



Care of the Acutely and Critically Ill Adult

Therapeutic hypothermia at an urban public hospital: Development, implementation, experience and outcomes



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ABSTRACT

Background: Therapeutic hypothermia (TH) improves the outcome of comatose patients suffering an out-of-hospital sudden cardiac arrest (SCA) with shockable rhythm and return of spontaneous circulation (ROSC). Evidence supporting its use in other circumstances is weak and the adoption of TH remains limited.

Objective: Describe the development and implementation of a TH program at an urban public hospital and report outcomes of out-of-hospital and in-hospital SCA and important quality measures.

Methods: The protocol was developed at 464-bed urban public hospital. We assembled historical and prospective samples of patients suffering an SCA. We measured the neurologic outcome of patients at the time of hospital discharge who underwent TH after SCA. We compared outcomes and important quality measures (duration of arrest, time to cooling, and time to target temperature) to existing literature. We determined reasons for not using TH in patients with in-hospital SCA.

Results: We described the development of our TH program and the challenges we faced implementing it. Of 45 patients treated with TH after SCA, 23 (51%) survived to discharge, 14 (31%) with good neurologic outcomes. In comparison to historical controls, TH did not improve outcome of in-hospital SCA. SCA from a shockable rhythm was associated with the best outcome. The time from return of spontaneous circulation to initiation of TH was consistently within 8 h.

Conclusions: Despite logistical and financial constraints, we were able to rapidly implement a TH program with quality and outcomes similar to published data. TH did not improve outcomes for patients with an in-hospital SCA.

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Introduction

Each year more than 300,000 sudden cardiac arrests (SCA) occur in the United States.^{1,2} Despite numerous improvements in resuscitation over the last decades, outcome remains poor. Less than 11% of out-of-hospital and 25% of in-hospital SCA victims survive to hospital discharge or are alive at 30 days.^{2–7} Less than 25% of these patients are discharged with good neurologic performance.^{8–11}

Only two large randomized multicenter studies evaluated comatose patients after out-of-hospital SCA with a shockable rhythm. They showed that therapeutic hypothermia (TH) improved survival and neurologic recovery.^{12,13} Subsequently, Holzer et al reported that TH was associated with better neurologic outcomes independent of location and rhythm.¹⁴ Based on this evidence, TH

has been strongly recommended by the American Heart Association (AHA) and the International Liaison Committee on Resuscitation (ILCOR) for patients suffering an out-of-hospital SCA.^{15–17}

Despite current recommendations, a survey in 2011 revealed that only 63% of hospitals in the US had a TH program in place. The reasons to forgo a TH program were its high cost, reservations about its effectiveness, and low numbers of out-of-hospital SCA.^{18–21}

The benefit of TH for non-shockable out-of-hospital SCA and for all in-hospital SCA is controversial. In a retrospective study of patients with non-shockable rhythm, TH treatment did not improve survival or neurological outcomes when compared to historical controls.²² In addition, Dumas et al showed a trend towards worse outcomes in patients receiving TH after an SCA with an initial non-shockable rhythm.²³ In contrast, Sung et al, in a registry based study, showed that TH improved neurologic outcomes in patient suffering an out-of-hospital SCA with a non-shockable rhythm.²⁴ Arrich et al and Kory et al showed that TH did not improve survival or neurologic outcome in patients suffering an in-hospital SCA.^{25,26}

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The AHA strongly recommends (Class I expert opinion) the initiation of TH in comatose patients after both out-of-hospital SCA with non-shockable rhythm and in-hospital SCA independent of initial rhythm.^{15–17} The ILCOR makes a much weaker recommendation for TH in these patient populations.²⁷

The primary objectives of this study were to 1) describe the implementation of a TH program at a large urban public hospital, 2) describe outcomes based on location and rhythm, 3) evaluate quality measures of administration of TH and 4) compare survival and neurologic outcome of historical controls to the outcomes of patients treated with TH after an in-hospital SCA.

Materials and methods

We performed a retrospective-prospective cohort study to evaluate the quality and the outcomes of our institution's TH program from August 2009 through December 2014. IRB approved the data collection of patients treated with TH and of historical controls.

Institution characteristics and protocol development

Cook County Hospital (Stroger) is a 464-bed urban public hospital with a medical intensive care unit (MICU) and separate cardiac (CCU), surgical, neurosurgical, trauma and burn intensive care units. In February of 2009, the hospital's Critical Care Committee formed a multidisciplinary TH committee headed by physicians and nurses from the MICU and the Department of Emergency Medicine (ED) (Table 1).

The committee completed and approved the TH protocol in June of 2009 and made it available for clinicians on the hospital's intranet. The protocol outlined the inclusion and exclusion criteria; specific procedures for induction, maintenance, and re-warming phases; the monitoring standards; and the management of shivering (Appendix Tables A1–A3, Fig. A).

Patients

We assembled multiple samples to answer the study questions (Table 2). We created a registry of the patients that underwent treatment with TH. For each patient we recorded age, gender, race, Charlson score, location, and initial rhythm of SCA. Neurologic outcomes were recorded at the time of discharge using the Cerebral Performance Category (CPC). Good neurologic outcome was defined as a CPC of 1 or 2 (CPC 1: Good cerebral performance: conscious, alert, able to work, might have mild neurologic or psychologic deficit. CPC 2: Moderate cerebral disability: conscious, sufficient cerebral function for independent activities of daily life, able to work in sheltered

Table 1
Timeline for the implementation of the TH program at our institution.

Dates	Steps
February 2009	Multidisciplinary TH committee
June 2009	Creation of the TH protocol
August 2009–July 2010	Quarterly meeting with the committee Initiation of hotline pager
August 2009–Present	Yearly simulation lab for MICU fellows
December 2009	Posting of laminated TH reminder posters
July 2010	Placing of the TH protocol on the intranet
December 2013	Creation of electronic TH care-set
July 2014	Formation of an electronic cardiac arrest note with reminder to assess patient for TH eligibility

Table 2
Study subjects.

Time	Sample (n)	Study sample description
July–December 2008	Historical controls (8)	In-hospital SCA
August 2009–December 2014	TH cases (45)	All SCA
April 2013–December 2014	Non-TH cases (82)	In-hospital SCA and did not receive TH

environment).²⁸ The accuracy of the extracted data was verified by one of the authors (RG).

To evaluate the effect of TH on the outcome of patients that suffered an in-hospital SCA, we compared patients that underwent TH to historical controls selected from the local cardiac arrest database. These were the patients who suffered an SCA in the 6 months before the implementation of the TH protocol and met all criteria for TH at the time of ROSC.

We also determined the reasons for not performing TH in patients suffering an in-hospital SCA from April 2013 to December 2014. These were categorized into groups of hemodynamic instability, rapid neurologic recovery, active infection, advanced malignancy, or high risk of bleeding.

The quality measures that were evaluated were time from: 1) SCA to ROSC, 2) SCA to TH initiation, 3) SCA to reaching target temperature and 4) ROSC to target temperature.

We selected time from ROSC to target temperature to describe the quality of our TH program.

Analysis

We performed univariate analysis to identify determinants of survival and good neurologic. Fisher exact test was used to compare the percentage between the groups. *T*-test was used to compare means. Variables that were associated with good neurologic outcome in univariate analysis were entered into a logistic regression. A *p*-value of <0.05 was considered significant. Statistical analysis was performed using MedCalc®.

Results

TH protocol development

The TH committee included representatives from emergency medicine, neurology, neurosurgery, anesthesiology, cardiology, cardiothoracic surgery, critical care, critical care nursing and pharmacy. The committee comprehensively reviewed the literature and assessed local available resources.

We based the indications and contraindications on current literature. We found that the use of TH was controversial in three groups: pregnant woman, patient with non-shockable rhythm and patients with an in-hospital SCA. Therefore the committee members agreed to apply TH to all these patients as the probability of severe adverse events was low. In pregnant women, the decision to initiate TH would be based on a discussion between the treating and the fetomaternal attending physicians.

Another issue that we discussed at length was the control of shivering. Some argued to paralyze all patients at the onset of TH to prevent shivering. Others supported the use of paralytics only after shivering occurred. We ultimately agreed to treat all patients, unless contraindicated, with buspirone and acetaminophen to decrease the shivering threshold and to grade and treat shivering with a stepped protocol (Appendix Fig. A).

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