Hypothermia Guideline for Treatment of Increased Intracranial Pressure

Guideline of Care

Increased intracranial pressure (ICP) has been associated with poor outcomes in brain-injured patients, including, those with hepatic encephalopathy. Hypothermia may provide benefit in controlling ICP; however, this has not always translated to improved patient outcomes. Often hypothermia is considered in the management of refractory ICP. Hypothermia for ICP control is a Level III recommendation in the Traumatic Brain Injury guidelines published by the Brain Trauma Foundation.

Patient Selection

Patients who have been shown to benefit from induced hypothermia for elevated ICP include:

1. Traumatic brain injury (TBI)
2. Stroke
3. Hepatic Encephalopathy

Relative Exclusion Criteria

Patients in whom hypothermia may come with increased risk include those with:

1. Recent major surgery within 14 days - hypothermia may increase the risk of infection and bleeding.
2. Systemic infection/sepsis- hypothermia inhibits immune function and is associated with an increased risk of infection.
3. Patients with active ongoing bleeding - hypothermia may impair the clotting system.

Preparation

Cooling should be instituted as early as possible when ICP is felt to be refractory to conventional measures.

1. A continuous temperature monitor will aid in the cooling process and prevents "overcooling."
   - A bladder temperature probe is used to monitor the temperature.
   - Pulmonary artery temperature probe may be used, if available.
2. It is recommended that a secondary temperature device (Exergen) be used to also monitor temperature. The bladder probe is only accurate when there is adequate urine output; therefore, an alternative to the bladder temperature probe is required in the setting of oliguria. This alternative temperature probe can be any core temperature monitor that is compatible with the Arctic Sun console.

Methods

A. Cold saline chilled to 4° degrees Celsius has been used to lower temperature during hypothermic therapy. It may also be useful in “breaking” high fever in neurologically impaired patients.
   a. Exclusions: Patients who may not tolerate large amounts of fluid over 30 minutes due to cardiac insufficiency

Materials needed:
1) Foley catheter with temperature measurement port
2) Temperature measurement cable and Marquette monitor port
3) Cooled Normal Saline at 3 degrees Celsius from medication refrigerator.
4) Patient weight determines the amount of saline delivered
   a. Calculation is 30cc of saline per Kg.
5) **Peripheral IV access recommended**. Cold Saline should be delivered through a peripheral line. Subclavian and internal jugular infusions have been known to cause lethal arrhythmia. Delivery by a femoral venous line may be acceptable if no peripheral access is available.

Procedure:
1) Place catheter and record both Exergen and bladder temperature on the flow sheet.
2) Set up first liter of Normal Saline on large bore tubing and into a pressure bag for delivery into a **peripheral** I.V. Total fluid volume is calculated as **30cc of saline per Kg. To run over 30-45 minutes.**
3) **Cold Saline should be given via a peripheral line.**
4) Record temperature with Exergen and bladder catheter every 10 minutes,

B. **Cooling with an external cooling pad device:**
   a. Eligibility confirmed and materials gathered.
   b. Place continuous temperature device and place cooling pad on patient.
   c. After applying pads, set target goal. **Mild hypothermia [35C (95°F)-34°C (93.2°F)].**
   d. Assess for shivering and medicate to cease shivering if needed.
   e. These pads may be used with external pacing pads. Place the external pacing pads on the chest and cover with Arctic sun pads.
   f. Refer to re-warming for strategies to re-warm.
Supportive Therapy

1. Monitor ICP. Continue other medical therapies that support treatment of increased ICP.
2. Keep CPP > 60mmHg. Often BP remains elevated during hypothermia as a result of peripheral vasoconstriction. Hypotension is a particular concern during the warming phase due to vasodilation, and thus controlled slow re-warming is necessary.
3. Monitor patient for arrhythmias (most commonly bradycardia) associated with hypothermia. An Osbourne or camel wave may be present when cooling, and does not require specific therapy. If significant dysrhythmias, hemodynamic instability or bleeding develop, then cooling should be discontinued, and the patient actively re-warmed. Rebound increased ICP and/or hypotension may occur if patient is rewarmed too quickly.
4. Blood work requirements include electrolyte panel, glucose, CBC, and blood cultures at 12 hours and 24 hours. Hypothermia commonly causes hypokalemia, which may be exacerbated by insulin administration. Conversely, when patients are re-warmed, potassium exits cells, and hyperkalemia may occur. Both hypo- and hyperkalemia should be treated when they occur. Unexplained hyperglycemia and increases in serum amylase and lipase have been observed during hypothermic therapy.
5. All ABG measurements must be analyzed at the patient's actual body temperature. For CO2 goal discuss with the treating physician.
6. Assess skin every 6 hours by gently peeling back the external cooling pads. (Arctic Sun)
7. Always use a secondary temperature monitoring device when using any cooling device. Record the patient temp on the device, the secondary temp source (Exergen) and the water temperature of the Arctic Sun. The water temp will help to determine the work of the machine in trying to keep the patient at target.

Shiver Management

Assessment and management of shivering is critical to the success of any temperature management strategy. Shivering increases the metabolic rate and heat production which is detrimental to ICP management and counteracts any attempts to cool the patient. Also, microshivering or non-detectable shivering should be suspected if patient does not reach cooling goal with 2 hours.

Methods:

1) Assess patient for shivering, including monitoring of time to target.
   a. Shivering scales may be used to help with assessment and evaluation.
2) Apply a warm air blanket (Bair Hugger).
a. Countermeasures to combat shiver include the use of a warm air blanket placed over the patient, socks or mittens. This may “trick” the brain’s thermoregulation system into thinking that homeostasis has been maintained.

### Suggested Shivering Medication Regime:

<table>
<thead>
<tr>
<th>Indication</th>
<th>Scale</th>
<th>Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Shivering</td>
<td>0</td>
<td>Forced air convection warming blanket *(Bair Hugger) on low</td>
</tr>
<tr>
<td>Shivering &lt; 5 minutes</td>
<td>1</td>
<td>*Forced air convection warming</td>
</tr>
<tr>
<td></td>
<td></td>
<td>* Avoid uncovering entire body for nursing care</td>
</tr>
<tr>
<td></td>
<td></td>
<td>* Meperidine intermittent IV push. Do not use in patients with renal insufficiency (creat &gt;1.5) or patients who have taken MAO inhibitors within the past 2 weeks</td>
</tr>
<tr>
<td></td>
<td></td>
<td>* Buspirone, onset of action ~2-3d</td>
</tr>
<tr>
<td>Shivering for &gt; 5 minutes</td>
<td>2</td>
<td>*Meperidine infusion or Propofol</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Despite Bair hugger, Demerol IVP</td>
</tr>
<tr>
<td>Breakthrough Shivering</td>
<td>3</td>
<td>* Consider Dexmedetomidine if Propofol or Meperidine ineffective.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>* Consider Magnesium 1g/hour and titrate to serum magnesium of 3mmol/l if Dexmedetomidine ineffective</td>
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<tr>
<td></td>
<td></td>
<td>* Consider Dantrolene</td>
</tr>
</tbody>
</table>
### MGH Drug dosage ranges

<table>
<thead>
<tr>
<th>DRUG NAME</th>
<th>BOLUS DOSE</th>
<th>ROUTE</th>
<th>USUAL RANGE</th>
<th>MAXIMUM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buspirone</td>
<td>N/A</td>
<td>PO</td>
<td>start 5mg q8h</td>
<td>20mg q6h</td>
</tr>
<tr>
<td>Cisatracurium</td>
<td>150mcg/kg (10-15mg)</td>
<td>IV</td>
<td>2mcg/kg/min (4-12mg/h)</td>
<td>N/A</td>
</tr>
<tr>
<td>Dantrolene</td>
<td>N/A</td>
<td>IV</td>
<td>1-2.5mg/kg q6h</td>
<td>N/A</td>
</tr>
<tr>
<td>Dexmedetomidine</td>
<td>1mcg/kg</td>
<td>IV</td>
<td>0.2-0.7mcg/kg/h</td>
<td>1.4mcg/kg/h</td>
</tr>
<tr>
<td>Meperidine</td>
<td>12.5-50mg</td>
<td>IV</td>
<td>12.5-75mg/h</td>
<td>100mg/h</td>
</tr>
<tr>
<td>Propofol</td>
<td>10-50mg</td>
<td>IV</td>
<td>0-300mg/h</td>
<td>300mg/h</td>
</tr>
</tbody>
</table>

The bispectral index monitor (BIS) has not been tested on hypothermia patients and is considered unreliable for measurement of sedation or shiver during cooling. The train of four is also not tested and considered unreliable due to nerve conduction delays imposed by cooling.

**Re-warming**

The re-warming phase is the most critical as re-warming too quickly can lead to rebound elevated ICP, poor patient outcomes and even death. **Re-warming should be done very slowly over a period of at least 24 hours.** Peripheral beds, which were once constricted, start to dilate. This shift sometimes causes hypotension. Monitor for rebound elevated ICP.

1. Monitor patient for hypotension related to re-warming, secondary to vasodilation.
2. Monitor patient for hyperkalemia during re-warming as potassium moves from intracellular to extra cellular compartment.
3. Monitor for hypoglycemia as intrinsic insulin stores increase.
4. The goal after re-warming is normothermia 37 ºC(i.e. avoidance of hyperthermia)
5. Normothermia should be maintained aggressively for at least 24 hours once reached. This will ensure the management of fever which may cause an increased risk of cerebral edema.

**Controlled Re-warming using an external vest device (Arctic Sun):**

The device can be programmed for controlled re-warming over a period of at least 24 hours. Dial in the desired warming rate on the machine. The device should be programmed to maintain a target temp of 37°C (98.6°F) at a rate of no more than 0.5 degrees per hour.
References

Brain Trauma Foundation; American Association of Neurological Surgeons; Congress of Neurological Surgeons; Joint Section on Neurotrauma and Critical Care, AANS/CNS. Guidelines for the management of sever traumatic brain injury III. Prophylactic hypothermia. *Journal of Neurotrauma.* 2007; 24: S21-25.


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