Inducing Hypothermia After Cardiac Arrest

Other than using an endovascular cooling device, what are the most effective mechanisms for inducing hypothermia after cardiac arrest?

Karen McQuillan, RN, MS, CCRN, CNRN, replies:

Evidence-based recommendations from the International Liaison Committee on Resuscitation (ILCOR), also incorporated into the guidelines of the American Heart Association (AHA), advocate use of 12 to 24 hours of mild hypothermia (32°C [89.6°F]-34°C [93.2°F]) for adults experiencing out-of-hospital cardiac arrest with an initial rhythm of ventricular fibrillation who have return of spontaneous circulation but remain unconscious on admission. This recommendation is based primarily on findings from 2 randomized controlled trials that compared maintaining normothermia versus cooling to 32°C to 34°C for 12 to 24 hours within hours to minutes after return of spontaneous circulation in adults who had regained hemodynamic stability but remained comatose after out-of-hospital ventricular fibrillation cardiac arrest. Study results indicated that use of mild hypothermia reduced mortality and improved neurological outcomes. ILCOR and AHA also recommend that therapeutic hypothermia may benefit patients who have had a cardiac arrest associated with rhythms other than ventricular fibrillation outside the hospital or had an in-hospital cardiac arrest. Although a more recent consensus statement from the ILCOR and the AHA provides distinct advantages and disadvantages of using various techniques to attain mild hypothermia after cardiac arrest, the optimal method(s) for achieving and maintaining hypothermia are not well defined.

In addition to considerations about adverse effects, workload, and cost for each technique, the ability to achieve desired temperature changes while inducing and maintaining hypothermia and during rewarming should be considered when selecting methods for providing mild hypothermia. The goal is to rapidly reduce the patient’s body temperature to 34°C to 32°C so that risks of short-term complications (eg, shivering, hypovolemia, electrolyte imbalance, and hyperglycemia) most likely to occur during the induction phase are minimized. The hypothermic state is then maintained for 12 to 24 hours (most experts suggest 24 hours), preferably with minimal fluctuations. Rewarming should then be performed slowly (ideal rewarming rate is undefined but experts suggest 0.2-0.5°C/h) to avoid potential complications (eg, electrolyte imbalances) and preserve the neuroprotective benefits provided by therapeutic hypothermia.

A number of methods can be used to quickly achieve and then maintain the patient’s body temperature within the desired range of 32°C to 34°C. Hospital protocols may involve multiple interventions used simultaneously to cool the patient rapidly and then reduce the number of interventions needed to maintain hypothermia for 24 hours.
and to rewarm the patient. Each of these methods has a number of advantages and disadvantages that should be considered (see Table).

Intravenous infusion of 30 mL/kg (1500-3000 mL) of cold (4°C) crystalloid solution (usually saline or lactated Ringer solution) is an easy-to-use, safe, and effective method for inducing hypothermia. Cold fluid can be kept readily available for infusion, and

### Table: Advantages and disadvantages of methods used to provide mild therapeutic hypothermia after cardiac arrest

<table>
<thead>
<tr>
<th>Method</th>
<th>Advantages</th>
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<tbody>
<tr>
<td>Endovascular catheter</td>
<td>Rapidly lowers body temperature (cools 1.5°C/h to as fast as 4.5°C/h, depending on the type of catheter)(^7) Has a continuous temperature feedback mechanism and can be programmed to effectively maintain patients' body temperature at a specific target temperature Decreases risk of temperature deviation outside the desired range Allows for controlled slow rewarming Requires minimal nursing workload to maintain hypothermia once catheter is inserted</td>
</tr>
<tr>
<td>Extracorporeal circulation</td>
<td>Able to cool patient rapidly (cools at a rate of 4.0°C/h to 6.0°C/h)(^7)</td>
</tr>
<tr>
<td>Cold (4°C) crystalloid infusion</td>
<td>Can rapidly induce hypothermia at rates of about 2.5°C/h to 3.5°C/h(^7) Can be kept readily available Easy to use Inexpensive Minimally invasive Often used in conjunction with other cooling methods that help with rapid induction and then maintain hypothermia(^8,9)</td>
</tr>
<tr>
<td>External surface cooling methods</td>
<td></td>
</tr>
<tr>
<td>Water-circulating cooling blankets and pads</td>
<td>Cooling rates of 1.0°C/h to 1.5°C/h when 2 water-circulating blankets are applied and as high as 1.5°C/h to 2.0°C/h for hydrogel-coated water-circulating pads(^7) Can be easily applied by a nurse Typically, 2 water-circulating blankets needed if the sole cooling source during induction(^7) Most devices have a continuous temperature feedback mechanism and can be programmed to maintain patient’s body temperature at a specific target temperature, so devices are effective during the maintenance and rewarming phases</td>
</tr>
<tr>
<td>Air-circulating cooling system</td>
<td>Can be easily applied by a nurse Relatively inexpensive(^7)</td>
</tr>
<tr>
<td>Ice packs</td>
<td>Cool at moderate rate of 0.9°C/h to 1°C/h(^7) Can be easily applied by a nurse Inexpensive</td>
</tr>
<tr>
<td>Cold water or alcohol sponge baths or sprays</td>
<td>Can be initiated by the nurse Rate of heat loss is greater when alcohol-based solutions, which have a higher evaporation rate, are used(^7) Inexpensive</td>
</tr>
<tr>
<td>Fan</td>
<td>Inexpensive Easy to use</td>
</tr>
<tr>
<td>Gastric lavage</td>
<td>Inexpensive Can be readily initiated by the nurse</td>
</tr>
</tbody>
</table>
Endovascular cooling systems use a special heat-exchange catheter inserted into the inferior vena cava or another central vein that connects to an external temperature control module. A patient temperature sensor provides feedback to the control module, which is set by the provider to achieve and maintain a specific target patient temperature.

This technique requires a trained practitioner to place the catheter, and thus initiation of cooling may be delayed. Although the most costly method, the endovascular technique does provide efficient cooling and is the most reliable means to maintain a stable desired body temperature. The ability of this system to control the patient’s body temperature for a prolonged period helps prevent potentially detrimental overcooling (reducing body temperature below 32°C) and facilitates controlled slow rewarming.

External cooling strategies include use of fans, ice packs, water-circulating cooling blankets or pads, air-circulating cooling systems, and cold water or alcohol sponge baths. Water-circulating systems include those that have water-filled blankets or pads or hydrogel-coated energy transfer pads placed on the patient. These water-circulating systems typically use a control module with a continuous temperature feedback mechanism that automatically adjusts the water temperature in the system to achieve the desired temperature for the patient as programmed by the practitioner. Those systems that have an automatic temperature control mechanism tend to be more effective in maintaining the desired body temperature.
A number of cooling options can be employed for therapeutic hypothermia after cardiac arrest. The effectiveness, advantages, and disadvantages inherent in each of these cooling methods should be considered when institutional guidelines are being developed. Defining the optimal methods for achieving and maintaining hypothermia after cardiac arrest and then rewarming patients continues to be a fertile area for research. Optimizing use of this neuroprotective strategy offers hope for restoration of optimal neurological function after global cerebral ischemia caused by cardiac arrest.

### References

### Financial Disclosures
None reported.

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A Karen McQuillan

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