



CASE REPORT

Therapeutic Benefits of Induced Hypothermia: In and Out of Hospital Cardiac Arrest

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Introduction

Cardiac arrest accounts for approximately 32,500 deaths per year and has a survival rate of 5% to 35%.¹ Following the arrest, if there is no oxygen to brain within few minutes, there is generation of free radicals and chemical mediators initiating a cascade of reaction resulting in cerebral injury (hypoxic injury).² Reoxygenation following arrest causes further damage due to necrosis and apoptosis of neural tissue (reperfusion-induced cell death).^{3,4} Injury to the brain can continue up to 24 hours after the initial event and its extent depends on arrest time, reperfusion time, and severity of injury.⁵ Only 11% to 17% of patients discharged following cardiac arrest have a good neurological outcome.⁶ Therefore, post cardiac resuscitation should involve cerebral resuscitation.

Therapeutic hypothermia is believed to prevent this chain reaction and protect against ischemic/reperfusion injury resulting in better outcome⁶ and cost effectiveness⁷. The patient should be cooled within 3-6 hours after cardiac arrest and maintained at a target temperature of 32-34°C for 24 hours.^{1,8} Adverse effects of hypothermia can range from bradycardia to coagulation abnormalities, immunosuppression, and infections.⁹

Use of hypothermia in neurological surgeries and the knowledge that tissues recover from hypoxic injury better at low

temperatures have been known for years.⁹ However, it was only after 2002, when two groundbreaking studies were published that made induced hypothermia a routine part of post resuscitation care.^{9,10} In both studies, patients who were in the hypothermic group had a favorable neurological outcome. Bernard and colleagues¹⁰ found 49% of patients on the hypothermic protocol as compared to 26% of patients in the control group had better survival to hospital discharge with good neurological recovery. Good neurological recovery was described as patient discharged to home or rehabilitation. A European study² found that 55% of patients on the hypothermic protocol as compared to 39% in the control group had a favorable neurological outcome according to Pittsburg cerebral performance category of 1 (good recovery) or 2 (moderate disability) on five-point scale. Secondary end points were 6-month mortality and complications within a week of cardiac arrest.

In 2005, the American Heart Association recommended including induced hypothermia as a standard of care in treatment of both in and out of hospital cardiac arrest.^{1,8} Yet, it has not gained popularity among American physicians. Merchant and colleagues¹¹ found the use of hypothermic intervention among physicians was 36% in Europe and only 26% in the USA. The

reasons that physicians gave for not using hypothermic intervention included they had insufficient data about the procedure, cooling was not part of Advanced Cardiac Life Support because lack of supporting data¹⁰, the procedure was technically difficult, they lacked devices that cool rapidly⁸, and there were insufficient human studies.

Case Report

A 40-year-old man presented to the emergency room with ventricular fibrillation. The patient had been found unresponsive at his neighbor's door (3:15 am). Emergency services arrived within five minutes (3:20 am). According to report, the patient had been motionless for unknown period of time. He was in ventricular fibrillation and compressions were provided by emergency services personnel. Rhythm was converted to ventricular tachycardia. He coded en route to the hospital. Another 200 joules cardioversion was given and he finally converted to sinus tachycardia (3:48 am).

The patient arrived to the hospital approximately 40 minutes after his discovery (3:54 am). On presentation, vital signs included a blood pressure of 176/136 mmHg, a pulse of 150 bpm, and an oxygen saturation of 99%. On examination, the lungs were congested with diffuse rales in all lung fields. He exhibited decorticate posture, spontaneous breathing, and a positive corneal reflex. Hypothermia immediately was induced with ice packs applied to his axilla and groin. Iced saline was started with an intravenous bolus for rapid infusion. The patient's core body temperature was maintained between 32-33° C by rectal thermometer.

The patient was placed on a ventilator and sedated with midazolam. Vecuronium was used to suppress shivering. He was monitored for any side effects of hypo-

thermia including arrhythmias, electrolyte imbalance, and infection. Hypothermia was maintained for 24 hours followed by passive rewarming (0.25-0.5° C per hour over an 8-hour period). The cooling device was removed with monitoring for any rebound hypothermia and adverse effects.

According to family, the patient had been ill for the past month and complained of shortness of breath, abdominal pain, and chest pain precipitated by anxiety, emotion, and anger. Family history was positive for hypertension. The patient had a history of heavy alcohol use (greater than 20 beers/day) and smoking (1-2 packs/day).

The patient had a slow response to hypothermic intervention. He awoke with continued neurologic findings of posturing and non-responsive arousing 48 hours after rewarming. Arousal with painful stimuli began to manifest on the third day. Spontaneous arousal, purposeful movement, and communication occurred on the fourth day.

A cardiology evaluation identified a 90% stenosis of the left anterior descending artery. Stenting was performed one week later. By week's end, the patient was walking and discharged with full neurological function.

Discussion

This case illustrates our experience with induced hypothermia as a part of post-resuscitation management. It emphasized the ease of administration and clinical benefit of a protocol for induced hypothermia. Early identification of eligible patients, inclusion criteria, and a rapid response in initiating hypothermia optimizes patient outcomes. Protocol procedures may be initiated by keeping iced saline in the emergency room refrigerator and applying ice bags to the axilla and groin. A rapid response time in initiating hypothermia and the importance of sedation in limiting cellular neurological damage have been

accepted widely and have become standard of care.⁸ Hospital staff should review patient criteria and consider initiating the protocol

as part of their initial evaluation of this patient population (see Table 1).

References

- ¹ Tran BP, McGuire CV, Maloney MA. Use of mild therapeutic hypothermia improves outcomes in cardiac arrest. *JAAPA* 2010; 23(3):43-48. PMID: 20232725.
- ² The Hypothermia after Cardiac Arrest Study Group. Mild therapeutic hypothermia to improve the neurological outcome after cardiac arrest. *N Engl J Med* 2002; 346(8):549-556. PMID: 11856793.
- ³ Polderman KH. Application of therapeutic hypothermia in the ICU: Opportunities and pitfalls of a promising treatment modality. Part 1: indications and evidence. *Intensive Care Med* 2004; 30(4):556-575. PMID: 14767591.
- ⁴ Ambrosio G, Zweier JL, Flaherty JT. The relationship between oxygen radical generation and impairment of myocardial energy metabolism following post-ischemic reperfusion. *J Mol. Cell Cardiology* 1991; 23(12):1359-1374. PMID: 1811055.
- ⁵ Hammer MD, Krieger DW. Hypothermia for acute ischemic stroke: Not just another neuroprotectant. *Neurologist* 2003; 9(6):280-289. PMID: 14629782.
- ⁶ Cheung KW, Green RS, Magee KD. Systematic review of randomized controlled trials of therapeutic hypothermia as a neuroprotectant in post cardiac arrest patients. *CJEM* 2006; 8(5): 329-337. PMID: 17338844.
- ⁷ Merchant RM, Becker LB, Abella BS, Asch DA, Groeneveld PW. Cost-effectiveness of therapeutic hypothermia after cardiac arrest. *Circ Cardiovasc Qual Outcomes* 2009; 2(5):421-428. PMID: 20031872.
- ⁸ Nolan JP, Morley PT, Vanden Hoek TL, et al. Therapeutic hypothermia after cardiac arrest: An advisory statement by the advanced life support task force of the International Liaison Committee on Resuscitation. *Circulation* 2003; 108(1):118-121. PMID: 12847056.
- ⁹ Lampe JW, Becker LB. State of the art in therapeutic hypothermia. *Annu Rev Med* 2011; 62:79-93. PMID: 20854174.
- ¹⁰ Bernard SA, Gray TW, Buist MD, et al. Treatment of comatose survivors of out-of-hospital cardiac arrest with induced hypothermia. *N Engl J Med* 2002; 346(8):557-563. PMID: 11856794.
- ¹¹ Merchant RM, Soar J, Skrifvars MB, et al. Therapeutic hypothermia utilization among physicians after resuscitation from cardiac arrest. *Crit Care Med* 2006; 34(7):1935-1940. PMID: 16691134.

keywords: induced hypothermia, out of hospital cardiac arrest, case report, Kansas

Table 1. Induced hypothermia protocol at Mercy Regional Health Center, Manhattan, KS.

Inclusion Criteria

- Post ventricular tachycardia/ventricular fibrillation arrest with return of spontaneous circulation (ROSC) within 60 minutes and Glasgow scale less than 10 for more than 45 minutes after ROSC where ACLS was started within 10 minutes form witnessed arrest.
- Platelet Count > 75,000.

Exclusion Criteria

- Increasing neurological status (able to respond to command after ROSC).
- Pregnancy
- Trauma
- Known coagulopathies (check PT/PTT, fibrinogen, D-dimer)
- Oxygen saturation < 85% for more than 15 minutes after ROSC.
- Core temperature < 85° F on admission.
- Hypotension for more than 30 minutes after ROSC or systolic BP < 90 mmHg despite use of vasopressors.

If the Criteria are Met

The patient is cooled for 24 hours to a goal temperature of 32□ - 33□C. The target time to reach the goal is 3-6 hours to achieve maximum effectiveness and should be started as soon as possible.

- Initiate Mechanical ventilator order set and place arterial line and Central Venous catheter.
- Apply external cooling with cooling blankets and application of ice packs to the groin, neck, and axilla. Completely expose the patient and place cooling blanket above and below with nothing between the blanket and skin. Cold saline infusion can be performed via a peripheral line to achieve the temperature goal.
- Monitor vital signs every 15 minutes during active cooling, then every 30 minutes during maintenance of target temperature. Place a continuous temperature monitoring device (rectal, bladder, or pulmonary artery).
- Medicate including analgesia, sedation, and paralytic per mechanical ventilation order.
- Obtain blood work include electrolytes, glucose, and complete blood count every six hours during the cooling period until normothermia. Blood cultures should be drawn at 12 hours after initiating of cooling.
- Rewarm after 24 hours of initiating cooling. The patient is rewarmed at a temperature of 1.8-3.6 degrees Fahrenheit per hour over an 8-hour period.
- The goal is normothermia. Once 36□C (96.8□ F) is reached, discontinue medications (titrate down slowly). Monitor for rebound hyperthermia, hypotension (due to vasodilatation), and hyperkalemia.
- Stroke services will continue to follow throughout and reassess the neurological status.