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Post Cardiac Arrest Targeted Temperature Management (TTM)\(^1\)

COOLING

- Consider goal temperature of 36°C with no cooled saline

- Initiate TTM\(^4\)
- Initiate Shivering Management protocol (Page 3)

- Development of complications\(^5\)?

- Continue TTM\(^4\)
- Continue Shivering Management protocol (Page 3)

Target temperature maintained for 24 hours?\(^6\)

PATIENT PRESENTATION

- Cardiac arrest
  - PEA
  - Asystole
  - Ventricular fibrillation
  - Pulseless ventricular tachycardia

- Sustained ROSC greater than 20 consecutive minutes?

- Does patient meet inclusion criteria\(^2\) for hypothermia?

- Does patient meet exclusion criteria\(^3\)?

- Pre-existing coagulopathy?

Patient not eligible for TTM Protocol

- Yes

- No

- Yes

- No

- Yes

- No

PEA = pulseless electrical activity
ROSC = return of spontaneous circulation

\(^1\)TTM should not delay imaging studies nor re-perfusion therapy
\(^2\)See Appendix A for Inclusion criteria
\(^3\)See Appendix B for Exclusion criteria
\(^4\)See Appendix C for TTM Protocol
\(^5\)See Appendix D for Complications
\(^6\)See Page 2 for Re-Warming Phase

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RE-WARMING

NORMOTHERMIA\textsuperscript{2}

Target temperature of 36°C achieved?  
\begin{itemize}
  \item Discontinue any paralytics
  \item Monitor train of four (TOF) every hour until 4/4 response
\end{itemize}

Yes  

TOF 4/4 achieved?  
\begin{itemize}
  \item Discontinue all sedatives, shivering medications, and analgesics
  \item Notify ICU team
\end{itemize}

Yes  

Sustained temperature of 36°C-37°C for 72 hours?  
\begin{itemize}
  \item Discontinue all sedatives, shivering medications, and analgesics
  \item Notify ICU team
\end{itemize}

Yes  

Assess neuro prognosis

No  

Continue supportive care to maintain temperature 36°C - 37°C

\begin{itemize}
  \item Discontinue any paralytics
  \item Monitor train of four (TOF) every hour until 4/4 response
\end{itemize}

No  

Continue re-warming phase\textsuperscript{1} until target temperature achieved

---

\textsuperscript{1}See Re-Warming Phase in Appendix C for TTM Protocol

\textsuperscript{2}See Normothermia Phase in Appendix C for TTM Protocol
Post Cardiac Arrest Targeted Temperature Management (TTM)

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SHIVERING MANAGEMENT

Initiate upon commencement of TTM → Sedation

Hemodynamically stable or minimal vasopressor support

More than one vasopressor

BSAS\(^1\) greater than or equal to 1

BSAS\(^2\) 2-3 AND patient is refractory to all other anti-shivering treatments

Access Bedside Shivering Assessment Scale (BSAS)\(^3\) every hour

Propofol 10-50 mcg/kg/minute IV continuous infusion
- If less than desired sedation, increase infusion by 10 mcg/kg/minute every 30 minutes to a maximum of 50 mcg/kg/minute
- If RASS\(^2\) is greater than or equal to goal, decrease infusion rate by 10 mcg/kg/minute every 30 minutes until desired RASS\(^2\) is attained
- Call ICU physician if greater than 50 mcg/kg/minute required

Midazolam 2 mg IV push bolus then infuse 2 mg/hour IV continuous infusion
- If less than desired sedation, give IV push bolus equal to the current infusion rate (maximum 2 mg) every 1 hour as needed to achieve target RASS\(^2\)
- If a 2\(^{nd}\) bolus is required within a 4 hour period, increase infusion rate by 1 mg/hour (maximum of 4 mg/hour)
- If RASS\(^2\) is greater than or equal to goal, decrease infusion rate by 1 mg/hour every 2 hours until desired RASS\(^2\) is attained

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 greater than or equal to 65 years), liver failure (Child-Turcotte-Pugh\(^4\) score C), and renal failure (serum creatinine greater than 1.5 mg/dL)
- Fentanyl 50 mcg IV every 1 hour as needed for BSAS\(^3\) greater than or equal to 1 despite meperidine administration

Cisatracurium 0.15 mg/kg IV every 30 minutes as needed
- Requires mechanical ventilation, analgesia and sedation to a RASS\(^2\) of -4 to -5
- No TOF monitoring. Use BSAS\(^1\) to determine need for additional boluses.

\(^1\) Sedation
- Propofol recommended as agent of choice due to more predictable clearance
- Use midazolam only if patient requires high dose vaspressors (use of more than one vaspressor with at least one of them infusing at a maximum rate)
- Midazolam clearance decreases by 11% for every degree drop in temperature less than 36.5\(^\circ\) C

\(^2\) See Appendix E for Richmond Agitation-Sedation Scale (RASS)

\(^3\) See Appendix F for Bedside Shivering Assessment Scale (BSAS)

\(^4\) See Appendix G for Child-Turcotte-Pugh (CTP) Scale

Acetaminophen 650 mg per feeding tube/rectum every 4 hours times 12 doses then discontinue

Magnesium sulfate 4 grams IV infused over 4 hours every 6 hours as needed for serum magnesium less than 2.5 mg/dL (adjust dose based on renal function)

Bair Hugger warming blanket applied to patient with temperature set at 43\(^\circ\)C

Access Bedside Shivering Assessment Scale (BSAS)\(^3\) every hour

Acetaminophen 650 mg per feeding tube/rectum every 4 hours times 12 doses then discontinue

Magnesium sulfate 4 grams IV infused over 4 hours every 6 hours as needed for serum magnesium less than 2.5 mg/dL (adjust dose based on renal function)

Bair Hugger warming blanket applied to patient with temperature set at 43\(^\circ\)C
Post Cardiac Arrest Targeted Temperature Management (TTM)

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APPENDIX A: Inclusion Criteria

- Down time less than 60 minutes (less than 15 minutes for asystole)
- Intubated requiring mechanical ventilation
- No meaningful response to verbal stimuli

APPENDIX B: Exclusion Criteria

- Major traumatic injury or isolated head injury
- Pregnancy
- Age less than 18 years
- Mean arterial pressure (MAP) less than 65 mmHg despite aggressive fluid resuscitation and vasopressor support
- Uncontrolled arrhythmias
- Major operative procedure within 72 hours
- Hypoxemia – oxygen saturation less than 88% on 100% FiO2 for greater than 30 minutes
- Hypothermia – temperature less than 30°C
- Uncontrolled bleeding
- Bleeding risk: Not related to chemotherapy or hematological malignancies
  - Platelets less than 50 K/microliter
  - INR greater than 1.5
  - PTT greater than 1.5 x control
- Poor prognosis as discussed with primary team
**Post Cardiac Arrest Targeted Temperature Management (TTM)**

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**APPENDIX C: TTM Protocol**

<table>
<thead>
<tr>
<th>Supportive Care</th>
<th>Cooling Phase</th>
<th>Maintenance Phase</th>
<th>Re-Warming Phase</th>
<th>Normothermia Phase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consultation:</td>
<td>Sodium chloride 0.9% 30 mL/kg IV cooled at 4°C</td>
<td>Chem-10, magnesium, phosphorous, calcium, CBC, PT/PTT every 6 hours</td>
<td>Begin re-warming 24 hours after target temperature achieved – 0.20°C/hour for a target temperature of 36-37°C</td>
<td>Once temperature is 36°C:</td>
</tr>
<tr>
<td>o Neuro-oncology</td>
<td>Cool to 33°C (goal to target less than 4 hours)</td>
<td>Call if serum potassium less than 3 mEq/L or greater than 5 mEq/L</td>
<td>o Discontinue any paralytics</td>
<td>o Monitor TOF every hour until 4/4 response</td>
</tr>
<tr>
<td>o Cardiology</td>
<td>Keep room as cool as possible</td>
<td>For serum potassium 3.4 mEq/L, give potassium chloride 20 mEq IVPB x 1</td>
<td>Call ICU team for temperature greater than 37°C</td>
<td>o Once TOF is 4/4:</td>
</tr>
<tr>
<td>Baseline labs and imaging</td>
<td>Record time of initiation of cooling and time of achieving 33°C</td>
<td>No electrolyte replacement protocols</td>
<td>o Discontinue all sedatives, shivering medications, and analgesics</td>
<td>o Notify ICU team</td>
</tr>
<tr>
<td>Nursing assessment:</td>
<td>Magnesium sulfate 4 grams IV x 1 dose over 30 minutes to 1 hour</td>
<td>Discuss dialysate/potassium baths with Nephrology if indicated</td>
<td>Respiratory therapy:</td>
<td></td>
</tr>
<tr>
<td>o Pupil checks every 1 hour</td>
<td>Respiratory therapy:</td>
<td>Hold potassium replacements 8 hours prior to re-warming</td>
<td>o No spontaneous breathing trials</td>
<td></td>
</tr>
<tr>
<td>o BSAS every 1 hour</td>
<td>o No spontaneous breathing trials</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>o Skin assessment every 1 hour</td>
<td>Shivering management – see Page 3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Placement of:</td>
<td>Placement of cooling blanket</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>o Nasogastric or Orogastric tube</td>
<td>Placement of esophageal temperature probe</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Placement of foley temperature probe</td>
<td>Placement of cooling blanket</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Placement of esophageal temperature probe</td>
<td>Daily 30 minute EEG</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>*May convert to continuous EEG if seizures identified</td>
<td>*May convert to continuous EEG if seizures identified</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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APPENDIX D: Complications

- MAP less than 65 mmHg despite aggressive fluid resuscitation and vasopressor support
- Uncontrolled arrhythmias
- Hypoxemia – oxygen saturation less than 88% on 100% FiO2 for greater than 30 minutes
- Uncontrolled bleeding
- Bleeding risk: Not related to chemotherapy or hematological malignancies
  - Platelets less than 50 K/microliter
  - INR greater than 1.5
  - PTT greater than 1.5 x control

APPENDIX E: Richmond Agitation-Sedation Scale (RASS)¹

| 4 Combative: | overtly combative, violent, danger to staff |
| 3 Very agitated: | pulls/removes tube(s) or catheter(s); aggressive |
| 2 Agitated: | frequent non-purposeful movement, fights ventilator |
| 1 Restless: | anxious but movements not aggressive or vigorous |
| 0 Alert and calm: |

-1 Drowsy: awakens to voice with eye contact for more than 10 seconds
-2 Light Sedation: awakens to voice with eye contact for less than 10 seconds
-3 Moderate Sedation: any movement (no eye contact to voice)
-4 Deep Sedation: no response to voice, or any movement to physical stimulation
-5 Unarousable: no response to voice or physical stimulation

APPENDIX F: Bedside Shivering Assessment Scale (BSAS)

| 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 RASS Notes:
- Target: RASS -4 to -5
- Document RASS every 1 hour until goal achieved, then reassess every 4 hours
- Do NOT down titrate if patient receiving a neuromuscular blocker

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### APPENDIX G: Child-Turcotte-Pugh (CTP) Scoring System

<table>
<thead>
<tr>
<th>Chemical and Biochemical Parameters</th>
<th>Scores (Points) for Increasing Abnormality</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Hepatic encephalopathy</td>
<td>None</td>
</tr>
<tr>
<td>Ascites</td>
<td>None</td>
</tr>
<tr>
<td>Serum albumin</td>
<td>Greater than 3.5 g/dL</td>
</tr>
<tr>
<td>Total bilirubin</td>
<td>Less than 2 mg/dL</td>
</tr>
<tr>
<td>For primary biliary cirrhosis</td>
<td>1 – 4 mg/dL</td>
</tr>
<tr>
<td>Prothrombin time prolonged or</td>
<td>less than 4 seconds</td>
</tr>
<tr>
<td>international normalized ratio</td>
<td>Less than 1.7</td>
</tr>
</tbody>
</table>

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
Post Cardiac Arrest Targeted Temperature Management (TTM)

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SUGGESTED READINGS


Post Cardiac Arrest Targeted Temperature Management (TTM)

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DEVELOPMENT CREDITS

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