Post Cardiac Arrest Targeted Temperature Management (TTM)

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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

EVALUATION

Sustained ROSC > 20 consecutive minutes?

Yes → Does patient meet inclusion criteria[2] for hypothermia?

Yes → Does patient meet exclusion criteria[3]?

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)

No → Patient not eligible for TTM

No → Patient not eligible for TTM

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 36 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 36 hours of ROSC, notify ICU team.

[5] See Appendix B for Complications

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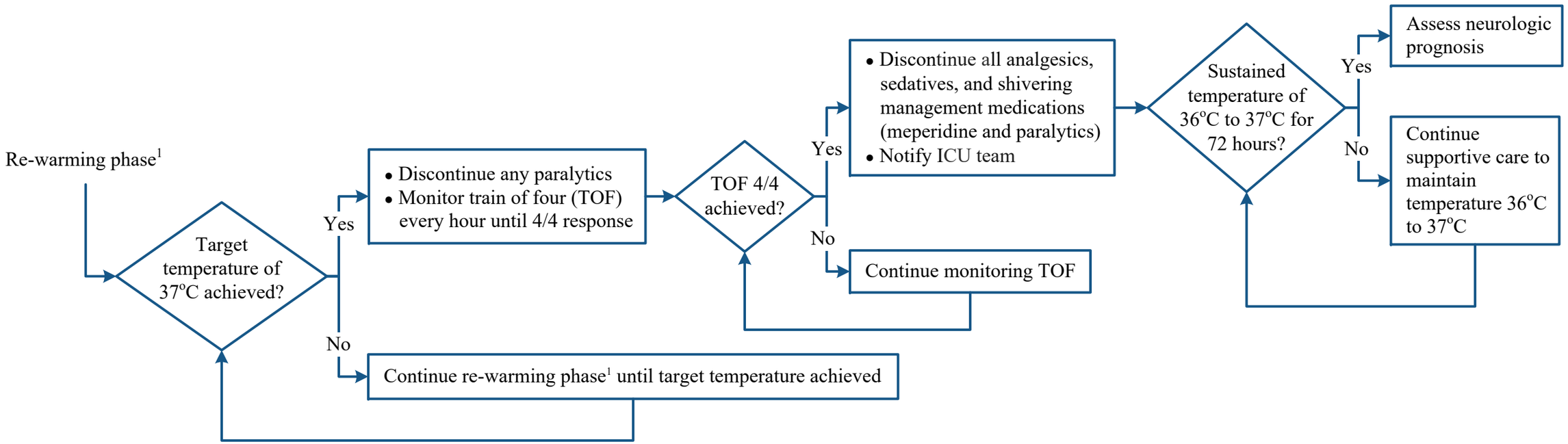
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RE-WARMING

NORMOTHERMIA[1]



[1] See Page 3 for TTM Protocol

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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 36 hours after target temperature achieved – no faster than 0.5°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 36 hours of ROSC, notify ICU team.

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SHIVERING MANAGEMENT

Initiate upon commencement of TTM

- Analgesia → **A**
  - Fentanyl 12.5-100 mcg/hour IV continuous infusion
    - If BPS[1] > 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 by 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 maintain 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

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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

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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

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