PROTOCOL **PATIENT CARE SERVICES** **HENRY FORD WEST BLOOMFIELD HOSPITAL** **WEST BLOOMFIELD, MICHIGAN**	**CODE:**	**NUMBER:**
	TITLE: ***Therapeutic Hypothermia – Cardiac Arrest***	
APPROVED: **REVIEWED:**	WRITTEN March 2015	

This guideline describes patient selection, methods, and management for therapeutic hypothermia (TH) in resuscitated cardiac arrest patients at **West Bloomfield, Henry Ford Hospital**. Therapeutic hypothermia may decrease anoxic brain injury following cardiac arrest and improve outcomes in mortality and neurologic recovery. A complete review of available literature on inducing hypothermia in STEMI patients to reduce infarct size was also reviewed and this protocol is not designed for that purpose.

Inclusion Criteria

- In-hospital or Out-of-hospital cardiac arrest - either a) witnessed by bystander/family member or b) with ventricular fibrillation (VF) or ventricular tachycardia (VT) as initial cardiac rhythm.
- Unconscious patient (Glasgow Coma Scale ≤ 10) with return of spontaneous circulation (ROSC) : Systolic Blood pressure of ≥ 90 mm Hg or MAP ≥ 50 mm Hg while receiving ≤2 vasopressor agents
- Interval from collapse to ROSC ≤ 60 minutes
- Ability to initiate cooling within 4 hours of arrest
- Patient age18-75 years

Exclusion Criteria

- Patients with an advanced directive specifying – Do Not Attempt Resuscitation (DNAR)
- Family member or designated medical decision maker who does not want resuscitative efforts to continue including hypothermia
- Response to verbal commands after return of spontaneous circulation (ROSC)
- Prolonged pulseless electrical activity (PEA) or asystole > 10 minutes at any time before or during resuscitation
- Estimated interval between the collapse and CPR/ first attempt at resuscitation greater than 15 minutes
- Time from first resuscitation attempt and restoration of circulation greater than 60 minutes
- Patient temperature below 34° Celsius
- Arrest not due to cardiac arrhythmia or acute myocardial infarction: (i.e. - pulmonary embolism, drug overdose, head trauma, acute stroke, gastrointestinal (GI) hemorrhage, etc.)
- End stage renal disease (dialysis-dependent) or serious existing medical condition with expected survival < 1 year (metastatic cancer, Class IV Heart Failure, etc.)
- Prior poor functional status or known history of drug/alcohol dependency
- Pregnancy
- IVC filter or inability to gain femoral venous access

Initiating/Prescribing Therapeutic Hypothermia

- Cardiology /ICU / ED Senior staff will determine if patient is eligible and likely to benefit from therapeutic hypothermia (TH).
- RN will follow the TH guidelines in the implementation, management, and care of the patient receiving TH.
- Cardiology, or ICU Senior Staff/ providers will initiate orders for therapeutic hypothermia using the ALSIUS Intravascular Temperature Management catheter
- If questions of patient's suitability for therapeutic hypothermia arise, discussion with Cardiologist or ICU Senior Staff should be initiated and resolved prior to catheter placement or hypothermia initiation in Catheterization Lab/ ICU/ED.
- External cooling using ice can be initiated by EMS if possible.

Therapeutic Hypothermia – Initial Patient/ECG Assessment & Triage

Initial patient assessment following cardiac arrest should include following:

- Obtain vital signs, temperature, Electrocardiogram (ECG), and standard labs (CBC, ABG, biochemistry profile, PT, PTT, troponin I, magnesium, phosphate, and calcium.

- Perform, review and document 12 lead ECG.
    - New ST-segment elevation or LBBB: Call Acute STEMI Hotline (313) 916-350-2718 for emergent activation and transfer to Cardiac Catheterization lab for coronary angiography/ primary PCI**.** In patients with suspected acute STEMI, cardiac catheterization should not be delayed for ED insertion/initiation of TH. Following coronary angiography/primary PCI procedure, Interventional Cardiology will insert intravascular cooling catheter prior to ICU transfer.
    - No acute ST-segment elevation or new LBBB: ED providers may insert venous intravascular cooling catheter in ED and/ or begin external cooling with ice packs and cooling pads prior to ICU admission. Currently such patients are being transferred to HFH-Detroit Campus. However, when the CON for the elective angioplasty is approved for the hospital then these patients can be admitted at WB ICU and cooling catheter to be placed either by the ED or ICU.

Initial Patient Assessment

- Perform baseline Glasgow Coma Scale (GCS) and neurological status.

- Perform assessment of ventilatory and oxygenation functioning (because of peripheral vasoconstriction, pulse oximetry is often unreliable).
- Assess bowel sounds, abdomen and GI function.
- Assess skin integrity (External cooling devices can cause or exacerbate skin injury especially if the patient has preexisting conditions such as diabetes and/or the patient is on 2 or more vasopressors)
- Foley catheter with temperature probe should be inserted

Therapeutic Hypothermia - Principles / Cooling Goals & Methods

- TH may be achieved by intravascular or external cooling techniques.
- The preferred TH method for Henry Ford West Bloomfield Hospital cardiac arrest patients is intravascular cooling using a central venous intravascular cooling system – ALSIUS Intravascular Temperature Management ™ (IVTM).
- Initiation of cooling will generally commence in the Cardiac Catheterization Lab/ ICU/ ED.
- The goal of therapeutic hypothermia is to achieve core temperature of 36° Celsius within 4 hours of cardiac arrest and to maintain this target temperature for 28 hours.
- Achievement of hypothermia and outcomes may be improved with early bolus administration of iced- cool saline. Consider administration of 0.9% normal saline infusion (4°C) 20 mL/Kg over 30 minutes.
- All patients undergoing therapeutic hypothermia will be mechanically ventilated and sedated with neuromuscular blocking agents potentially added in patients for shivering control
- Attempts should be made to minimize travel & transport in patients receiving therapeutic hypothermia. Pads or intravascular catheter should be left in place if patient requires transport during hypothermia
- A Neurology consultation should be considered during the initial period.

Special considerations – ALSIUS Intravascular Temperature Management™

- Femoral venous catheterization/insertion is advised using the ALSIUS ICY® catheter (9.3 F, 38 cm length, heparin-coated, Latex free, MRI compatible)
- Initiate cooling as soon as possible after arrest and within 4 hours of collapse.
- Maximal duration of use for Icy catheter is 4 days (96 hours).
- Special Foley catheter-temperature probe must be inserted at time of initiating TH

- If goal temperature has not been reached within 4 hours of initiating the ALSIUS IVTM, utilize ice packs to aid in the cooling process.
- The ALSIUS IVTM™ console and catheters will initially be kept in the West Bloomfield Cardiac Catheterization lab.

Sedation and Analgesia:

- Initiate sedation ± analgesia at the start of cooling, as inadequate sedation has been shown to counteract the benefits of therapeutic hypothermia.
- Initially prescribe benzodiazepine (midazolam 5 mg IV bolus), followed by a continuous IV infusion at 2 mg/hr. Titrate midazolam dose according to HFH/WB ICU Sedation protocol to a MAAS of 2 (maximal recommended dose = 20 mg/hr).
- Initiate opiate analgesia with fentanyl 50 mcg IV bolus, followed by an IV infusion at 50 mcg/hr. Fentanyl can be titrated for VAS score per Fentanyl Dosing Guideline (Appendix 1)
- For patients who fail to achieve adequate sedation with maximal doses of midazolam, or for those with liver failure (Childs Pugh score B or C), propofol IV infusion can be considered. Propofol is started at 5 mcg/kg/min (no bolus) and titrated upward in increments of 5-10 mcg/kg/min every 10 minutes until MAAS is 2 per protocol in Appendix 1 (range 5 – 80 mcg/kg/min).
- During rewarming, consider discontinuation of sedation once temperature reaches 37 degrees Celsius

Shivering Implications & Prevention

- Shivering will slow the rate of cooling and the effectiveness of therapeutic hypothermia. If shivering is present, ICU physician, nurse and pharmacist should collaborate for optimal management.
- Additional boluses of midazolam 2 – 4 mg IV or fentanyl 50 – 100 mcg IV can be used to control shivering.
- Magnesium 2 - 4 grams IV can also be used to control shivering (avoid if serum magnesium is >3.5 mg/dL).
- If shivering is severe or persists despite adequate dosing of midazolam, fentanyl, magnesium – then a paralytic/neuromuscular blocking agent should be promptly administered. (Cisatracurium 0.15-0.20 mg/kg IV loading dose followed by continuous infusion 1-10 mcg/kg/min for maintenance
- Detailed Recommendations for Cisatracurium use
    - Patient must be on sedation

- During acute cooling phase – start Cisatracurium IV drip at 3 mcg/kg/min, titrate per "train of four" (TOF) response of 2 out of 4 to a maximum dose of 10 mcg/kg/min to eliminate shivering.
- Neuromuscular blockade should be monitored per HFH ICU policy with cisatracurium dose targeted for 2/4 "train of four" twitch response. If the patient has TOF of 2/4 but is still shivering, please contact physician for additional paralytic orders.
- Continuous infusion of paralytic agents is often <u>not</u> required during the maintenance cooling period. Providers may discontinue cisatracurium infusion when temperature reaches 37 degrees Celsius
- During cooling maintenance (patient maintained at 36°), Cisatracurium 10 mg IV bolus Q30 min PRN may be adequate to control shivering. Consider resuming infusion of cisatracurium if patient is requires frequent bolus doses
- At the start of rewarming phase: Resume cisatracurium IV infusion at 3 mcg/kg/min, titrate per TOF to a maximal dose of 10 mcg/kg/min to eliminate shivering. Discontinue when temperature reaches 36 degrees Celsius.

- "Bair hugger" warming blanket, set to room air temperature, should be applied to cover patient.

Hemodynamic Agents, Concurrent Medications, Electrolytes

- Hypothermia generally causes diuresis. IV Fluids (0.9% NS) advised and generally required for fluid resuscitation and maintenance of MAP ≥60 mmHG
- Consider Dopamine (max 20 mcg/kg/min) or Norepinephrine (max 140 mcg/min) as needed for MAP ≥ 60 mmHG
- Hypothermia may cause coagulopathy. Clinical bleeding should be treated with platelet transfusion and FFP.
- IV heparin is not required for catheter use/therapeutic hypothermia and anticoagulation (unfractionated heparin) should be prescribed during TH with appropriate indications/conditions (Acute coronary syndrome, Deep vein thrombosis or Pulmonary embolism, etc.)
- Avoid mannitol administration through Icy Catheter ports as it will crystallize.
- Therapeutic Hypothermia requires modification in standard HFH ICU glucose and electrolyte management. Providers should implement standard HFH Glucose control and Electrolyte protocols with following modifications:

  - Hypothermia generally causes Hyperglycemia and Accu-checks (Fingersticks) may be inaccurate during TH due to vasoconstriction. The preferred method for assessing serum glucose is obtaining a sample from the arterial line (with the use of the VAMP system- Venous Arterial Blood Management Protection system – Do not use Fingersticks). Samples obtained from the VAMP system can be tested with standard glucometers. Alternatively, venous samples obtained from a central line can be used on the standard glucometer. If neither of these options is available, then a whole blood sample should be sent to the central laboratory for processing.
  - Serum magnesium levels 2.5 – 3.5 mg/dL may be optimal for shivering prevention. During therapeutic hypothermia, magnesium replacement should be individualized by physician order, and the ICU Magnesium protocol should be suspended.
  - Hypothermia generally causes hypokalemia and Rewarming will cause hyperkalemia. Standard ICU Potassium replacement protocols should therefore not be used / followed during the initial cooling, Maintenance cooling, or Rewarming periods. During TH, physician should write order discontinuing the ICU Potassium Replacement protocol, monitor serum K+ level at least q 6 hours and prescribe individualized potassium replacement as needed. During Rewarming (36°→37.0°), potassium replacement doses should generally not be given if K+ >3.0 mmol/L.

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Important Cooling Points:

- Decreasing the patient's "target temperature" on either machine will not make the machine cool more aggressively.
- Patients with known coagulation abnormalities or with active or ongoing bleeding, it is important to note that hypothermia may further impair the patient's intrinsic clotting mechanism.
- Hypothermia may suppress the innate immune response in patients with sepsis and diminish patient's ability to exhibit SIRS.
- Turn room temperature to 68°F during cooling and 72° F during Rewarming
- Mechanical ventilator circuit should not be warmed during initial cooling or hypothermia maintenance periods
- Collaborate with RT to have the temperature set to the lowest temperature (or off) in the ventilatory circuit, note that the temperature cannot be adjusted with the Draiger ventilator thus it is acceptable for the humidification/ temperature regulation system to be OFF during the hypothermia treatment period.
- Consider discontinuation of therapeutic hypothermia if patient develops refractory arrhythmias/ bradycardia or thrombocytopenia.

Therapeutic Hypothermia - Assessment and documentation:

- Vital signs with physical assessment should be done as per unit (ICU) standards
- Check and document temperature q 15 minutes during initiation of TH and q1hr during maintenance and rewarming of patients. Both patient temperature (temperature (measured by Foley catheter / internal temperature probe AND 1 alternative body site) and device set temperature
- Hemodynamic parameters are per ICU/ED standards.
- Laboratory assessments (CBC, electrolytes, PT, PTT, amylase, lactate, amylase) should be performed at minimum every 12 hours
- Assess for signs of shivering:
  - Palpate mandible for "humming" vibration
  - Observe for skeletal muscle movement that may be first detected as ECG artifact.
- If severe shivering occurs and unable to use pulse oximetry available, use ABG's to monitor oxygenation until shivering ceases.
- Attempt to use forehead/temporal artery for pulse oximetry measurements.
- Document nursing assessments, intake and output, and hemodynamic parameters per ICU standards.

Rewarming should be done at controlled rate of 0.25° Celsius per hour after 28 hours of cooling. Patients should NOT be rewarmed in Max Power mode. Place the patient in standby mode, set a target temp 37º and set the controlled rate of rewarming at 0.25 degrees Celsius per hour. Goal is to maintain the body temperature for unconscious pts below 37.5 until 72 hours post arrest, with use of fever- control measures.

- Potassium replacement should cease at initiation of rewarming if K+ > 3.0 mmol/L
- Cisatracurium and sedation may be discontinued when temperature reaches 37° Celsius
- Withdrawal of device will be performed by ICU provider team / Nursing team when patient has reached core temperature of 37° C

Goals of Care/ Declaration of Death/Organ Donation

- Once initiated, therapeutic hypothermia goal is to maintain temperature at 36° C for 28 hours and to continue aggressive ICU support during gradual rewarming period for a total of 48 -72 hours.
- Neurological assessment and determination of brain death are not reliable while patient is hypothermic
- Withdrawal of ICU support/ measures, stoppage of medical therapies, and extubation from mechanical ventilator should not be enacted during hypothermia therapy or Re-warming periods. Most patients should receive additional 24-72 hours of ICU therapies after Re-warming before Palliative/Comfort care measures advised.
- Cessation of therapeutic hypothermia, removal of device, and withdrawal of ICU/medical therapies will be decision of ICU Senior staff after discussion with family or medical decision maker

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APPENDIX 1: Guideline for titration of Sedation/Analgesia in Therapeutic Hypothermia

Midazolam Dosing Guideline for Hypothermia

Midazolam – Initial Dosing						
Midazolam (versed) 5 mg IVP ×1 then 2 mg/hr continuous infusion						
Midazolam Maintenance Dose Titration- Goal MAAS 2						
MAAS Score	0	1	2	3	4	5 or 6
MIDAZOLAM Infusion rate	decrease drip by 2 mg/hr (or by half if dose 2mg/hr or less)	decrease drip by 0.5mg -1 mg/hr	At Goal No Adjustment needed	2 mg IVP ×1 AND increase drip by 1 mg/hr	4 mg IVP ×1 AND increase drip by 2 mg/hr	6 mg IVP ×1 AND increase drip by 2 mg/hr
Dosage Changes: The dose of midazolam can be changed whenever the MAAS score changes. The goal is a MAAS score of "2". If the MAAS score remains "6" after the bolus and increase in infusion rate wait 15 minutes before further dosing.						

Fentanyl Dosing Guideline for Hypothermia

Fentanyl - Initial Dosing
Fentanyl 50 mcg IVP x 1 then start 50 mcg/hr continuous infusion
Fentanyl - Maintenance Dose Titration
For VAS (visual analog scale) greater than 4 give fentanyl 25 mcg IVP x1 and increase infusion by 25 mcg/hr Maximum fentanyl infusion 200 mcg/hr (more requires a physician order)
Nurse will assess VAS (Visual Analog Scale) every 1 hour and as needed for pain Document VAS in electronic medical record Goal VAS is less than or equal to 4

Propofol Dosing Guideline for Hypothermia - Goal MAAS 2

Propofol – Initial Dosing - No Boluses
Starting Dose is 5mcg/kg/min - NO BOLUSES Dosages greater than 80 mcg/kg/min for greater than 48 hours are associated with greater risk of mortality from propofol infusion syndrome **Monitor: every hour unless clinically indicated. Adjustment in dose can be done every 10 minutes if needed**.

Propofol Maintenance Dose Titration – Goal MAAS 2							
MAAS Score	0	1	2	3	4	5	6
PROPOFOL Infusion rate (Goal MAAS 2)	Hold for 10 minutes, Reassess and reduce drip by 10 mcg/kg/min	Decrease drip by 5 mcg/kg/min	**At Goal** No Adjustment needed	Increase drip by 5 mcg/kg/min	Increase drip by 10 mcg/kg/min	Increase drip by 10 mcg/kg/min Reassess in 10 minutes and if still agitated increase by 15 mcg/kg/min	Increase drip by 10 mcg/kg/min. Reassess in 10 minutes and if still agitated increase by 15 mcg/kg/min. If still agitated contact Physician

Cisatracurium Dosing Guideline for Hypothermia-Associated Shivering

Cisatracurium – Initial Dosing - Patient must be on sedation	
Can be considered if shivering is severe or persists despite adequate dosing of midazolam, fentanyl, magnesium. Loading Dose is 0.15-0.2 mg/kg IV followed by 1-10 mcg/kg/min continuous infusion	
Cisatracurium – Maintenance Dose Titration – Goal train of four (TOF) 2 out of 4	
Acute cooling phase	Start cisatracurium 3 mcg/kg/min continuous infusion, titrate per "train of four" (TOF) response of 2 out of 4 to a maximum dose of 10 mcg/kg/min to eliminate shivering.
Maintenance cooling phase	Continuous infusion of paralytic agents is often not required during the maintenance cooling period. Providers may discontinue cisatracurium infusion when temperature reaches 37 degrees Celsius. During cooling maintenance (patient maintained at 36°), Cisatracurium 10 mg IV bolus Q30 min PRN may be adequate to control shivering. Consider resuming infusion of cisatracurium if patient is requires frequent bolus doses.
Start of rewarming phase	Resume cisatracurium IV infusion at 3 mcg/kg/min, titrate per TOF to a maximal dose of 10 mcg/kg/min to eliminate shivering. Discontinue when temperature reaches 36 degrees Celsius
Neuromuscular blockade should be monitored per HFH ICU policy with cisatracurium dose targeted for 2/4 "train of four" twitch response. If the patient has TOF of 2/4 but is still shivering, please contact physician for additional paralytic orders.	

Motor Activity Assessment Scale (MAAS)

MAAS Score	Description	Definition
0	Unresponsive	Does not move with noxious stimulus
1	Responsive to noxious stimulus	Opens eyes **or** raises eyebrows **or** turns head toward stimulus **or** moves limbs when touched **or** name is called loudly
2	Responsive to touch or name	Opens eyes **or** raises eyebrows **or** turns head toward stimulus or moves limbs when touched **or** name is loudly spoken
3	Calm & Cooperative	No external stimulus is required to elicit movement **and** patient is adjusting sheets **or** clothes purposely **and** follows commands
4	Restless & cooperative	No external stimulus is required to elicit movement **and** patient is picking at sheets **or** tubes **or** uncovering self **and** follows commands
5	Agitated	No external stimulus is required to elicit movement **and** attempts to sit up **or** move limbs out of bed **and** does not consistently follow commands (i.e. will lie down when asked but soon reverts back to the attempts to sit up or move limbs out of bed)
6	Dangerously agitated, uncooperative	No external stimulus is required to elicit movement **and** patient is pulling at tubes **or** lines **or** thrashing side to side **or** striking at staff **or** trying to climb our to bed **and** does not calm down when asked

Noxious stimulus = suctioning OR after 5 seconds of vigorous orbital, sternal, or nail-bed pressure OR when vigorously pinched

DOCUMENTATION:

1. Documentation of all assessments (including the MAAS and pain score) are to be recorded in the electronic medical record
2. All drugs are to be recorded on the MAR in the one time section and scheduled dose sections, and all sedation drips are to be named with dosage and infusing rates in the applicable portions of the electronic medical record

MONITORING:

1. The agitation score (MAAS score) will be assessed and documented every hour.
2. The Pain score (VAS) will be assessed and documented every hour.