG silence, etc.</td>
</tr>
</tbody>
</table>

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Note: If patient is anesthetized, paralyzed, or intubated, use “as is” clinical condition to calculate scores.

Appendix D: Shivering Prophylaxis / Pharmacological Management of Shivering

Induction of Hypothermia

- Fentanyl 50 mcg/hr continuous IV
- Midazolam 1 mg/hr continuous IV (given for synergistic antishivering effect)

Shivering?

NO (BSAS= 0)

- Monitor BSAS
- Monitor for changes to temperature control and address by starting at previous steps in algorithm

BSAS = 1-2 (mild to moderate and localized)

- Place forced air blanket on patient and turn warmer setting to 38°C (if cooling cath in place)
- Antishivering bundle: meperidine, Buspar, magnesium

BSAS = 3 (severe whole body)

- Place forced air blanket on patient and set to 38°C (if cooling cath in place)
- Antishivering bundle: meperidine, Buspar, magnesium
- If minimal response, consider adding propofol

Potential seizure activity

- STAT neurology consult
- Consider midazolam bolus

BSAS 3 (severe whole body)

If above is unsuccessful and NO SEIZURE suspicion:
- Neurology consult prior to NMB
- Consider neuromuscular blocker (NMB) per order set (start with bolus doses initially and progress to continuous infusion, if needed)

Antishivering medication bundle

- Magnesium sulfate 2Gm IVPB x1
- Meperidine 25 mg IV every 5 minutes until shivering stops x2 doses
- Buspirone 30 mg tablet via OGT x1

*see order set for maintenance doses and schedule

Allow 30 mins to evaluate interventions