THE UNIVERSITY OF TEXAS MD Anderson Cancer Center
Making Cancer History®

Post Cardiac Arrest Targeted Temperature Management (TTM)

Disclaimer: *This algorithm has been developed for MD Anderson using a multidisciplinary approach considering circumstances particular to MD Anderson's specific patient population, services and structure, and clinical information. This is not intended to replace the independent medical or professional judgment of physicians or other health care providers in the context of individual clinical circumstances to determine a patient's care. This algorithm should not be used to treat pregnant women.*

Note: TTM should not delay imaging studies, renal replacement therapy or re-perfusion therapy

PATIENT PRESENTATION

Cardiac arrest[1]
- PEA
- Asystole
- Ventricular fibrillation
- Pulseless ventricular tachycardia

Sustained ROSC > 20 consecutive minutes?
- No → Patient not eligible for TTM
- Yes → Does patient meet inclusion criteria[2] for hypothermia?
  - No → Patient not eligible for TTM
  - Yes → Does patient meet exclusion criteria[3]?
    - Yes → Patient not eligible for TTM
    - No → Initiate Post Cardiac Arrest TTM order set[4] with target temperature of 36°C
      - See Page 3 for TTM protocol
      - Initiate shivering management (see Page 4)

COOLING

Development of complications[5]?
- Yes → See Page 2 for re-warming phase
- No → Continue TTM
  - Continue shivering management (see Page 4)

Target temperature maintained for 24 hours?
- No → Continue TTM
- Yes → See Page 2 for re-warming phase

FiO_2 = fraction of inspired oxygen
PEA = pulseless electrical activity
ROSC = return of spontaneous circulation

[1] Refer to Post-Cardiac Arrest Care - Adults algorithm and initiate order set as indicated

[2] Inclusion criteria:
- Down time < 60 minutes (< 15 minutes for asystole)
- Intubated requiring mechanical ventilation
- No meaningful response to verbal stimuli (Glasgow Coma Scale < 9, see Appendix A)
- ≤ 12 hours from ROSC

[3] Exclusion criteria:
- Major traumatic injury or isolated head injury
- Major operative procedure within 72 hours
- Hypoxemia - oxygen saturation < 88% on 100% FiO_2 for > 30 minutes
- Pregnancy
- Uncontrolled arrhythmias
- Age < 18 years
- Uncontrolled bleeding
- Hypothermia - temperature < 30°C
- Mean arterial pressure (MAP) < 70 mmHg despite aggressive fluid resuscitation and vasopressor support
- Poor prognosis as discussed with primary team

[4] If temperature < 36°C, no cooling required. If temperature > 36°C within 24 hours of ROSC, ICU team to initiate TTM order set.

[5] See Appendix B for Complications

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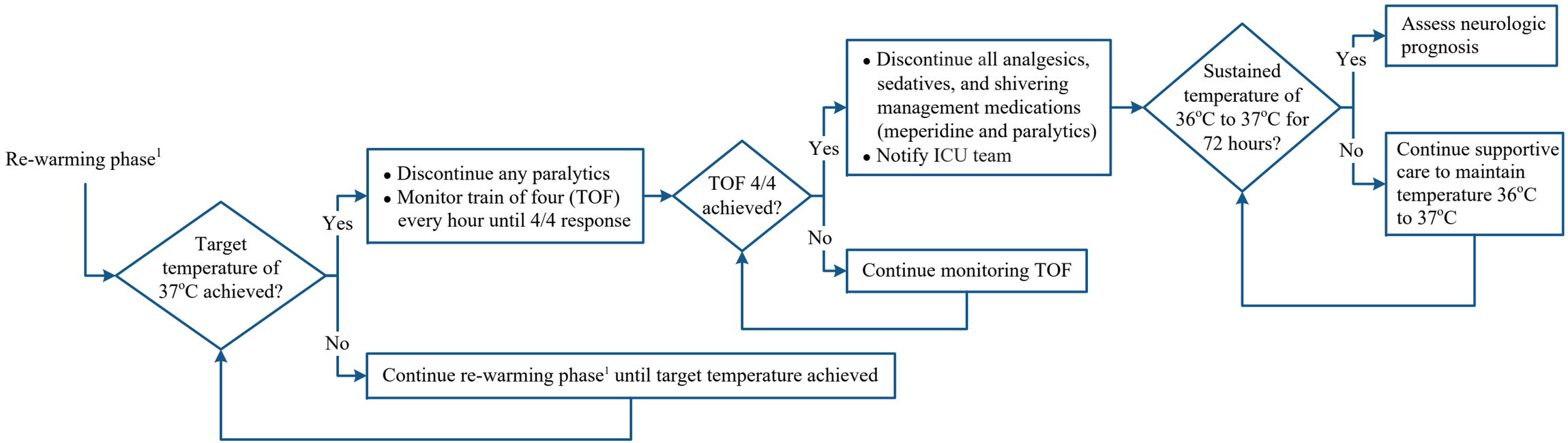
RE-WARMING

NORMOTHERMIA[1]



[1] See Page 3 for TTM Protocol

Post Cardiac Arrest Targeted Temperature Management (TTM)

TTM Protocol (TTM should not delay imaging studies, continuous renal replacement, or re-perfusion therapy)

Supportive Care	Cooling Phase[4]	Maintenance Phase	Re-Warming Phase	Normothermia Phase
• Consultation: ◦ Neuro-oncology ◦ Cardiology • Baseline labs and imaging • Nursing assessment: ◦ Pupil checks every 1 hour ◦ BPS[1] per TTM order set ◦ BSAS[2] per TTM order set ◦ RASS[3] per TTM order set ◦ Skin assessment every hour • Placement of: ◦ Nasogastric **or** ◦ Orogastric tube • Placement of cooling blanket • Placement of foley temperature probe ◦ If foley temperature probe contraindicated, physician to place esophageal temperature probe • Daily 30 minute EEG ◦ May convert to continuous EEG if seizures identified	• Cool to 36°C (goal to target temperature < 4 hours) • Record time of initiation of TTM and time of achieving 36°C • Keep room as cool as possible • Magnesium sulfate 32 mEq IV for one dose over 1 hour • Respiratory therapy: ◦ No spontaneous breathing trials • Shivering management (see Page 4) • Notify ICU team for development of complications (see Appendix B)	• Basic metabolic panel, magnesium, phosphorous, ionized calcium, CBC with differential, PT/PTT every 6 hours	• Begin re-warming 24 hours after target temperature achieved – 0.20°C/hour for a target temperature of 37°C • Maintain target temperature of 36°C to 37°C • Call ICU team for temperature > 37°C • Warm room to normal temperature • Respiratory therapy: ◦ No spontaneous breathing trials	• Once temperature is 37°C: ◦ Discontinue any paralytics ◦ Monitor TOF every hour until 4/4 response • Once TOF is 4/4: ◦ Discontinue all sedatives, shivering management medications, and analgesics ◦ Notify ICU team

[1] See Appendix C Behavioral Pain Score (BPS)
[2] See Appendix D Bedside Shivering Assessment Scale (BSAS)
[3] See Appendix E Richmond Agitation-Sedation Scale (RASS)
[4] If temperature < 36°C, no cooling required. If temperature > 36°C within 24 hours of ROSC, ICU team to initiate TTM order set.

Post Cardiac Arrest Targeted Temperature Management (TTM)

SHIVERING MANAGEMENT

Initiate upon commencement of TTM

- Analgesia → **A**
  - Fentanyl 12.5-100 mcg/hour IV continuous infusion
    - If BPS[1] is > 5 and/or BSAS[2] > 0, give bolus equal to twice the current infusion dose (maximum 25 mcg) every 15 minutes as needed
    - If a second bolus is required within a 2 hour period, increase infusion dose 12.5-25 mcg/hour to a maximum dose of 100 mcg/hour
- Sedation[3]
  - Hemodynamically stable or minimal vasopressor support → Propofol 10-50 mcg/kg/minute IV continuous infusion
    - Titrate up or down by 5-10 mcg/kg/minute every 5-20 minutes as needed to achieve and maintain target RASS[4]. Maximum dose is 50 mcg/kg/minute.
  - More than one vasopressor → Midazolam 1-4 mg/hour IV continuous infusion
    - Midazolam 2 mg IV push bolus then infuse at 1 mg/hour
    - If less than desired sedation, give IV push bolus equal to the current infusion dose (maximum 2 mg) every 15 minutes as needed to achieve target RASS[4]
    - If a second bolus is required within a 2 hour period, increase infusion dose by 1 mg/hour (maximum dose of 4 mg/hour)

Box A →
- Acetaminophen 650 mg per feeding tube/rectum every 4 hours for 12 doses then discontinue
- Magnesium sulfate 32 mEq IV infused over 4 hours every 6 hours as needed for magnesium < 2.5 mg/dL (adjust dose based on renal function)

Assess BSAS[2] every hour

- BSAS[2] ≥ 1
  - Optimize fentanyl infusion via titration orders (see Box A above)
  - Meperidine 12.5 mg or 25 mg IV every 2 hours as needed
    - Reduce dose to 12.5 mg IV every 2 hours in elderly (age ≥ 65 years), liver failure (Child-Turcotte-Pugh[5] score C), and renal failure[6]
- BSAS[2] 2-3 **and** patient is refractory to all other anti-shivering treatments
  - Cisatracurium 0.15 mg/kg IV every 30 minutes as needed
    - Requires mechanical ventilation, analgesia and sedation to a RASS[4] of -4 to -5
    - No TOF monitoring. Use BSAS[2] to determine need for additional boluses.
    - Nurse to notify respiratory therapist for controlled mode of mechanical ventilation prior to administration

[1] See Appendix C Behavioral Pain Score (BPS)
[2] See Appendix D Bedside Shivering Assessment Scale (BSAS)
[3] Sedation
- Propofol recommended as agent of choice due to more predictable clearance
- Use midazolam only if patient requires use of more than one vasopressor with at least one infusing at a maximum rate
- Midazolam clearance decreases by 11% for every degree drop in temperature < 36.5°C

[4] See Appendix E Richmond Agitation-Sedation Scale (RASS)
[5] See Appendix F Child-Turcotte-Pugh (CTP) Scale
[6] Creatinine > 1.5 mg/dL, creatinine change > 0.5 mg/dL from baseline, creatinine clearance < 50 mL/minute, **and/or** urine output < 500 mL in previous 24 hours

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APPENDIX A: Glasgow Coma Scale (GCS)[1]

Item	Description	Score
Eye Opening Response	Spontaneous	4
	To verbal stimuli, command, speech	3
	To pain only (not applied to face)	2
	No response	1
Verbal Response	Oriented	5
	Confused conversation, but able to answer questions	4
	Inappropriate words	3
	Incomprehensible speech	2
	No response	1
Motor Response	Obeys commands for movement	6
	Localizes pain	5
	Withdraws in response to pain	4
	Flexion in response to pain	3
	Extension in response to pain	2
	No response	1

[1] GCS is obtained by adding the total score for each parameter
- Score < 9 = coma (no eye opening, no ability to follow commands, no word verbalizations)

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APPENDIX B: Complications

- MAP < 70 mmHg despite aggressive fluid resuscitation and vasopressor support
- Uncontrolled arrhythmias
- Hypoxemia - oxygen saturation < 88% on 100% FiO2 for > 30 minutes
- Uncontrolled bleeding
- Electrolyte abnormalities

APPENDIX C: Behavioral Pain Score (BPS)[1]

Item	Description	Score
Facial Expression	Relaxed	1
	Partially tightened (*e.g.,* brow lowering)	2
	Fully tightened (*e.g.,* eyelid closing)	3
	Grimacing	4
Upper Limbs	No movement	1
	Partially bent	2
	Fully bent with finger flexion	3
	Permanently retracted	4
Compliance with Ventilation	Tolerating movement	1
	Coughing but tolerating ventilator most of time	2
	Fighting ventilator	3
	Unable to control ventilator	4

[1] BPS is obtained by adding the total score for each parameter
- Target: BPS ≤ 5
- Score ≤ 3 = no pain
- Score of 12 = maximum pain
- Document BPS per TTM order set

APPENDIX D: Bedside Shivering Assessment Scale (BSAS)[1]

0 None:	No shivering noted on palpation of the masseter, neck or chest wall
1 Mild:	Shivering localized to the neck and/or thorax only
2 Moderate:	Shivering involves gross movement of the upper extremities (in addition to the neck and thorax)
3 Severe:	Shivering involves gross movements of the trunk and upper and lower extremities

[1] BSAS:
- Target: BSAS = 0
- Document BSAS every 1 hour during TTM

APPENDIX E: Richmond Agitation-Sedation Scale (RASS)[2]

4 Combative:	Overtly combative, violent, danger to staff	**-1 Drowsy:**	Awakens to voice with eye contact for more than 10 seconds
3 Very agitated:	Pulls/removes tube(s) or catheter(s); aggressive	**-2 Light Sedation:**	Awakens to voice with eye contact for less than 10 seconds
2 Agitated:	Frequent non-purposeful movement, fights ventilator	**-3 Moderate Sedation:**	Any movement (no eye contact to voice)
1 Restless:	Anxious but movements not aggressive or vigorous	**-4 Deep Sedation:**	No response to voice, or any movement to physical stimulation
0 Alert and calm		**-5 Unarousable:**	No response to voice or physical stimulation

[2] RASS:
- Target: RASS -4 to -5
- Document RASS per TTM order set

APPENDIX F: Child-Turcotte-Pugh (CTP) Scoring System[1]

Chemical and Biochemical Parameters	Scores (Points) for Increasing Abnormality		
	1	2	3
Hepatic encephalopathy	None	Grade 1 or 2, or suppressed with medication	Grade 3 or 4, or refractory to medication
Ascites	None	Mild to moderate (diuretic responsive)	Severe (diuretic refractory)
Albumin	> 3.5 g/dL	2.8 – 3.5 g/dL	< 2.8 g/dL
Total bilirubin For primary biliary cirrhosis	< 2 mg/dL < 4 mg/dL	2 – 3 mg/dL 4 – 10 mg/dL	> 3 md/dL > 10 mg/dL
Prothrombin time prolonged or international normalized ratio	< 4 seconds < 1.7	4 – 6 seconds 1.7 – 2.3	> 6 seconds > 2.3

[1] CTP score is obtained by adding the score for each parameter
CTP class:
Class A = 5 to 6 points
Class B = 7 to 9 points
Class C = 10 to 15 points

SUGGESTED READINGS

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