

**POST-CARDIAC ARREST CARE PATHWAY**

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## I. EQUIPMENT LIST

All equipment is available in ED, MICU & CCU.

**If protocol initiated in MICU or CCU, have all equipment available and assembled at bedside before transfer to unit.**

1. Arterial line kits (both radial and femoral).
2. PreSep central venous oximetry catheter (Edwards Lifesciences).
3. Two one liter bags of cold 0.9% saline (stored in ED and ICU refrigerators).
4. Gaymar Medi-Therm III 7900 external cooling system (available in ED and ICU):
  - a. Gaymar Rapr-Round cooling pads: one torso and two thigh cooling pads, sized appropriately for patient.
  - b. Weight of Gaymar wraps when filled:
    1. Large Torso: 3.0 lbs
    2. Medium/Small Torso: 2.5 lbs
    3. Each Leg: 2.0 lbs
5. Temperature probe foley catheter with appropriate adapter for cooling device.  
(Gaymar Medi-Therm III requires 1/8 inch to 1/4 inch converter)
6. Neuromuscular blockade equipment (not required for ED):
  - a. Twitch monitor
  - b. BIS monitor and sensor
7. Ensure fluid warmer is available in case need arises after cooling.

## II. LOGISTICAL PEARLS REGARDING THERAPEUTIC HYPOTHERMIA

1. Ensure appropriate supervisory staff is notified:

Dave Gaieski MD (ED) pagers--215-312-4560 (personal), 215-265-2464 (ED Resuscitation pager; contacts ED resuscitation resident also), or cell--302-588-7083

Benjamin Abella MD, MPhil (ED) 215-279-3452

Marion Leary, RN, BSN (ED) 215-776-4235

Barry Fuchs MD (MICU) 215-314-2920 or 215-460-2680

Cheryl Maguire RN (MICU) 215-350-8688

Cardiac Arrest Team 267-253-9035

2. If the patient is appropriate for MICU or CCU, then MICU or CCU will make a bed for hypothermia patient as opposed to admitting these patients to a ready-bed on another unit.
3. ED personnel should continue to implement hypothermia protocol until MICU or CCU bed is available and all equipment is ready for patient.
4. Place arterial line while initiating cooling.
5. Paralyze (after sedation) patient before initiating cooling. Initiation of paralysis may not be necessary if patient's temperature is already below 34°C before active cooling, unless they start to rewarm or shiver. Maintain paralysis until after re-warming is complete (36°C).
  - Set the Gaymar Medi-Therm III device to automatic (rapid cool) with target temp 33°C. (Goal is target temp within 4 hours.)
  - Rewarming is begun 24 hours after initiating hypothermia. Set in automatic mode, gradual, with target temperature of 37°C (this will rewarm patient @ 0.17°C/hr, [1°C/6hrs]). Maintain sedation and paralysis until temperature reaches 36°C to avoid shivering and rapid rewarming.
  - Use order set and protocol to guide therapy.
  - Call appropriate supervisory staff for guidance!
6. Notify epilepsy fellow ASAP, page 215-404-6771, to arrange for continuous EEG monitoring within 6 hrs and no later than 12 hrs (EEG techs are not available between midnight and 7:30 am).
7. Once cooled, maintain cooling for duration of treatment, even if patient becomes hemodynamically unstable.

**III. PURPOSE:** To provide a guideline to optimize the care of comatose cardiac arrest survivors.

#### **IV. BACKGROUND**

##### *A. Therapeutic Hypothermia*

Brain temperature during the first 24 hours after resuscitation from cardiac arrest has a significant effect on survival and neurological recovery.

Fever ( $T^{\circ}\text{max}$ ) during the first 48 hours is associated with a decreased chance of good neurological recovery (OR 2.26 [1.24, 4.12] for each  $1^{\circ}\text{C}$  over  $37^{\circ}\text{C}$ )<sup>1</sup>. Cooling to  $32\text{-}34^{\circ}\text{C}$  for 24 hours decreases chance of death (OR 0.74 [0.58, 0.95]) and increases chance of good neurological recovery (OR 1.40 [1.08, 1.81])<sup>2</sup>. Cooling to  $32\text{-}34^{\circ}\text{C}$  for 12 hours increases chance of good neurological recovery (OR 2.65 [1.02, 6.88])<sup>3</sup>.

##### *B. Early Coronary Revascularization*

Out-of-hospital cardiac arrest patients have a high incidence of acute coronary syndrome and early coronary revascularization has been demonstrated to improve survival (OR 5.2 [1.1, 24.5])<sup>4</sup>.

##### *C. Early Goal-Directed Therapy*

Post-resuscitation syndrome has many pathophysiological features in common with acute sepsis<sup>5</sup>. Early goal-directed therapy has been demonstrated to decrease in-hospital mortality of patients suffering from severe sepsis with an elevated lactate or septic shock (OR 0.58 [0.38-0.87])<sup>6</sup>. A similar approach is likely to have the same beneficial effects in post-resuscitation syndrome.

##### *D. Glycemic Control*

Tight glycemic control (maintaining serum glucose 80 to 110 mg/dl) has been demonstrated to improve survival in critically ill patients in the ICU setting<sup>7,8</sup>. This approach is likely to have the same beneficial effects in patients suffering from post-resuscitation syndrome.

##### *E. Management of Adrenal Insufficiency*

Acute adrenal insufficiency is a well-documented component of post-resuscitation syndrome. In patients with acute sepsis, treatment of acute adrenal insufficiency significantly reduces mortality (OR 0.67 [0.47-0.95])<sup>9</sup>. Diagnosis and treatment of acute adrenal insufficiency will improve hemodynamic stability and potentially improve survival of patients after cardiac arrest.

##### *F. Prognosis*

The neurologic prognosis of the majority of comatose cardiac arrest survivors cannot be reliably predicted until at least 72 hours after resuscitation<sup>10</sup>. Furthermore, the reliability of the routinely utilized parameters has not been evaluated in the face of effective interventions such as therapeutic hypothermia. Therefore DNR status should not be established and care should not be withdrawn **based on neurologic prognosis** before 72 hours after return of spontaneous circulation (ROSC).

**V. EFFECTS OF THERAPEUTIC HYPOTHERMIA<sup>11</sup>**

- Hypothermia activates the sympathetic nervous system causing vasoconstriction and shivering. Shivering increases O<sub>2</sub> consumption by 40-100%. Sedatives, opiates, and neuromuscular blockers can counteract these responses and enhance the effectiveness of active cooling. However, initiating paralysis in a patient that is already hypothermic should be avoided because it can result in a precipitous drop in core body temperature. Elderly patients will cool more quickly than younger or obese patients.
- Hypothermia shifts the oxyhemoglobin curve to the left, which may result in decreased O<sub>2</sub> delivery. However, the metabolic rate is also lowered, decreasing O<sub>2</sub> consumption/CO<sub>2</sub> production, cardiac output and cerebral blood flow. Ventilator settings may need to be adjusted due to decreased CO<sub>2</sub> production, using temperature-corrected blood gases.
- Hypothermia initially causes sinus tachycardia, then bradycardia. With temperature <30°C there is an increased risk for arrhythmias. With temperature <28°C there is an increased risk for ventricular fibrillation. The severely hypothermic myocardium (<30°C) is less responsive to defibrillation and medications. Therefore it is extremely important to keep temperature >30°C.
- Hypothermia can induce coagulopathy which is treatable with platelets and FFP.
- Hypothermia-induced diuresis is to be expected and should be treated aggressively with fluid and electrolyte repletion. Magnesium, phosphorus and potassium should be monitored closely and maintained in the normal (because it will rebound to a higher range with rewarming) range.
- Decreased insulin secretion and decreased insulin sensitivity leads to hyperglycemia, which should be treated aggressively.
- Re-warming too rapidly can cause vasodilation, hypotension, and rapid electrolyte shifts.

**Temperature Conversion Table**

Celsius	Fahrenheit
38.0	100.4
37.0	98.6
36.0	96.8
35.0	95.0
34.0	93.2
33.0	91.4
32.0	89.6
31.0	87.8
30.0	86.0

**POTENTIAL LABORATORY ABNORMALITIES ASSOCIATED WITH HYPOTHERMIA:**

Potential Lab Abnormality	Treatment
Increased amylase	No intervention unless persistent after rewarming
Increased LFTs	No intervention unless persistent after rewarming
Increased serum glucose	Follow Insulin protocol
Decreased K <sup>+</sup> , Mg, Phos, Ca	Correct as needed
Increased lactate	Optimize oxygen delivery
Metabolic acidosis	Optimize oxygen delivery
Thrombocytopenia	Correct if active bleeding
Leukopenia	No intervention unless persistent after rewarming
Increased PT/PTT	Correct if active bleeding

## **VI. ELIGIBILITY CRITERIA FOR POST-CARDIAC ARREST CARE PATHWAY**

Post-cardiac arrest, defined as a period of absence of pulses requiring chest compressions, regardless of location or presenting rhythm followed by return of spontaneous circulation (ROSC).

Not DNR or DNI status prior to Cardiac Arrest.

Pre-arrest cognitive status not severely impaired (i.e. performed ADL independently).

## **VII. ELIGIBILITY CRITERIA FOR POST-CARDIAC ARREST THERAPEUTIC HYPOTHERMIA**

Meets eligibility criteria for Post-Cardiac Arrest Care Pathway.

Comatose at enrollment with a Glasgow Coma Motor Score <6 pre-sedation (i.e., doesn't follow commands).

No other obvious reasons for coma.

No uncontrolled bleeding.

Hemodynamically stable with no evidence of:

- Uncontrollable dysrhythmias

No existing, multi-organ dysfunction syndrome, severe sepsis, or comorbidities with minimal chance of meaningful survival independent of neurological status.

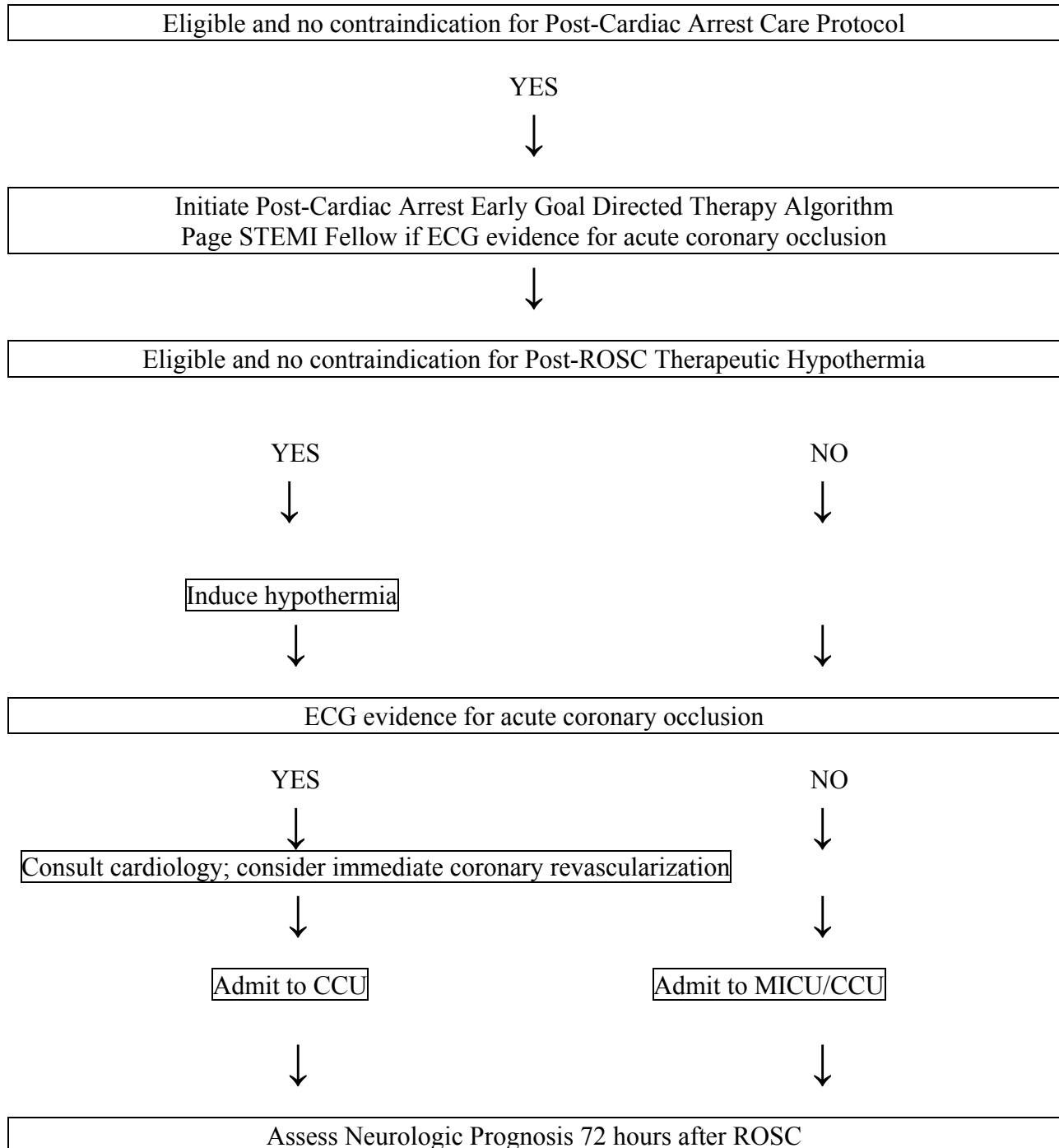
## **VIII. RELATIVE CONTRAINDICATIONS FOR THERAPEUTIC HYPOTHERMIA:**

Prolonged arrest time (> 60 minutes).

Pregnancy (as per one case report, therapeutic hypothermia can be performed safely on a pregnant female<sup>14</sup>)

- Consult Maternal Fetal Medicine service if pregnant and therapeutic hypothermia instituted.

## IX. Post-Cardiac Arrest Care Flow Chart



## X. POST-CARDIAC ARREST CARE PATHWAY

**NOTE:** *Data Gathering (Section A), Monitoring (Section B), and Interventions (Section C) are all initiated immediately and carried out simultaneously when feasible.*

**A. Initial Data Gathering (after ABCs are stabilized)**

**1. History:**

- a. Review eligibility, contraindications, advance directives and overall prognosis
- b. Discuss issues with health care proxy, if available

**2. Physical: Baseline Neurological Evaluation**

- a. Exclude other causes of coma (mass lesions, metabolic coma, seizures etc)
- b. Document Glasgow Motor Score and Glasgow Coma Score

**3. Initial laboratories:**

- a. ABG with iCa<sup>+</sup>, Mg<sup>+</sup>
- b. CBC / PT / PTT/INR, Fibrinogen
- c. P7, plus iCa / Mg / Phos
- d. Lactate/CPK-MB/CK/Troponin
- e. Cortisol level
- f. Urinalysis
- g. Blood Cultures, Urine Culture, and Sputum Culture (if appropriate)
- h. Toxicology screen if appropriate
  1. Amylase, Lipase
- j. Beta Hcg on all women of child-bearing age
- k. Co-oximetry (Central)

**4. Serial laboratories:**

- a. Co-oximetry q1-2 hrs for first 6 hours until re-warmed and then q 6 hrs if ScvO<sub>2</sub> not used
- b. Lactate q 6 hrs x 2 days
- c. Repeat CPK-MB/CK/Troponin at 6 hrs
- d. CBC / PT / PTT/INR, P7 / Ca / Mg / Phos q 12 hrs x 4
- e. ABG q6hr and PRN

**5. CXR**

**6. Head CT:** To rule out intracranial hemorrhage as deemed medically necessary

**7. Consult:**

- a. Cardiology in all cases.

*Note:* If cardiac catheterization is indicated, hypothermia should not be delayed.

*Echocardiogram:* To r/o regional wall motion abnormality and severe contractile dysfunction.

- b. Maternal Fetal Medicine if +Hcg (while initiating hypothermia).
- c. Nutrition support on day 3.

d. Neurology/ EEG.

**B. Establish Appropriate Monitoring Immediately:**

**1. Cardiovascular:**

- a. ECG after initial stabilization and repeat q 8 hours x 2 and prn to r/o acute coronary syndrome.
- b. Arterial-line for continuous arterial blood pressure monitoring (essential prior to initiating hypothermia). Attempt radial artery x 1 and then proceed to femoral artery if necessary.
- c. Temperature monitoring Foley for continuous urine output and temperature monitoring. If urine output < 4mL/hr, use an alternative site for temperature measurement such as an esophageal temperature probe.
- d. PreSep catheter or other CVC (MAC) for CVP & ScvO<sub>2</sub> (RIJ or SCV site preferred) though don't delay initiation of hypothermia to perform this.

**2. Pulmonary:** Continuous SaO<sub>2</sub> probe, frequent ABGs (use temperature correction).

**3. Temperature:** Foley with temperature probe (use alternative site if < 4 mL/hr urine output).

**4. Neurologic:**

- a. Continuous EEG monitoring beginning ASAP while paralyzed.
- b. Once in ICU, use BIS monitor to titrate sedation (with goal of 40-60).
- c. Neuro checks q 2 hrs (while paralyzed follow pupils and titrate paralysis per NMB Nursing Policy).

**5. Additional monitoring and follow-up studies:**

- a. If net fluid balance is > 5 liters in 24 hrs, monitor intrabdominal pressure (IAP) via Foley catheter after cooling device has been discontinued (call medical resident if IAP is ≥ 20 mmHg).
- b. Consider repeat echocardiogram 24 hours after ROSC or as clinically indicated.
- c. Repeat CXR in AM and after 72 hours to rule out aspiration pneumonia.

**C. Initiate Appropriate Interventions**

*NOTE: Interventions should be carried out simultaneously when appropriate and feasible*

**1. Post-Cardiac Arrest Early Goal-Directed Therapy**

**2. Therapeutic hypothermia (if indicated)**

**3. Treat acute coronary syndrome**

**4. Treat hyperglycemia**

**5. Fever prophylaxis**

**6. Other ICU protocols**

**1. Post-Cardiac Arrest Early Goal-Directed Therapy (See appendix or laminated algorithm)**

- a. Initial Fluid Infusion: Use NSS for first two liters (use 4°C NSS if initiating hypothermia) of IVF then change to LR unless hyperkalemia or hepatic insufficiency. Change IVF back to NSS immediately prior to rewarming (to avoid rebound hyperkalemia).
- b. IVF Resuscitation and CVP goals: Titrate IVF to ensure volume repletion using CVP as a guide. A minimum CVP ≥ 8 mm Hg is a reasonable target goal in most patients. Continue

fluid boluses to reach MAP target, unless CHF, CVP>15, or > 5 liters; then consider right heart catheterization (RHC). If MAP target is reached, but shock is present ( $\downarrow$ ScvO<sub>2</sub>, particularly if oliguric or acidotic (elevated lactate), bolus IVF to CVP > 8, providing no CHF. If CHF, CVP>15, high dose vasopressors, or >5 liters positive fluid balance, proceed with RHC. If no hypotension or shock, no need to give fluid regardless of the CVP (i.e. even if < 8) if adequate urine output (>1mL/kg/hr).

c. Vasoactive Drug Use in the Volume Repleted Patient:

1. HTN: If MAP > 100 mmHg, titrate IV nitroglycerin, starting @ 10 mcg/min, to MAP < 100 mmHg. If acute coronary syndrome, maintain MAP at low end of range. (See algorithm for additional detail.) If tachycardic or acute ischemia/MI without significant LV dysfunction (based on ECHO, absence of CHF, or venous desaturation) consider Esmalol drip.

2. Hypotension: Goal MAP is 80-100 mmHg. Use upper range, if no evidence of ACS, CHF, or shock. If ACS, CHF, or shock, use lower range and may require goal as low as 65 mmHg, depending on degree of myocardial ischemia/dysfunction.

a. If EF is normal (> 50%), use Norepinephrine to MAP > 70-80 mmHg.

b. If EF is reduced (<50%):

- MAP Titration: Use dobutamine (2.5-20 mcg/kg/min) to reach ScvO<sub>2</sub> >65%. If MAP falls, add Dopamine, Norepinephrine or Intra-Aortic Balloon Pump (IABP) if severe.
- ScvO<sub>2</sub> Titration: Regardless of MAP, if ScvO<sub>2</sub> is low (< 65%), particularly if other signs of shock are present, consider PRBC to Hgb >10 gram/dL and increase Dobutamine as tolerated. **NOTE**: When rewarming, anticipate vasodilation and volume depletion ( $\downarrow$ CVP and  $\downarrow$ ScvO<sub>2</sub> +/-  $\downarrow$ MAP), and treat with IVF boluses based on same algorithm.

c. Institute appropriate critical care protocols for sepsis, GI /DVT/ VAP prophylaxis, low stretch protocol, etc.

**2. *Initiate therapeutic hypothermia if indicated***

a. Goal: Achieve target temp of 33°C (range 32°-34 °C) within 4 hrs and maintain for 24 hours from time cooling target temperature is reached.

b. Induction: Sedative and paralytic medications are begun prior to inducing hypothermia and are continued until patient is rewarmed to 36°C. If patients temp is  $\leq$  34° on presentation, maintain temp at 32-34°C with cooling blanket. Hold paralysis unless temp rises to > 34°C despite cooling measures.

1. Use an HME for vent humidification.
2. Initiate sedation and analgesia with fentanyl (50 to 100 mcg IV bolus followed by 50 mcg/hour infusion) and/or propofol (5-10 mcg/kg/min infusion). Titrate using BIS monitor (ICU) to 40-60. (Lorazepam can be used as alternative to propofol.)
3. Initiate paralysis with Cisatracurium (0.15-0.2 mg/kg IV bolus followed by 1-3 mcg/kg/min IV drip). Paralysis guided by nerve stimulator (TOF) and patient assessment as per RN policy.
4. Infuse 2 liters (or 30 ml/kg) of 4°C NSS over 30 minutes (stored in ED and ICU refrigerators).
5. Initiate active external cooling using Gaymar Medi-therm III 7900 cooling system with Rapr-Round cooling wraps.

<b>Gaymar Medi-Therm III Cooling Unit</b>
Keep device plugged in at all times
Connect circumferential torso pad to first cooling hose, fill with water, then apply to patient Connect (in series) circumferential thigh cooling pads to second cooling hose, fill with water, then apply to patient
Connect temperature monitoring foley to temperature monitoring port on cooling device (if urine output less < 4 cc/hr switch to esophageal temperature probe)
Frequent assessment of wraps to ensure proper cooling.
Set to automatic mode, rapid cooling, with target time of 33°C

7. If target temperature not achieved within 4 hours:
  - a. Contact house officer
  - b. Add ice packs to groin and axillae (wrapped in sheet or pillow case)
  - c. Consider additional 500cc boluses of 4°C IVF
8. If target overshoot: (Temp < 32°C)
  - a. Contact house officer
  - b. Cooling device will actively warm patient in automatic mode
  - c. If temp < 31°C, consider infusing 250 mL boluses of warm 40°C IV NSS or LR until temperature > 32°C

*c. Maintenance (Once core temp of 33°C is achieved)*

1. Maintain cooling device at gradual automatic setting with set point 33°C.
2. Continue sedation, analgesia, and paralysis for 24 hours, even if patient becomes hemodynamically unstable

*d. Rewarming (24 hrs after initiating cooling):*

1. Important Considerations:
  - a. Anticipate reduction in venous return (cardiac output) and BP (with ↓CVP) as cooler blood shifts from core to extremities. K<sup>+</sup> shifts to extracellular compartment.
  - b. Vitals signs q 1 hour until temp reaches 36°C.
2. Prior to rewarming
  - a. Volume load aggressively with NS to compensate for reductions in BP/ScvO<sub>2</sub>/CVP.
  - b. Discontinue all K<sup>+</sup> containing fluids but always correct hypokalemia, and other electrolyte abnormalities, to the normal range.
  - c. Follow K<sup>+</sup> closely q 6 hours and as needed.

- d. Follow ABG q 1-2 hours and as needed (temperature corrected--must inform the laboratory).
3. Rewarm gradually:
  - a. Maintain paralysis until patient reaches 36°C.
  - b. Program cooling unit to rewarm patient by increasing set point to 37°C.

<b>Gaymar Medi-Therm III Cooling Unit</b>
Set in automatic mode, gradual, with target temperature of 37°C (this will rewarm patient @ 0.17°C/hr, [1°C/6hrs]).

4. When TOF is 4/4 discontinue BIS monitor and titrate Propofol and Fentanyl to comfort/vent synchrony.
5. Meperidine 12.5-25 mg q4-6 hrs IVP (not to exceed 100 mg) can be used to treat shivering once NMBs have been stopped (if renal failure or oliguria isn't present and patient not taking an MAO inhibitor, Buspirone, or SSRI).
6. Discontinue active rewarming when patient reaches temperature of 37°C.

**3. Treat acute coronary syndrome**

- a. Treat everyone with single dose Aspirin per rectum (300 mg suppository) or OG (325mg Tab), unless contraindicated (allergy or active bleeding).
- b. If ST segment MI or new LBBB, and no prolonged arrest time, cardiology may perform early cath. NOTE: Patients may receive cardiac interventions as needed while hypothermic.

**4. Treat hyperglycemia** Use HUP/ICU Insulin Infusion Protocol

**5. Fever prophylaxis** Acetaminophen 1 gram per rectum or per NGT, then 500 mg q 6 hours

**6. Other ICU protocols**

- a. If bilateral pulmonary infiltrates, use low stretch protocol based on PBW (obtain patient height)<sup>13</sup>.
- b. Pneumonia prevention with mouth care protocol and HOB > 30° at all times (unless hypotensive).
- c. GI and DVT prophylaxis with ranitidine and SQ Heparin & Intermittent Compression Stockings.
- d. NPO.

**XI. Assessment of Neurologic Prognosis (Determined 72 hours after ROSC)**

1. Determination of neurological prognosis is unreliable before 72 hours after ROSC.
2. Recommended criteria for initiating DNR status and/or withdrawal of care<sup>10</sup>:

Brain Region	Test 72 hours POST-ROSC	Specificity for poor outcome	95% CI
Cortical and brainstem	HUP Brain Death Protocol	100%	
Brain stem	Absence of pupillary light reflex	100%	88 to 100%
Cortical	Absence of motor response to pain	100%	93 to 100%
Cortical	Bilateral absence of early cortical SSEPs	100%	98 to 100%

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