5 Q&As On... Saving the Brain After Cardiac Arrest

Survival after cardiac arrest is uncommon and patients who do survive have a high incidence of anoxic brain injury. What can be done to manage patients who have been successfully resuscitated, and is the induction of hypothermia a viable option?

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Victims of cardiac arrest (CA) are challenging patients for primary care physicians. In fact, few other patients require simultaneous diagnosis and treatment in a more rapid manner than CA patients.

Unfortunately, survival from a CA is uncommon. Overall, survival after a pre-hospital CA is < 5% in Canada.[1] Patients who have an asystolic or pulseless electricular activity CA survive <1% of the time, while patients who arrest from ventricular fibrillation (VF) or pulseless ventricular tachycardia (VT) have up to a 33% survival rate.[2]

Guidelines produced by the American Heart Association, and supported by the Canadian Heart and Stroke Foundation, provide rhythm-specific algorithms for the management of patients in CA.[3] Unfortunately, the few patients who are able to be resuscitated have a high incidence of anoxic brain injury.[4]

Survival from CA does not necessarily indicate a neurologically intact patient. With the onset of CA, the brain becomes ischemic almost immediately and, within 20 seconds, cellular oxygen stores are depleted.[4,5] After five minutes, glucose and adenosine triphosphate stores are depleted and irreversible cellular injury begins.

Unfortunately, the return of spontaneous circulation itself can result in further insult to the ischemic brain by inducing free radical formation, excitatory amino acid release, and transmembrane calcium shifts.

Clinicians have long sought a therapy which could decrease the neurologic consequences of the

Shane's case

Shane, 76, is brought to the emergency department (ED) after being resuscitated from a cardiac arrest by paramedics.

The paramedics said they found Shane's initial rhythm to be ventricular fibrillation. After defibrillating him three times, intravenous epinepherine, 1 mg, was administered. After a forth defibrillation at 360 J, his rhythm converted to a sinus tachycardia.

Shane was intubated, as his level of consciousness was depressed. In total, 23 minutes elapsed from the time of collapse to a perfusing rhythm.

Shane's vitals on arrival in the ED are listed.

Shane's vital signs

- Heart rate: 108 beats/minute
- Respiratory rate: 18 breaths/minute
- Blood pressure: 160/110 mmHg
- Oxygen saturation: 100%
- Glasgow coma scale: 7

What would you do for Shane?

low flow state typical of CA. Despite the high incidence of anoxic brain injury and intense investigation into the pathogenesis and treatment options, no specific therapy has previously been identified to mitigate the detrimental effects after CA resuscitation.[5] However, recent literature has demonstrated a significant increase in neurologically intact survivors when comatose patients were cooled after successful resuscitation.[6,7] Hypothermic modulation of anoxic brain injury (HMABI) is an exciting new treatment option to maximize neurologic recovery after CA.

Table 1

Clinical trial results of mild hypothermia after cardiac arrest

	European	Australian
Randomization of participants	Hypothermia: 136 Standard: 137	Hypothermia: 43 Standard: 34
Hypothermic temperature goal	32-34 C	33 C
Method of hypothermia	Cooling blanket[1] ± ice packs	Ice packs[2]
Duration of hypothermia	24 hours	12 hours
Morbidity	ARR: 16%; NNT: 6 (Pittsburgh cerebral performance[3] category 1 or 2)	ARR: 23%; NNT: 4 (Survival to hospital discharge, home, or rehab facility)
Mortality	At 6 months: ARR: 14%; NNT: 7	ARR: 17%; NS[4]

ARR: Absolute risk reduction
NNT: Number needed to treat
NS: Non-significant

[1] Cooling blanket initially used; 93/132 (70%) required the addition of ice packs
[2] Cold packs applied initially by prehospital personnel
[3] Pittsburgh cerebral performance score: 1: Good recovery; 2: Moderate disability; 3: Severe disability; 4: Vegative state; 5: Death
[4] Absolute risk reduction in death 17% in patients treated with mild hypothermia; non-significant (p=0.145)

1. *What are the priorities in managing patients successfully resuscitated from CA?*

Patients who are resuscitated from CA are inherently unstable and require meticulous attention. The goals in managing the post-resuscitation patient are to stabilize the cardio-respiratory system, while searching for the etiology of the CA.

- ***Vital signs*** should be kept within normal limits to maximize the chance of full neurologic recovery.
- ***Blood pressure*** should be maintained at a mean pressure > 70 mmHg to maintain a cerebral perfusion pressure adequate to provide blood flow to the brain. The use of vasopressor and inotropic agents to achieve this goal is recommended, if needed.
- ***Oxygen saturation*** and the measured ***arterial oxygen pressure*** should be kept above 96% and 70 mEq/L, respectively.

An ECG in the early stages of management is crucial in order to search for potentially reversible primary cardiac causes for an arrest. It should be assumed that patients with acute ST elevation have had a CA due to an

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Table 2

Inclusion and exclusion criteria for hypothermia after cardiac arrest

Inclusion
• Primary rhythm VF/VT
• Time to ACLS < 15 minutes
• ACLS time < 60 minutes
• Persistent coma (GCS < 10)
Exclusion
• Improving neurologic status
• Non-cardiac arrest
• Persistent shock (SBP < 90) despite vasopressors
• MAP < 60 mmHg for > 30 minutes
• History of terminal illness

VF: Ventricular fibrillation
VT: Ventricular tachycardia
ACLS: Advanced cardiac life support
GCS: Glasgow coma scale
SBP: Systolic blood pressure
MAP: Mean arterial pressure

Table 3

Cooling options for HMABI

- Expose patient to ambient air
- Apply ice packs to head, axilla, and groin
- Use wet sheet and fan
- Cold saline infusion (30 mL/kg of 4 C NS over 30-60 minutes
- Use cooling blanket

NS: 0.9% normal saline

acute myocardial infarction and, therefore, require early consultation with a cardiologist.

Once the cardio-respiratory system is stabilized, a detailed neurologic exam should be performed. Specifically, the patient's Glasgow coma scale should be calculated, in addition to an evaluation of the pupillary and corneal reflexes and the patient's motor response.

2. *Is there any therapy that can decrease neurologic injury in survivors of CA?*

The induction of mild hypothermia in successfully resuscitated comatose CA patients can significantly increase the chances of a meaningful neurologic recovery.[6-8] Two separate trials, published in 2002, randomized patients who were successfully resuscitated from a VF/VT CA to standard, normothermic treatment or mild hypothermia (Table 1). Despite some differences in protocol, including the method of inducing and the degree and duration of hypothermia, the primary outcome of both studies was neurologic recovery.

Overall, the use of hypothermia in VF/VT-resuscitated patients reduces the chance of a poor neurologic outcome by 16% to 33%. Although mortality was not a primary outcome, patients randomized to mild hypothermia had a 14% to 17% reduction in mortality.

3. *Who should be cooled after CA?*

The trials that have established a beneficial effect of mild hypothermia enrolled only a very specific group and a minority of CA patients. Patients who have a CA secondary to VF/VT, who have a short arrest time, and are comatose after resuscitation should be assessed for mild hypothermia. Specific exclusion criteria must also be assessed (Table 2).

The use of mild hypothermia in non-VF/VT CA survivors is controversial. The pathophysiology of anoxic brain injury is similar whether a CA is secondary to asystole or VF. Although patients who meet other inclusion and exclusion criteria theoretically may benefit from mild hypothermia, data to support its use is lacking.

Figure 1. CA survivor during the induction of mild hypothermia with bagged ice around head, axilla, and groin.

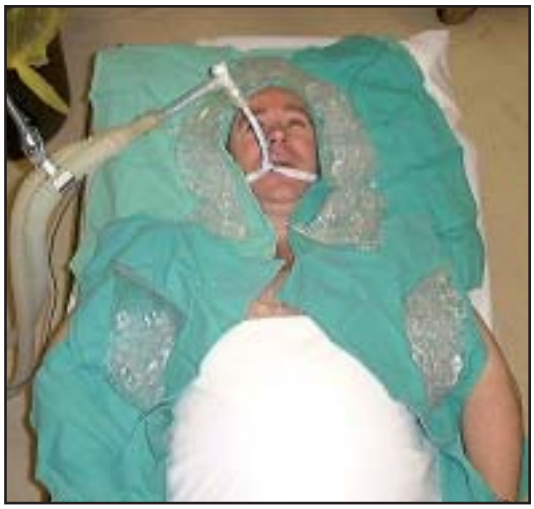

Figure 2. Proper placement of cranial bagged ice for hypothermic modulation of anoxic brain injury.

4. How can hypothermia be instituted, and for how long?

Various options are available for the induction of hypothermia (Table 3). Perhaps the most practical is the use of ice packs around a patient's head, axilla, and groin (Figure 1). The addition of a small amount of water to the bagged ice may be of added benefit, as it will increase the total contact area. A towel should be placed between the bagged ice and the skin so as to avoid any potential tissue damage (Figure 2). Multiple cooling methods may be applied simultaneously, as the goal is a core temperature reduction to between 32 C and 34 C within two to six hours after a CA.

Table 4

Sedation and paralysis options for HMABI

Sedatives

- Midazolam infusion: 0.04-0.2 mg/kg/hr
- Propofol infusion: 1-5 mg/kg/hr
- Fentanyl infusion: 0.7-10 µg/kg/hr

Paralytic agents

- Vecuronium
  - Bolus: 0.08 mg/kg
  - Infusion: 50-70 µg/kg/hr
- Atracurium
  - Bolus: 0.5 mg/kg
  - Infusion: 0.6-1.2 mg/kg/hr
- Rocuronium 0.6-1 mg/kg

HMABI: Hypothermic modulation of anoxic brain injury

Despite the patient's semi-conscious state, the induction of hypothermia can be uncomfortable. Liberal use of sedatives, analgesics, and paralytic agents are recommended to ensure patient comfort and to reduce shivering (Table 4).

Temperature reduction should be initiated as soon as possible after the resuscitation to stable hemodynamics. Mild hypothermia should be maintained for 12 to 24 hours, as demonstrated in the trials. Patients will require ongoing management in an intensive care unit, with meticulous attention to maintaining cardio-respiratory stability. After 12 to 24 hours, the patients should be allowed to rewarm, and serial neurologic exams performed to determine neurologic recovery.

5. Are there any downsides to cooling?

Despite its recent popularity due to positive publications, hypothermia has actually been used in the CA

t Readings

ILCOR Advisory Statement—Therapeutic Hypothermia After Cardiac Arrest: *http://circ.ahajournals.org/cgi/content/full/108/1/118*

management for over 50 years.[8] A major reason for its decline in use was an association with an increased rate of adverse events.

For the most part, the adverse events can be grouped in one of three categories:

- hemodynamic instability,
- excessive bleeding, and
- infections.

Most of these complications have only been found in patients who were cooled below 32 C for a prolonged period of time. In fact, the recent trials involving mild hypothermia found no significant increase in the incidence of any adverse events.[6,7] Despite this, patients who are treated with mild hypothermia require expert care so that adverse events are rapidly identified and managed appropriately.

What's the final message?

Despite our best efforts, patients who survive a CA often suffer irreversible neurologic damage. The use of mild hypothermia to decrease the effects of cerebral anoxia has been demonstrated to be beneficial in victims of VF/VT CA. Various international organizations, such as the American Heart Association and the Canadian Heart and Stroke Foundation, recommend the use of mild hypothermia in appropriate patients.[9]

Take-home message

- Hypothermic modulation of anoxic brain injury is an exciting new treatment option to maximize neurologic recovery after CA.
- Patients who have a CA secondary to VF/VT, a short arrest time, and are comatose after resuscitation should be assessed for mild hypothermia.
- The most practical method of hypothermia induction is the placement of ice packs around a patient's head, axilla, and groin.
- Liberal use of sedatives, analgesics, and paralytic agents is recommended to ensure patient comfort during hypothermia induction.

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