Therapeutic Hypothermia after Cardiac Arrest
General Guideline

I. Associated Guidelines and Appendices

1. Neurological Prognosis after Cardiac Arrest
2. Hypothermia after Cardiac Arrest Algorithm
3. Effect of Hypothermia on Medications

II. Rationale

VF cardiac arrest
Ischemic brain damage commonly occurs in patients post cardiac arrest. Studies have shown that lowering brain temperature even by a few degrees decreases ischemic damage. In studies of out of hospital cardiac arrest due to ventricular fibrillation (VF), induced hypothermia improves neurological outcomes. Recent evidence suggests that targeted temperature management of 36°C may provide equivalent benefit to mild hypothermia. See the Normothermia for Neuroprotection guideline for further details, if targeted temperature management is preferred. (Class I recommendation, Level of Evidence B)

Non-VF cardiac arrest
Several retrospective studies with historical controls report a beneficial effect of hypothermia in non-VF arrest. One study showed potential benefit of both in- and out-of-hospital arrest. In the absence of conclusive data, patients with non-VF cardiac arrest should be considered eligible for therapeutic hypothermia or targeted temperature management of 36°C (Class IIb recommendation, Level of Evidence B).

Concurrent ACS treatment
Medical or interventional treatments may be considered for treatment of acute coronary syndrome (ACS) and should not be deferred in the presence of coma or in conjunction with hypothermia. Concurrent percutaneous coronary intervention (PCI) and hypothermia is feasible, with outcomes comparable to comatose patients who undergo PCI without cooling.

Other conditions
There are possible benefits of therapeutic hypothermia for other conditions such as ARDS, sepsis, severe liver failure and after open heart cardiothoracic surgery complicated by circulatory arrest. The decision to apply therapeutic hypothermia for these indications relies on the judgment of the treating clinicians.

III. Patient Selection

1. In- or out-of-hospital VF, asystole, or PEA cardiac arrest requiring CPR and with return of spontaneous circulation (ROSC). Other conditions can be considered (see above) on a patient-by-patient basis.

2. Comatose, defined as Glasgow Coma Score (GCS) < 8.
3. Rapid initiation of hypothermia, but at a maximum within six hours of ROSC.
4. Sufficient hemodynamic stability that cooling would not cause hemodynamic collapse.
5. Adults age ≥18 years old. For pediatric patients, please see Pediatric ICU guideline for therapeutic hypothermia.
6. The Stroke/ICU consult Service should be consulted to assess and document the comatose state prior to or immediately after the initiation of hypothermia. Page the Stroke/ICU consult Service (beeper 20202) for the initial consult.

IV. Relative Exclusion Criteria

1. Pre-existing coma from other causes.
2. Intractable and/or unmanageable hemodynamic instability where cooling may result in further hemodynamic collapse. In such cases, consider targeted temperature management. Consult the Normothermia for Neuroprotection guideline.
3. Suspected sepsis with systemic inflammatory response syndrome (SIRS) physiology - hypothermia inhibits immune function and may exacerbate life-threatening infection.
4. Major surgery within 14 days - hypothermia may increase the risk of infection and bleeding.
5. Active bleeding - Note that hypothermia is recommended in patients who have received systemic thrombolysis with IV tPA or who are concurrently being treated with antiplatelet agents or anticoagulants (such as IV heparin).
6. Major head trauma - if clinical suspicion for possible head injury with arrest, a non-contrast head CT should be performed to rule out intracerebral hemorrhage. Cooling can be initiated and if the emergent CT shows hemorrhage then cooling should be aborted.
7. Induced hypothermia is not recommended for patients with an isolated respiratory arrest.
8. Active DNR status should prompt a conversation with the legally authorized representative or next of kin.

Clinical Objective

If criteria are met, the patient is cooled using the induced hypothermia protocol for 24 hours to a goal temperature of 32-34° C (89-93° F). The goal is to begin cooling as soon as absolutely possible, but no later than 6 hours after ROSC.

The hypothermia target is maintained for 24 hours starting at the time from initiation of therapy. Rewarming begins at hour 24 and is recommended at a rate no faster than 0.5°C per hour. A period of normothermia is recommended for another 24 hours once rewarming is achieved.

Cooling must be done ***rapidly*** to achieve maximum effectiveness, and should be instituted as ***early as possible***. This is best achieved by using two methods: one for initiation and the other for maintenance of hypothermia.

In some patients, hypothermia cannot be tolerated due to the relative exclusion criteria listed above. In these instances, targeted temperature management of 36°C may be considered. If

patients are below this target temperature, then the temperature should be increased to 36°C at a rewarming rate of 0.5°C per hour.

Rapid Initiation

Initiation of cooling should begin as soon as possible, in the field or at any site of entry to MGH. One of the following methods should be considered:

1. Placement of ice packs in the axilla, side of neck and groin regions.
   or
2. Cold saline infusion in a **peripheral IV catheter or femoral venous catheter *only*** at 30 cc/kg of 4ºC normal saline infused over 30 minutes. This typically corresponds to about 2L of pre-chilled saline. The administration via an internal jugular or subclavian venous catheter is unsafe.
3. This step may be deferred in patients whose body temperature is already <34°C on presentation.

Preparation

1. Place arterial line for blood pressure monitoring.
2. A continuous temperature monitor will aid in the cooling process and prevents "overcooling."
   - A bladder temperature probe or esophageal catheter may be used to monitor temperature. . There are limitations with these devices . The bladder probe may only be accurate when there is adequate urine output. An esophageal catheter must be positioned correctly and is influenced by the temperature of liquids introduced by an oral gastic or nasal gastic tube or humidified air of endotracheal tube which may sit in close proximity.
3. It is recommended that a secondary temperature device (Exergen) also be used to monitor temperature. This secondary temperature device acts as a safety check
4. Gather drugs needed to promote sedation and combat shivering.
5. Place cooling pads on patient (per manufacturer's suggestion) and attach pads and bladder temperature probe to cooling device console.
6. After applying pads, set target temperature goal of **33°C** (91.4˚F)
   - These pads may be used with external pacing pads. Place the external pacing pads on the chest and cover with Arctic sun pads
7. **Medicate** patient for sedation, analgesia and paralyzing agents

   Sedation
   - **Propofol (Diprivan)** for sedation – Optional bolus of 0.3-0.5mg/kg, followed by an infusion 5 mg/kg/hr while patient is paralyzed,
     or
   - **Midazolam (Versed**) – Optional bolus of 0.5 to 2.0 mg, followed by a maintenance infusion at a rate of 0.125 mg/kg/hr.

- **Titration** to sedation level (such as RAS score) is **not** indicated in this patient population due to the concurrent use of paralytics.

Analgesia

- **Fentanyl** infusion at 100mcg/hr is recommended. The maintenance infusion dose should be selected at the discretion of the treating team, taking into consideration the clinical status of the patient.

Paralysis

- **Cisatracurium (Nimbex)** infusion for paralysis - 150mcg/kg bolus, maintenance dose 2 mcg/kg/min

or

- **Vecuronium** bolus 0.1mg/kg (optional), maintenance of 1 mcg/kg/min.

- Neither the bispectral index or the train of four are recommended for use during hypothermia.

8. Obtain Bair Hugger blanket applied to provide counterwarming.
9. Record water temperature of external surface cooling device, patient and Exergen thermometer. If water temperature goes below 70°F when desired cooling temperature is reached, consider fever workup and treatment.

Supportive Therapy

1. Hemodynamics

   MAP range of >90mmHg is preferred for cerebral perfusion, using inotropes as needed. However, cooling should not be terminated if a MAP goal of 90 cannot be achieved. Clinicians should use discretion about the degree of pressor support, taking into consideration the context of individual patients with the amount of pressor needed to meet MAP >90mmHg. BP may remain elevated during hypothermia as a result of peripheral vasoconstriction.

2. Dysrrhythmias

   The most common dysrrhythmia associated with hypothermia is bradycardia. This may be successfully managed by use of agents to stimulate heart rate, such as dopamine. If bradycardia becomes clinically significant, then active cooling should be discontinued, and the patient actively re-warmed. An Osbourne wave may be present when cooling, and does not require specific therapy.

3. Infection

   Infection can be a complication of hypothermia. Studies show that early peripheral infection (such as aspiration pneumonia, UTI etc) increase brain injury. Treatment should be initiated promptly for early signs and symptoms of infection during hypothermia. For patients using surface cooling such as the Arctic Sun, a “fever

workup" should be obtained for water temps <70°F during active cooling. Consider early treatment with broad-spectrum antibiotics until cultures come back.

4. Labs

   Electrolyte disturbances are common during cooling and rewarming. Infection may develop and be difficult to detect through ordinary measures. Therefore, electrolyte panel, CBC, and blood cultures should be drawn every 12 hours during the cooling and rewarming phases. 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. ABGs

   Measurements must be analyzed at the patient's actual body temperature, and should be recorded on the lab slip. CO2 should be maintained in the normal range (35-45).

6. Skin care

   Skin integrity should be checked under the external cooling pads at least every 6 hours.

7. EEG monitoring

   Continuous EEG may be considered for prognostic purposes. Please see the associated Neurological Prognosis After Cardiac Arrest guideline for the indication and interpretation of EEG monitoring.

Re-warming

Controlled rewarming should begin 24 hours after *initiation* of therapeutic hypothermia. Slow and controlled re-warming is critical to minimize the risk of hypotension and hyperkalemia. Peripheral vascular beds, which were once constricted, start to dilate. This shift sometimes causes hypotension. Potassium shifts from intracellular to extracellular compartments.

1. Maintain paralytic and sedation until temperature of 36°C (96.8°F) is reached.
2. Set the console to rewarm to 37°C (98.6˚F) at a rate of no more than 0.5°C per hour. This typically corresponds to a re-warming period of 8-10 hours. The Arctic Sun device is used in automatic mode only to maintain safe rewarming.
3. Often, the pupillary response is the only intact neurological exam finding during cooling due to the use of paralytics. If patient shows a less reactive or new fixed and dilated pupillary sign during rewarming, please stop rewarming immediately and call the stroke/ICU consult service pager (p20202) to consider workup and treatment.
4. Monitor patient for hypotension related to re-warming. Treat with IV fluids and/or vasopressors as clinically indicated.
5. Monitor patient for hyperkalemia during re-warming as potassium moves from intracellular to extra cellular compartment.
6. Monitor for hypoglycemia as intrinsic insulin stores increase.
7. Once a temperature of about 36°C (96.8°F) is reached, discontinue paralytic.

8. Once a temperature of 37°C (98.6°F) is reached, taper sedation and use as clinically indicated for mechanical ventilation.
9. Euthermia at 37°C is maintained for 24 hours then therapy discontinued.

The stroke/ICU consult service (pager 20202) will continue to follow throughout, and will reassess the neurological status after the discontinuation of hypothermia.

Pediatric Population

Hypothermia after cardiac arrest for children has additional considerations. Please contact the Pediatric ICU staff for details in treating this patient population.

VI. References

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VI. Authoring Information

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