

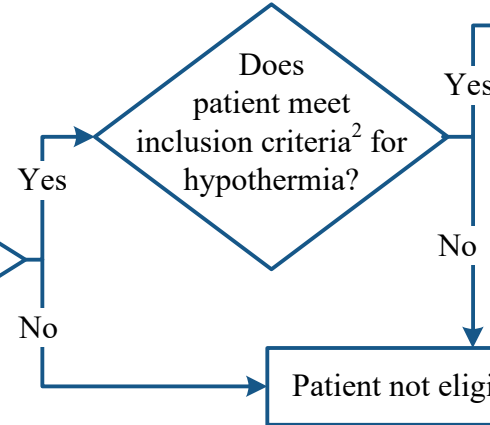
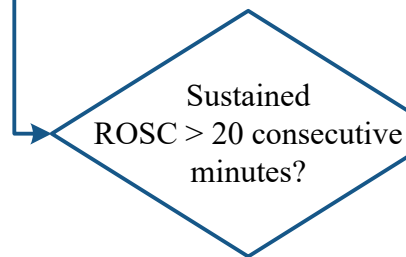
# Post Cardiac Arrest Targeted Temperature Management (TTM)

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<sup>1</sup>
- PEA
  - Asystole
  - Ventricular fibrillation
  - Pulseless ventricular tachycardia



PEA = pulseless electrical activity  
 ROSC = return of spontaneous circulation

<sup>1</sup> Refer to [Post-Cardiac Arrest Care - Adults algorithm](#) and initiate order set as indicated

<sup>2</sup> 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

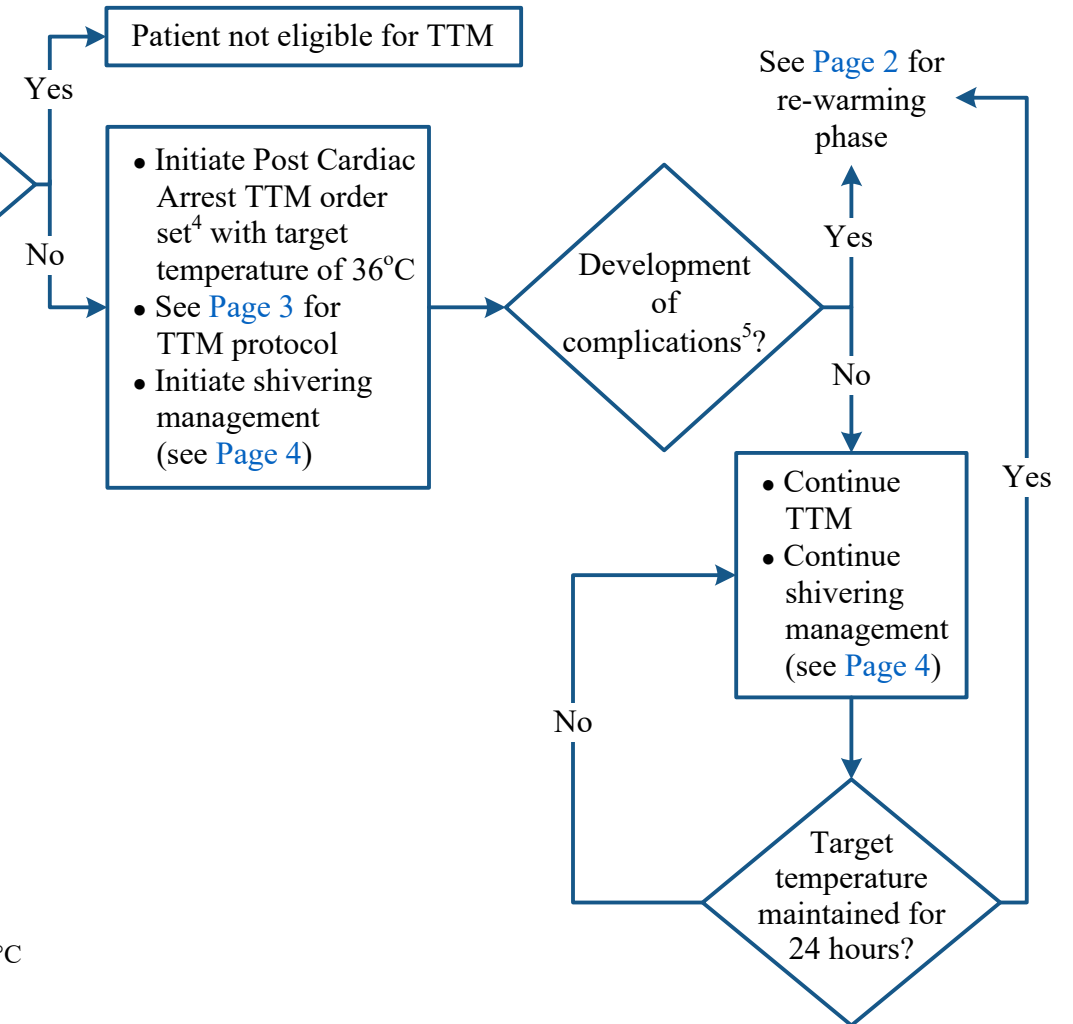
<sup>3</sup> Exclusion criteria:

- |                                                                                                         |                                    |                         |
|---------------------------------------------------------------------------------------------------------|------------------------------------|-------------------------|
| • Major traumatic injury or isolated head injury                                                        | • Pregnancy                        | • Age < 18 years        |
| • Major operative procedure within 72 hours                                                             | • Uncontrolled arrhythmias         | • Uncontrolled bleeding |
| • Hypoxemia – oxygen saturation < 88% on 100% FiO <sub>2</sub> for > 30 minutes                         | • Hypothermia – temperature < 30°C |                         |
| • Mean arterial pressure (MAP) < 70 mmHg despite aggressive fluid resuscitation and vasopressor support |                                    |                         |
| • Poor prognosis as discussed with primary team                                                         |                                    |                         |

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

<sup>5</sup> See [Appendix B](#) for Complications

## COOLING

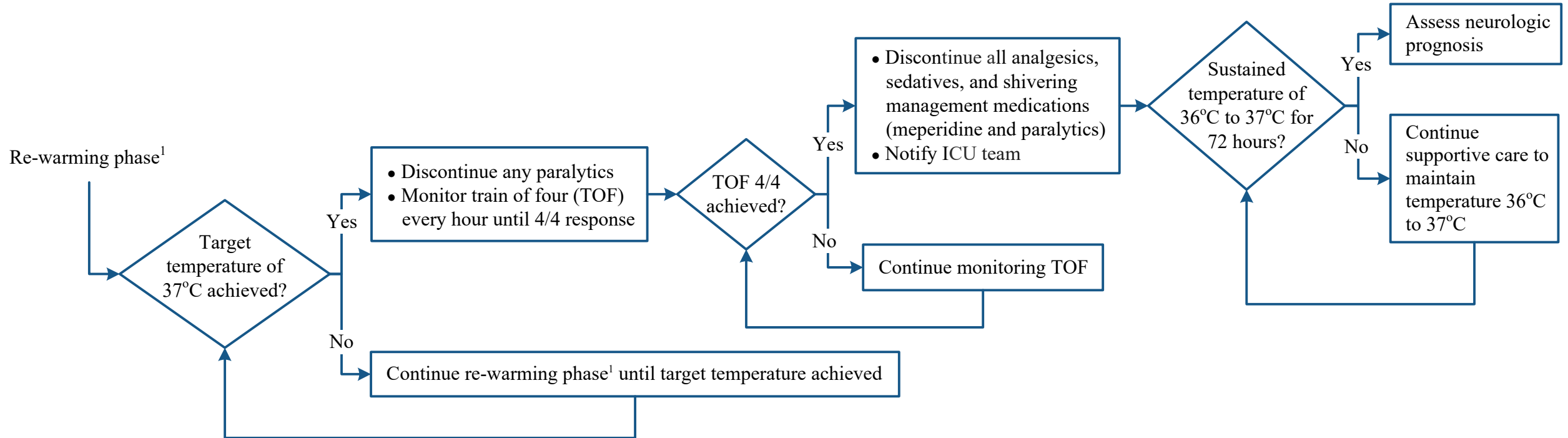


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## RE-WARMING

## NORMOTHERMIA<sup>1</sup>



<sup>1</sup> 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 <sup>4</sup>	Maintenance Phase	Re-Warming Phase	Normothermia Phase
<ul style="list-style-type: none"> <li>• Consultation:               <ul style="list-style-type: none"> <li>◦ Neuro-oncology</li> <li>◦ Cardiology</li> </ul> </li> <li>• Baseline labs and imaging</li> <li>• Nursing assessment:               <ul style="list-style-type: none"> <li>◦ Pupil checks every 1 hour</li> <li>◦ BPS<sup>1</sup> per TTM order set</li> <li>◦ BSAS<sup>2</sup> per TTM order set</li> <li>◦ RASS<sup>3</sup> per TTM order set</li> <li>◦ Skin assessment every hour</li> </ul> </li> <li>• Placement of:               <ul style="list-style-type: none"> <li>◦ Nasogastric <b>or</b></li> <li>◦ Orogastric tube</li> </ul> </li> <li>• Placement of cooling blanket</li> <li>• Placement of foley temperature probe               <ul style="list-style-type: none"> <li>◦ If foley temperature probe contraindicated, physician to place esophageal temperature probe</li> </ul> </li> <li>• Daily 30 minute EEG               <ul style="list-style-type: none"> <li>◦ May convert to continuous EEG if seizures identified</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• Cool to 36°C (goal to target temperature &lt; 4 hours)</li> <li>• Record time of initiation of TTM and time of achieving 36°C</li> <li>• Keep room as cool as possible</li> <li>• Magnesium sulfate 32 mEq IV for one dose over 1 hour</li> <li>• Respiratory therapy:               <ul style="list-style-type: none"> <li>◦ No spontaneous breathing trials</li> </ul> </li> <li>• Shivering management (see <a href="#">Page 4</a>)</li> <li>• Notify ICU team for development of complications (see <a href="#">Appendix B</a>)</li> </ul>	<ul style="list-style-type: none"> <li>• Basic metabolic panel, magnesium, phosphorous, ionized calcium, CBC with differential, PT/PTT every 6 hours</li> </ul>	<ul style="list-style-type: none"> <li>• Begin re-warming 24 hours after target temperature achieved – 0.20°C/hour for a target temperature of 37°C</li> <li>• Maintain target temperature of 36°C to 37°C</li> <li>• Call ICU team for temperature &gt; 37°C</li> <li>• Warm room to normal temperature</li> <li>• Respiratory therapy:               <ul style="list-style-type: none"> <li>◦ No spontaneous breathing trials</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• Once temperature is 37°C:               <ul style="list-style-type: none"> <li>◦ Discontinue any paralytics</li> <li>◦ Monitor TOF every hour until 4/4 response</li> </ul> </li> <li>• Once TOF is 4/4:               <ul style="list-style-type: none"> <li>◦ Discontinue all sedatives, shivering management medications, and analgesics</li> <li>◦ Notify ICU team</li> </ul> </li> </ul>

<sup>1</sup> See [Appendix C](#) Behavioral Pain Score (BPS)

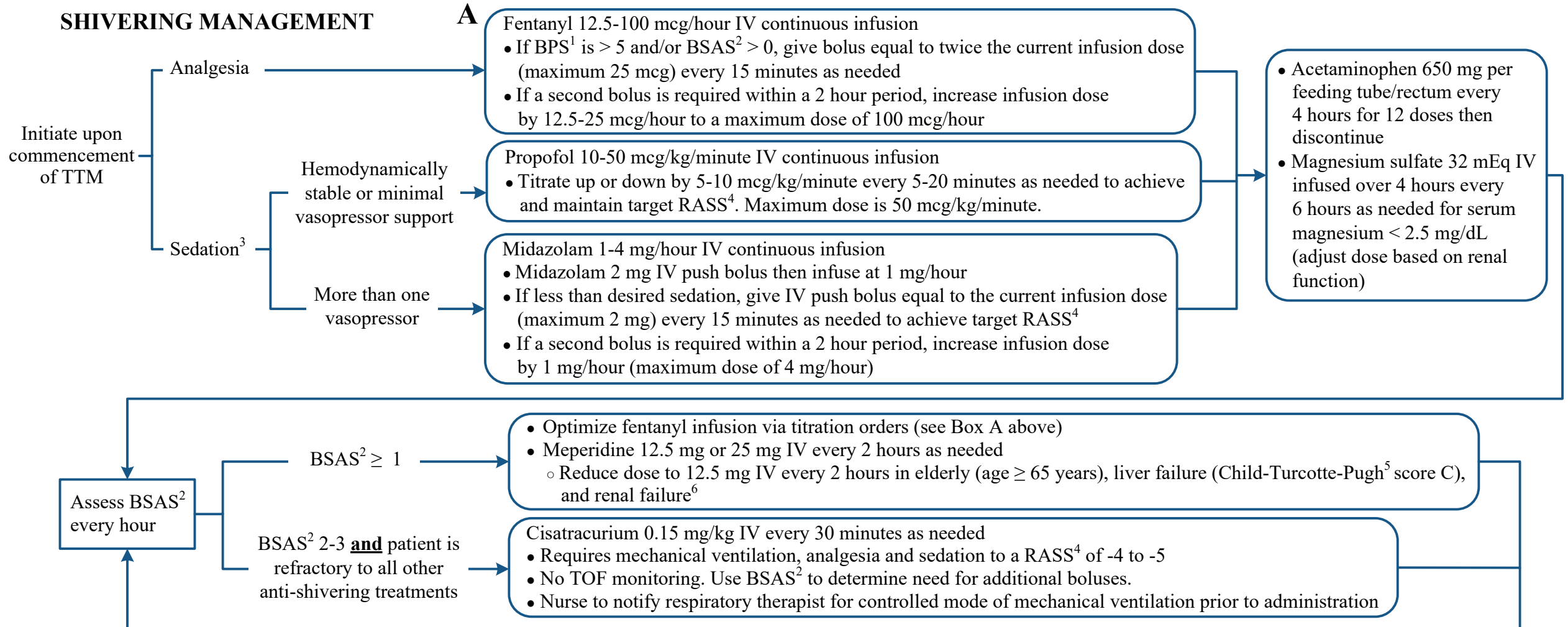
<sup>2</sup> See [Appendix D](#) Bedside Shivering Assessment Scale (BSAS)

<sup>3</sup> See [Appendix E](#) Richmond Agitation-Sedation Scale (RASS)

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

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<sup>1</sup> See Appendix C Behavioral Pain Score (BPS)

<sup>2</sup> See Appendix D Bedside Shivering Assessment Scale (BSAS)

<sup>3</sup> 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

<sup>4</sup> See Appendix E Richmond Agitation-Sedation Scale (RASS)

<sup>5</sup> See Appendix F Child-Turcotte-Pugh (CTP) Scale

<sup>6</sup> Serum creatinine > 1.5 mg/dL, serum 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)<sup>1</sup>

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

<sup>1</sup> 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

## APPENDIX C: Behavioral Pain Score (BPS)<sup>1</sup>

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

<sup>1</sup> 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)<sup>1</sup>

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

<sup>1</sup> BSAS:

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

## APPENDIX E: Richmond Agitation-Sedation Scale (RASS)<sup>2</sup>

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

<sup>2</sup> RASS:

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



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## APPENDIX F: Child-Turcotte-Pugh (CTP) Scoring System<sup>1</sup>

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)
Serum 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

<sup>1</sup> 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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## SUGGESTED READINGS

- Badjatia, M., Strongilis, E., Gordon, E., Prescutti, M., Fernandez, L., Fernandez, A., . . . Mayer, S. A. (2008). Metabolic impact of shivering during therapeutic temperature modulation: The bedside shivering assessment scale. *Stroke*, 39(12), 3242-3247. <https://doi.org/10.1161/STROKEAHA.108.523654>
- Broessner, G., Fischer, M., Schubert, G., Metzler, B., & Schmutzhard, E. (2012). Update on therapeutic temperature management [Abstract]. *Critical Care*, 16(2), A1. <https://doi.org/10.1186/cc11259>
- Crepeau, A. Z., Rabinstein, A. A., Fugate, J. E., Mandrekar, J., Wijdicks, E. F., White, R. D., & Britton, J. W. (2013). Continuous EEG in therapeutic hypothermia after cardiac arrest: Prognostic and clinical value. *Neurology*, 80(4), 339-344. <https://doi.org/10.1212/WNL.0b013e31827f089d>
- Dankiewicz, J., Cronberg, T., Lilja, G., Jakobsen, J. C., Levin, H., Ullén, S., . . . Nielsen, N. (2021). Hypothermia versus normothermia after out-of-hospital cardiac arrest. *The New England Journal of Medicine*, 384(24), 2283-2294. <https://doi.org/10.1056/NEJMoa2100591>
- The Hypothermia after Cardiac Arrest Study Group. (2002). Mild therapeutic hypothermia to improve the neurologic outcome after cardiac arrest. *The New England Journal of Medicine*, 346(8), 549-556. <https://doi.org/10.1056/NEJMoa012689>
- McKean, S. (2009). Induced moderate hypothermia after cardiac arrest. *AACN Advanced Critical Care*, 20(4), 343-355. <https://doi.org/10.4037/15597768-2009-4008>
- Nielsen, N., Wetterslev, J., Cronberg, T., Erlinge, D., Gasche, Y., Hassager, C., . . . Friberg, H. (2013). Target temperature management at 33°C versus 36°C after cardiac arrest. *The New England Journal of Medicine*, 369(23), 2197-2206. <https://doi.org/10.1056/NEJMoa1310519>
- Payen, J. F., Bru, O., Bosson, J. L., Lagrasta, A., Novel, E., Deschaux, I., . . . Jacquot, C. (2001). Assessing pain in critically ill sedated patients by using a behavioral pain scale. *Critical Care Medicine*, 29(12), 2258-2263. <https://doi.org/10.1097/00003246-200112000-00004>
- Polderman, K. H. (2009). Mechanisms of action, physiological effects, and complications of hypothermia. *Critical Care Medicine*, 37(7), S186-S202. <https://doi.org/10.1097/CCM.0b013e3181aa5241>
- Pugh, R. N. H., Murray-Lyon, I. M., Dawson, J. L., Pietroni, M. C., & Williams, R. (1973). Transection of the oesophagus for bleeding oesophageal varices. *British Journal of Surgery*, 60(8), 646-649. <https://doi.org/10.1002/bjs.1800600817>
- Scirica, M. B. (2013). Therapeutic hypothermia after cardiac arrest. *Circulation*, 127(2), 244-250. <https://doi.org/10.1161/CIRCULATIONAHA.111.076851>
- Šunjić, K. M., Webb, A. C., Šunjić, I., Palà Creus, M., & Folsø, S. L. (2015). Pharmacokinetic and other considerations for drug therapy during targeted temperature management. *Critical Care Medicine*, 43(10), 2228-2238. <https://doi.org/10.1097/CCM.0000000000001223>
- U.S. Food & Drug Administration. (2003). Pharmacokinetics in patients with impaired hepatic function: Study design, data analysis, and impact on dosing and labeling. Retrieved from <https://www.fda.gov/regulatory-information/search-fda-guidance-documents/pharmacokinetics-patients-impaired-hepatic-function-study-design-data-analysis-and-impact-dosing-and>
- Weant, K. A., Martin, J. E., Humphries, R. L., & Cook, A. M. (2010). Pharmacologic options for reducing the shivering response to therapeutic hypothermia. *Pharmacotherapy: The Journal of Human Pharmacology and Drug Therapy*, 30(8), 830-841. <https://doi.org/10.1592/phco.30.8.830>

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## DEVELOPMENT CREDITS

This practice consensus statement is based on majority opinion of the TTM experts at the University of Texas MD Anderson Cancer Center for the patient population. These experts included:

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