Targeted Temperature Management (TTM) After Cardiac Arrest Guide

General:

- Implement this protocol on patients remaining **unresponsive** (not following commands) after ventricular fibrillation, ventricular tachycardia, asystole or pulseless electrical activity (PEA) arrests.
- 24 hour cooling period begins when patient reaches goal temp of 36°C for the first time.
- Closely monitor potassium levels.
    - During the *cooling phase, potassium will shift into the cells* leaving a state of hypokalemia.
    - Conversely, *during the re-warming phase, potassium will shift out of the cell*, leaving a state of hyperkalemia.
- **Do not use the ICU Analgesia, Sedation for Mechanical Ventilation protocol during the TTM protocol period** (cooling & re-warming), sedation is included in TTM protocol
- Do not treat bradycardia unless symptomatic
- If hypotensive, consider the administration of IV fluids (cooling can cause diuresis)
- For bariatric patients, utilize additional universal surface cooling pads (available in Med Stores)
- If glucose is consistently >180, initiate the Insulin Infusion Orders with a goal glucose of 100 – 180.
- Do not stop neuromuscular blockade (NMB) infusion once it is started during the TTM protocol, until post re-warming phase.

Seizure Monitoring

- Neurology consult and continuous EEG monitoring are HIGHLY recommended at initiation of this protocol for recognition of sub-clinical seizure activity (not uncommon) in the setting of neuromuscular blocker use, **and** for neurological prognostication.
- Begin EEG monitoring ASAP.

Phase 1: Induction of cooling (cool to 36°C):

- BMP (M7), Mg, ABG & PT/PTT upon initiation of the protocol
- Insert esophageal temperature sensor; connect to surface cooling device and record temperature as ordered
- If water temperature is dropping or the patient's temperature is rising, this may be an indication that patient is shivering and requires more sedation/neuromuscular blockade.
- Start scheduled acetaminophen IV x24 hr, then switch to PFT Q6 hrs scheduled, through entirety of protocol.
- Start sedation and neuromuscular blockade (NMB) at the initiation of the protocol.

Lab Chart

	Initiation	At goal temp of 36C	PHASE 1/2 (hr 0-24)		PHASE 3 (hr 24-29)		PHASE 4 (hr 29-77)	
CBC	X							
BMP	X	X	Q12 hours					
Magnesium	X	X	Q12 hours		Q4 hours			
Blood Gas, ART	X	X	Q12 hours					
Prothrombin Time w/INR and PTT	X		Q12 hours					
Creatinine Kinase, Total Activitiy	X		Q8 hours x3 (total)					
Troponin-1		X	Q8 hours x3 (total)					
Potassium	X		Q6 hours					
ABG	X	X	Q12 hours					

Medication Chart

	PHASE1/2: cooling /maintenance (hr 0-24)	PHASE 3: Rewarming to 37.5 C (hr 24-29)	PHASE 4: 48 hr post TTM temp monitor (hr 29-77)
Counterwarming	Continuous—warm towels on feet and hands or Bair hugger @ 38C		
Acetaminophen IV x24 hr, then PFT x48 hr	Q6 hours		
Sedation (propofol OR midazolam)	Continuous infusion		Stop 1 hour after 37.5C goal temp reached.
NMB (vecuronium OR cisatracurium)	Continuous infusion		
Magnesium drip		Continuous infusion	
Dexmedetomidine PRN shivering			Continuous infusion
Fentanyl PRN perceived pain	Bolus or continuous infusion		

- Thick black line indicates starting point of scheduled medications.
- Always start sedation prior to neuromuscular blockade (NMB) or at the same time.
- Note blocks—if two medications do not overlap blocks, they should not be given at the same time i.e. Sedation and NMB should be off prior to starting dexmedetomidine.

		Agent	Bolus	Starting rate	Max rate	Info	
Medications	**Sedation**	Propofol	50 mg IV x 1	**Weight for calc:** **≤ 120 kg:** 20 mcg/kg/min **121 - 150 kg:** 15 mcg/kg/min **≥ 151 kg:** 10 mcg/kg/min	25 mcg/kg/min		Start immediately upon initiation of phase 1 Assess pt is adequately fluid resuscitated to prevent hypotension. Use with caution in pt's with reduced CO and EF. Sedation should be started prior to or with the neuromuscular blockade.
		Midazolam	1 mg IV x1 for pt < or = 70 kg 2 mg IV x 1 for pts > 70 kg	2 mg/hr for pts < or = 70 kg 4 mg/hr for pts > 70 kg	2 mg/hr or 4 mg/hr based on pt weight. Set dose, do not titrate.		
	NMBs	Vecuronium	0.1 mg/kg x1	Start infusion at 1 mcg/kg/min		**TITRATE to keep patient from shivering (clinical or delta temperature), NOT to TOF.**	**All NMBs** must be started with or after sedative agent is started.
		Cisatracurium	0.2 mg/kg x1	Start infusion at 1 mcg/kg/min			Preferred for pts with significant renal or hepatic dysfunction.
	Analgesic	Fentanyl	25-50 mcg IV Q1 hour prn		Bolus only		For unexplained tachycardia, hypertension or other signs of pain

Monitoring/titration of neuromuscular blockade (NMB)

DO NOT USE TRAIN OF FOUR (TOF) for monitoring of NMB.

Monitor every 1 hour for unexplained, shivering or increased delta temperature (patient – water > 1°C). If detected, re-bolus at 0.1 mg/kg and increase infusion by 10% of CURRENT DOSE. (See example calculation below)

Re-bolus Dose: AGENT	INITIAL BOLUS (mg/kg)
Vecuronioum (Norcuron®)	0.1 mg/kg
Cisatracurium (Nimbex®)	0.2 mg/kg

Dose Calculation (for increase in NMB infusion):

Increase dose by 10%	Current infusion dose (mcg/kg/min) x 1.1 = New infusion dose (mcg/kg/min) _____ mcg/kg/min x 1.1 = _____ mcg/kg/min current dose new dose *Example: 1.5 mcg/kg/min x 1.1 = 1.65 mcg/kg/min*

Summary Table for Arctic Sun Programming

- Instructions for patients presenting with a temperature < 36°C
- TTM settings
- Re-warming phase settings
- 48 hour post TTM monitoring settings

Summary Table for Arctic Sun Programming		
Patient Temperature	Action	Re-assessment
Place Temperature Pads on all patients Always use "Cool Patient" Mode for Temp Management Connect Artic Sun to Spacelab monitor		
<30°C (rare)	• **Therapy to 30°C using all pads** • **Select Hypothermia Treatment, Cool Patient** • Set ArcticSun goal temperature to **33°C, duration 2 hours.** Device will rewarm at maximum rate (water temp of 38°C) • "Slave" Arctic Sun temperature to spacelab monitor and set alarm limit to 30°C. • Consider internal IVC warming device if unstable (TICU Charge RN & GenSurg for placement)	• Temp q30min until 30°C • Set Spacelab temp alarm to 30°C
30-33°C (rare)	• **Therapy to 33°C.** Apply all four pads but **only connect torso pads**. • If treatment was given for < 30°C, purge all four pads and refill torso pads. • **Select Hypothermia Treatment, Cool Patient** • Set ArcticSun goal temperature to **33°C, duration 2 hours.** Device will rewarm at maximum rate (water temp of 38°C)	• Temp q30min until 33°C • Set Spacelab temp alarm to 33°C
33-35.5°C	• **Passive warming to 35.5°C** • Turn the machine on, select hypothermia but do not start therapy. • Leave pads in place and purge all pads if treatment for lower temperatures was given. • "Slave" Arctic Sun temperature to spacelab monitor and set alarm limit to 35.5°C. • If pt. does not rewarm, can actively warm at 0.3°C / hour.	• Temp q30min until 35.5°C • Set Spacelab temp alarm to 35.5°C
≥ 36°C	• **Targeted Temp Management** • **Select hypothermia treatment, cool patient** • Set ArcticSun goal temp **36°C, duration 24 hours.** • Note: If the patient's temp is 35.5°C, Arctic Sun will rewarm to 36°C.	• see TTM orders
37.5 °C Rewarm	• Select Rewarm Patient • Target temp: 37.5°C • "Start Rewarm Patient" • Adjust Spacelab alarm limits: high limit: 37°C	• Rewarm patient at a rate of 0.3 °C/hr
37.5 °C 48 hrs post TTM monitoring	Once Rewarming Complete • Minimize/discontinue use of all NMB, benzodiazepines, and opiates. • To control shivering, use interventions that decrease sedation (see order set). • Continue cooling therapy to a target temperature of 37°C using **HYPOTHERMIA treatment, cool patient** • Target temp: 37.5ºC • Duration: 48 hours • Push "save", then "start cool patient"	• DO NOT select Normothermia.

Phase 2: Maintenance (maintain 36°C x 24 hrs):

- Phase begins when patient reaches goal temp of 36°C and should remain at this temp for a full 24 hours.
- Verify esophageal probe placement with chest radiograph.
- Utilize forehead oximetry sensor to monitor SpO_2.
- Assess for seizure activity, especially if shivering occurs (see seizure specific information below)
- Record the water temperature every 1 hour when the Arctic Sun is in use.
- Compare ArcticSun water temperature & patient temperature. IF device consistently colder than patient, it might indicate that microshivering is present.

Phase 3: Re-warming (re-warm to 37.5°C):

- At 24 hours (from when patient has reached goal temp), begin re-warming to 37.5°C at 0.3°C/hr using the surface cooling device.

During the Re-Warming Phase:

- Continue sedation and NMB.
- Start Magnesium infusion immediately prior to initiation of Phase 3.

Magnesium Sulfate Infusion for Shivering during TTM (start immediately prior to Phase 3)

- Obtain baseline serum Magnesium level and every 4 hours while on treatment
- Goal serum Mg level 3-4 mg/dL

Infusion Initiation

- If serum Mg level < 2:
  - Give 2 g IV bolus over one hour
  - Start maintenance infusion at 1 g/hr
- If serum Mg level > 2:
  - No bolus needed
  - Start maintenance infusion at 1 g/hr

Infusion Titration

Serum Magnesium Level	Intervention
2 - 2.4 mg/dL	Increase drip by 0.5 g/h
2.5 - 3 mg/dL	Increase drip by 0.25 g/h
3.1 - 3.7 mg/dL	Continue current drip rate
3.8 - 4 mg/dL	Decrease drip by 0.25 g/h
> 4	Hold drip, recheck Mg 2 hours later. If level < 4 restart at 0.5 g/h less than previous rate.

Phase 4: 48 hr Post TTM Temperature Monitoring (maintain 37.5°C x 48 hrs):

- Once the patient has reached 37.5°C:
  - Stop NMB infusion and wait 1 hour before stopping sedative infusion.
  - Minimize use of all other sedatives and opiates.
- On the Arctic sun, continue therapy to a target temperature of 37.5°C x 48 hours

Post Cardiac Arrest
Neurological Evaluation and Prognostication Guideline:
For patients who have received Targeted Temperature Management

Post-Arrest Care

- Return of Spontaneous Circulation
- Meet with family and review expected management & next steps
- If at any time the patient awakens and follows commands, this protocol will be stopped.

0 -24 hrs

- TTM protocol initiated and maintained for 80hrs
- Acetaminophen, counterwarming, NMB and sedatives utilized to achieve goal temp of 36^0C and prevent shivering
- Neurology consult for EEG monitoring and seizure management
- Family given education material on timing of prognostication

24 – 30 hrs

- Rewarming phase of TTM protocol
- For comastose survivors, avoid fever for additional 48 hours
- Minimize/discontinue use of all NMB, sedatives, and opiates
- Use counterwarming, acetaminophen, magnesium infusion, buspirone, or dexmedetomidine to control shivering
- No neurological testing done at this time

48 hrs

- Neurology Consult for detailed physical exam and planning of prognostic testing
- Plan for prognostication testing developed at this time with family, Neurology, and ICU team

60-96 hrs

- CK-BB obtained 60 - 72 hours after ROSC (obtain after MRI/CT if suspect cerebral swelling)
- MRI of brain with stroke protocol
- Bilateral median nerve SSEPs

96-120 hrs

- Neurology performs another detailed physical exam off of NMB, propofol (for 24h) benzodiapines (for 48h) and opiates
- Consider Palliative Care Consult to facilitate family meeting
- Family meeting to discuss test results, estimate neurological prognosis, and goals of care
- Consider spiritual care, social work, ICU liaison consults

"Operationally, the timing for prognostication is typically 4.5 to 5 days after ROSC for patients treated with TTM. This approach minimizes the possibility of obtaining false-positive results (ie, inaccurately suggesting a poor outcome) because of drug-induced depression of neurologic function. In making this recommendation, it is recognized that in some instances, withdrawal of life support may occur appropriately before 72 hours because of underlying terminal disease, brain herniation, or other clearly nonsurvivable situations." (Circulation. 2015;132(suppl 2):S465–S482)