INTRODUCTION:

Sudden cardiac arrest is a major health concern with more than 400,000 deaths annually in the United States. There is a 5-30% survival rate to hospital discharge for those patients successfully resuscitated post cardiac arrest. Ischemic brain injury as a result of the cardiac arrest leads to poor neurological outcomes and death. Targeted Temperature Management (TTM), also referred to as therapeutic hypothermia, has been shown to improve neurological outcomes for some post-cardiac arrest patients.

PURPOSE:

This guideline will outline priorities in the care of patients receiving Targeted Temperature Management (TTM) during post-resuscitation. Induction, maintenance and re-warming take place only in the Adult Critical Care Units and/or the Emergency Department (ED) and only after eligibility criteria have been satisfied. The following Critical Care beds are equipped for long term EEG monitoring: 3Widener beds 7, 12, 13 and 14 and 3Schiedt bed 13.

SCOPE OF PRACTICE:

This policy pertains to all RNs, NPs, PAs and physicians providing treatment or care to patients located in the ED and Adult Critical Care Units (3S, 3WA and 3WB only).

PATIENT SELECTION: ELIGIBILITY CRITERIA

The Critical Care Medicine attending physician or the ED attending physician with collaboration from Critical Care determines the appropriateness for TTM based on the following eligibility criteria:

- Post cardiac arrest with return of spontaneous circulation (ROSC).
- Onset of cardiac arrest less than 12 hours prior to induction of cooling therapy.
- Patient does not have an order for Do Not Resuscitate (DNR) or Do Not Intubate (DNI).
- Patient does not have comorbidities with minimal chance of meaningful survival independent of neurological status.
- Glasgow Coma Scale (GCS) Motor Score is less than 6 i.e. the patient does not follow commands.
- Patient’s pre-arrest cognitive status is not severely impaired (GCS = 15 or performed ADLs independently)
- No uncontrolled bleeding
- If patient is pregnant, OB/GYN has been consulted.

Important Note: If at any time during TTM the patient cannot maintain at MAP of 65 with or without support from vasoactive medications, the patient’s enrollment will be terminated.
EQUIPMENT

1. (2) 1 liter bags of **chilled** 0.9% Normal Saline (4˚C) stored in Med Room refrigerators; **replace at once.**
2. Gaymar III Cooling System (hypothermia unit) with 2 sets of hoses. **Important:** These special hoses (with Quick-Click Connectors) **must stay with their respective Gaymar units.**
3. Gaymar RaprRound Body Wraps (Call SPD to reorder as needed); SPD storeroom locations are as follows:
   - **Leg Wraps (2) and** SPD Location 15 – F0 – A
   - **Large Vest (1) or** SPD Location 15 – F0 – B
   - **Small/Medium Vest (1)** SPD Location 15 – F0 – C
4. Temperature-sensing indwelling bladder catheter; if not available, use standard Foley catheter and rectal probe.
5. Arterial line (A-line) kit and tubing set up
6. Central Venous Catheter (CVC) and tubing set up
7. 2 pressure bags (one each for A-line and chilled saline infusion)
8. Peripheral Nerve Stimulator (PNS) for Train of Four (TOF) testing. **Return the PNS** after cleaning with a germicidal wipe to its original storage location after use.
9. Supplies for rewarming in case indicated:
   - BAIR Hugger warming unit
   - For the ICU, BAIR Hugger 241 Blood/Fluid Warming Set
   - For the ED, rapid infuser and tubing set

PROCEDURE

A. **PROVIDE PATIENT AND FAMILY EDUCATION AND SUPPORT:**

1. Ideally, the first care provider in contact with the family will provide an explanation of TTM and the possible need for pharmacologic paralysis.
2. Discuss the risks/benefits of induced hypothermia with family.
3. Encourage the family to continue to talk to the patient.
4. Provide emotional support and answer any questions.

B. **PREPARATION FOR COOLING:**

1. Verify line placement prior to initiation of the cooling phase since lines are difficult to place once hypothermia is initiated. Line/tube placement includes:
   - 2 large gauge peripheral IVs
   - Arterial line
   - Central Venous Catheter
   - Foley catheter (when available, a temperature sensing Foley should be used)
   - NG Tube or OG Tube
Important: **Do not use Heparin** in the flush bags since heparin’s effect will be enhanced by TTM i.e. increased risk for bleeding

2. Verify the patient has been intubated and sedated. **The goal for sedation for this patient is a RASS score of −4.**
3. Obtain STAT labs per prescriber’s order (CBC, PT/PTT, Chemistry Panel, Arterial Blood Gas, CK Total and Troponin Ultra, Lactate level and LFTs; obtain HCG for all female patients of child bearing age)
4. Place temperature sensing indwelling bladder catheter or rectal probe for temperature monitoring per protocol.
5. Complete thorough skin assessment before applying cooling system wraps.

C. **COOLING PROTOCOL: INDUCTION PHASE**

**Goal for Induction:** Target temperature range is 32 - 34°C within 4 hours of protocol activation. If unable to arrive at target T °C within 6 hours, notify attending physician or resident physician. Once at target T °C, notify physician to discontinue Induction phase orders in electronic order entry system. Physician will then enter Maintenance phase orders in electronic medical record.

1. Infuse 2 liters chilled saline (0.9% Sodium Chloride) or 40mL/kg at 4˚C through the peripheral IVs (to a maximum of 2 liters) and record total amount of chilled saline on intake record.
2. Obtain Gaymar III external cooling unit with two complete sets of hoses, two (2) leg wraps and one size-appropriate torso vest. The cooling unit must have 2 sets of hoses with Quick-Click Connectors to operate with the vest and leg appliances.
3. **Follow instructions for Setting up the Gaymar III (See Electronic Resources) to arrive at target hypothermia temperature.** This appendix describes the step-by-step application of the cooling apparatus and adjustments nursing will make to arrive at target temperature.
   a. **Use Rapid Cooling Automatic mode of operation for cooling therapy.** Set Temperature to 34°C.
4. Assess shivering hourly.
   a. Shivering Scale:
      o **Mild**- facial tremors
      o **Moderate**- extremity tremors
      o **Severe**- full body tremors

**Train of Four (TOF Testing):**
- Conduct a baseline TOF test in anticipation of a need for neuromuscular blockade (NMB) during TTM. **Obtain a fresh battery before TOF testing is initiated.**
- Follow orders to initiate neuromuscular blockade if its use is being considered for management of moderate to severe shivering.
Optimize sedation before NMBA is initiated. (Refer to Peripheral Nerve Stimulator and Train of Four overview; see Section G, Electronic Resources).

**Electrode Placement:**
- Distal electrode (black) is placed at crease of wrist along the ulna nerve’s path
- Proximal electrode (red) is placed about 4 inches above the wrist level along the same nerve path

**Goal for NMBA:** 1-2 twitches of 4 twitches upon Peripheral Nerve Stimulator activation.

### D. TRANSFER of a PATIENT RECEIVING TTM from the ED to CRITICAL CARE after Induction:

1. Bed Control and Nursing Administrative Coordinators will expedite bed assignment for patients receiving TTM.
2. Report is given to Critical Care nursing team by ED nursing team when orders are entered into the electronic order entry system and there is a bed assignment.
3. Primary ED nurse will coordinate the assembly of respiratory and transport teams for transfer of patient to Critical Care. Nursing Administrative Coordinators will be called as needed for transport assistance.
4. When team and patient are ready for transport, turn Gaymar III off.*
5. Securely clamp all tubing on both the machine hoses and body wraps.
6. Disconnect torso and leg wrap tubing from machine hoses. For each leg wrap, connect male-end of tubing to the female-end of the opposite leg wrap’s tubing to create a closed circuit between the leg wraps. Secure closure by locking shut. Repeat closure process for the torso wrap tubing.
7. Patient is transferred to a Critical Care Unit per protocol.
8. Upon arrival in Critical Care, the Critical Care nursing team will attach the torso and leg wraps to the Critical Care Unit’s Gaymar III and reinitiate cooling process per guidelines.

*Gaymar III units will remain in their respective departments.

### E. COOLING PROTOCOL: MAINTENANCE PHASE

**Goal for Maintenance:** Maintain target temperature range of 32 - 34°C for 24 hours from the time the target temperature range is first met.

1. In the **Maintenance phase** when the patient’s temperature reading is in the target temperature range of 32 - 34°C, the Gaymar III unit will continue to operate in the **Gradual Cooling Automatic mode** of operation.
2. Set a target temperature of 33°C.
3. The patient will be maintained in this target temperature range for 24 hours.
4. Do not make any adjustments to the cooling unit while in the Gradual Cooling Automatic mode.
5. Once at target T °C for 24 hours duration, notify resident to discontinue Maintenance phase orders in electronic order entry system. Resident will then enter Re-warming phase orders in electronic order entry system.

F. RE-WARMING PROTOCOL

**Goal for Re-warming**: Slowly return core temperature to 36.5°C over the course of 6-8 hours.
The re-warming phase begins when the target temperature range (32 – 34 °C) has been maintained for a period of 24 hours.

1. Report CVP to physician prior to re-warming to address volume status and IV fluid rate.
2. Report last Potassium level to physician; anticipate the removal of all Potassium from IV fluids prior to the initiation of the re-warming phase.
3. Document time the re-warming is initiated
4. Increase Gaymar III setting by 0.5°C every 1 to 2 hours using the Gradual Automatic mode of operation (See Appendix A). Patient’s hemodynamic response to re-warming will dictate the duration of the Re-warming phase.
5. Do not exceed 0.5-1°C/hour increases in temperature during re-warming
6. Have NMBA discontinued by the physician when temperature reaches 36°C. Continue to monitor level of paralysis until TOF test is 4 of 4 twitches. At 36.5°C, adjust sedation to achieve a RASS score of (-2). **Note**: If shivering emerges after the NMBA has been discontinued, consider the use of meperidine for control of mild to moderate shivering.
7. **Stop active re-warming once the temperature of 36.5°C is reached.** Do not allow the patient to become hyperthermic in the re-warming phase.
8. Document time re-warming goal temperature is reached.
9. After re-warming is completed, consult physician for DVT prophylaxis orders.
10. Tylenol 650 mg suppository PR should be used to control fever for the first 24 hours after re-warming is completed.
11. When T reaches 36.5°C, notify the Resident that re-warming has been completed. Physician will then enter the Post Therapy phase orders in electronic order entry system.

G. DOCUMENTATION:

1. Use electronic documentation record or, during downtime procedure, the appropriate paper record to record: BP, MAP, HR, Pulse Oximetry, cardiac rhythm and CVP as follows:
   - Every 15 minutes during initiation of cooling until target temperature is reached
   - Every hour during the maintenance phase
• Every 15 minutes during re-warming phase until target temperature range of 36.5-37˚C is achieved.
• Every hour x 12 additional hours after re-warming is completed and as condition warrants

2. Hourly neuro checks
3. Record Temperature in °C every 15 minutes until 32 - 34˚C is reached, then every 30 minutes, and again every 15 minutes during re-warming. Record Temperature in °C every hour for 12 hours after re-warming is completed and as condition warrants.
4. Monitor Foley output hourly since patient may require frequent volume replacement as TTM induces diuresis.
5. Continuous cardiac monitoring. Please note: TTM initially causes a sinus tachycardia, then bradycardia. Other ECG changes may include prolonged Q-T interval and the occurrence of a J wave.

D. BLOOD PRESSURE MANAGEMENT

Cooling Phase: Goal: MAP greater than 65 and less than 120. Follow orders for nitroglycerin IV infusion titrated to a MAP less than 120 or obtain physician order for a suitable alternative IV anti-hypertensive medication. Rationale: TTM may cause severe vasoconstriction leading to hypertension.

Re-warming Phase: Follow order for norepinephrine or dopamine hydrochloride or obtain a physician order for a suitable alternative titrated to maintain MAP greater than 65. Rationale: Re-warming causes vasodilatation leading to hypotension and hypovolemia. Vasoactive medication support may be necessary during re-warming to correct severe vasodilation.

E. LABS, ELECTROLYTES AND DIAGNOSTICS

1. Stat Labs:
   o Lactate level
   o LFTs
   o CBC with Diff and PLTs
   o PT/PTT
   o Chemistry Panel including Ca, Mg and Phosphorus
   o CPK Total and Troponin Ultra
   o Arterial Blood Gas (ABG)
   o HCG (for female patients of child-bearing age)
2. **Ongoing Labs every 6 hours** during the cooling and re-warming phases of therapy:
   - Arterial Blood Gas
   - Central venous oxygen saturation
   - CBC with Diff and PLTs
   - Chemistry panel including Ca, Mg and Phosphorus
   - CPK Total and Troponin Ultra
   - Lactate level

3. **Potassium**: Monitor serum potassium every 6 hours during Cooling Induction and Maintenance phases. Obtain a STAT Potassium level prior to re-warming and report result to resident physician. Monitor potassium every 4 hours during Re-warming phase. **Rationale:** When TTM is initiated, hypokalemia is a result of intracellular potassium shift exacerbated by the cooling therapy. With re-warming, the potassium will move back into the serum, so more frequent monitoring of potassium levels is indicated.

4. **Glucose**: Monitor finger-stick glucose levels every hour. (Refer to the Insulin Protocol for glucose management; see Section G, Electronic Resources). **Rationale:** Cooling therapy leads to decreased insulin secretion and decreased sensitivity causing hyperglycemia. Hyperglycemia, in turn, contributes to increased brain ischemia. Re-warming resolves resistance to insulin and puts the patient at risk for developing a rebound hypoglycemia. Monitor glucose levels hourly for this reason.

5. **CXR**: Daily portable CXR

6. **EKG**: STAT EKG to be collected with induction of TTM and then routinely every 8 hours times two.

7. **EEG Monitoring**: When warranted, long term monitoring of EEG (LTM-EEG) may be used to monitor subclinical seizure activity. The patient must be placed in one of the following critical care beds: 3Widener beds 7, 12, 13 and 14 or 3Schiedt bed 13.
   a. The Medical Resident will first call the HUP Reading Room at 215.614.0194 to alert them of the cooling patient’s enrollment. After 4pm and on weekends or holidays, page 215.404.6771.
   b. When Neurology has been consulted, the Medical Resident will provide the HUP Reading Room with the contact information for the Neurology Resident.
   c. If Neurology has not been consulted, the Medical Resident provides their contact information: ICU Resident Beeper (215.422.1116) or ICU Intern Beeper (215.422.1117).
   d. Lastly, the Medical Resident calls Surgical Monitoring Associates (SMA) at 610.328.1166 to initiate LTM-EEG.
F. **Infection Prevention and General Nursing Care**

1. Follow Isolation Precautions if so ordered.
2. Use meticulous aseptic technique with all invasive lines and procedures.
3. Maintain compliance with vigorous hand washing by all caregivers and visitors.
4. Administer prophylactic antibiotics as ordered.
5. Provide oral care every 4 hours and as needed.
6. Skin integrity checks every 1 hour; reposition patient every 2 hours to prevent skin breakdown.
7. Eye care every 2 hours: apply lubricant to eyes per medication order.

G. **Electronic RESOURCES**

- **Instructions for Setting up the Gaymar III Cooling System Hypothermia**
  TTMMtp://uphsxnet.uphs.upenn.edu/pahome/criticalcare/pandp/protocols/hypothermia.pdf

- **Peripheral Nerve Stimulator and Train of Four**
  http://emedicine.medscape.com/article/2009530-overview

- **RASS Scale (CC homepage):**
  TTMMtp://uphsxnet.uphs.upenn.edu/pahome/criticalcare/resources/RASS.pdf

- **Insulin Drip Protocol (CC homepage):**
  TTMMtp://uphsxnet.uphs.upenn.edu/pahome/criticalcare/pandp/protocols/insulinprotocol.pdf

**REFERENCES:**


APPENDIX A

Temperature Conversion Scale

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