

Caring for Patients Treated With Therapeutic Hypothermia

Claranne Mathiesen, RN, MSN, CNRN, SCRN

Denise McPherson, RN, MSN, CRNP, CCRN

Carolyn Ordway, RN, MSN, CRNP, CCRN

Maureen Smith, RN, MSN, CNRN

Numerous studies have indicated that therapeutic hypothermia can improve neurological outcomes after cardiac arrest. This treatment has redefined care after resuscitation and offers an aggressive intervention that may mitigate postresuscitation syndrome. Caregivers at Lehigh Valley Health Network, Allentown, Pennsylvania, an academic, community Magnet hospital, treated more than 200 patients with therapeutic hypothermia during an 8-year period. An interprofessional team within the hospital developed, implemented, and refined a clinical practice guideline for therapeutic hypothermia. In their experience, beyond a protocol, 5 critical elements of success (interprofessional stakeholders, coordination of care delivery, education, interprofessional case analysis, and participation in a global database) enhanced translation into clinical practice. (*Critical Care Nurse*. 2015;35[5]:e1-e13)

Out-of-hospital cardiac arrest is a devastating event that affects more than 300 000 adults per year in the United States, with more than 250 000 cases resulting in death.¹ Many of the patients who survive have marked neurological deficits that affect the quality of life. Thus, preservation of neurological brain function is an important goal in the resuscitation of these patients.

Research¹ has suggested that therapeutic hypothermia improves neurological outcomes after cardiac arrest. Caregivers at Lehigh Valley Medical Network, an academic, community Magnet hospital in Allentown, Pennsylvania, have treated more than 200 patients with therapeutic hypothermia, attaining beneficial clinical outcomes similar to the results of randomized control trials.^{2,3} In this article, we detail the structures and processes used by an interprofessional team at the hospital to develop, implement, and refine a protocol for therapeutic hypothermia.

CE Continuing Education

This article has been designated for CE credit. A closed-book, multiple-choice examination follows this article, which tests your knowledge of the following objectives:

1. Review the literature supporting therapeutic hypothermia to better understand development of guidelines
2. Review elements of hypothermia program implementation
3. Evaluate best practices of hypothermia programs

©2015 American Association of Critical-Care Nurses doi: <http://dx.doi.org/10.4037/ccn2015168>

Literature Review

Therapeutic hypothermia involves purposely lowering the core body temperature to 32°C to 34°C for 12 to 24 hours.^{3,4} The aim is to reduce metabolic rate and oxygen demand of the body to improve survival and neurological outcomes. Therapeutic hypothermia was formally introduced in the 1950s in both neurological and cardiac surgical cases. Core temperature was lowered to less than 28°C, temperatures that would be considered severe hypothermia today.

The more recent use of therapeutic hypothermia after cardiac arrest to improve neurological recovery was instituted globally after publication of 2 landmark studies^{2,3} in 2002. Bernard et al² and the Hypothermia After Cardiac Arrest Study Group³ corroborated positive outcomes in patients with ventricular fibrillation. In both studies, the percentage of patients treated with therapeutic hypothermia who could be discharged from the hospital to home with good recovery or to a rehabilitation facility with modest disability was higher than the percentage in the nontreatment group. In the study by Bernard et al, 49% of the 43 patients treated with hypothermia (target temperature, 33°C) had good neurological function at discharge compared with 26% of the 34 patients in the normothermia group (core temperature, 37°C). In the study by the Hypothermia After Cardiac Arrest Group, favorable neurological outcomes occurred in 55% of the 136 patients in the hypothermia group (target temperature, 33°C) but in only 39% of the 137 patients in the normothermia group (core temperature, 37°C). Both studies had limitations: exclusion criteria that eliminated 92% of patients assessed for eligibility;

statistically nonsignificant physiological complications such as pneumonia, bleeding, and sepsis; and knowledge among patients of the treatment received. Although the focus of the studies was therapeutic hypothermia in patients with shockable rhythms, the benefit of therapeutic hypothermia on nonshockable rhythms and conditions was not ruled out.⁴ The positive outcome ratios of Bernard et al² and the Hypothermia After Cardiac Arrest Study Group³ were not possible before the advent of hypothermia as a treatment option.

After publication of these 2 landmark studies and the subsequent endorsements of therapeutic hypothermia by the International Liaison Committee on Resuscitation and the American Heart Association, institutions worldwide began to adopt the therapy. The effectiveness of therapeutic hypothermia gained further credence when the Advanced Cardiac Life Support update added consideration of the therapy to the algorithm for treatment after cardiac arrest.^{5,6} A vast array of publications on therapeutic hypothermia address the efficacy of the treatment (Table 1).

In a prospective study published in 2006, Oddo et al⁷ evaluated the use of therapeutic hypothermia outside the original indication of patients with cardiac arrest due to ventricular fibrillation. The results indicated a strong correlation between the length of time from collapse to return of spontaneous circulation (< 30 minutes with resuscitation by emergency personnel, $P = .09$) and the probability of survival and a good neurological outcome. Oddo et al defined a good neurological outcome by using the 5-point Pittsburgh Cerebral Performance Category Scale (from 1 = good recovery to 5 = death). In 2012, Storm et al¹⁶ published the results of an observational study to compare outcomes for patients who received therapeutic hypothermia in both shockable and nonshockable rhythms. They concluded that no significant improvement in neurological outcome occurred when the cardiac arrest was not due to ventricular fibrillation.

In a more recent study published in 2013, Nielsen et al¹⁸ compared the previously established target temperature of 33°C with a target temperature of 36°C. In this large, multicenter, randomized international trial, patients in the 33°C group did not differ significantly from patients in the 36°C group in overall mortality and neurological outcome at 180 days. The results led to a debate among experts in therapeutic hypothermia for several reasons, including the wide range of times

Authors

Claranne Mathiesen is the director, medical operations, neuroscience service line, at Lehigh Valley Health Network, Allentown, Pennsylvania.

Denise McPherson was director of the cardiac intensive care unit at Lehigh Valley Health Network when this article was written. That unit cares for patients undergoing therapeutic hypothermia after cardiac arrest.

Carolyn Ordway is the patient care specialist, cardiac intensive care unit, at Lehigh Valley Health Network.

Maureen Smith is the patient care specialist, neuroscience intensive care unit, at Lehigh Valley Health Network.

Corresponding author: Claranne Mathiesen, RN, MSN, CNRN, SCRN, 789 Sunset Lane, Stroudsburg, PA 18360 (e-mail: claranne.mathiesen@lvhn.org).

To purchase electronic or print reprints, contact the American Association of Critical-Care Nurses, 101 Columbia, Aliso Viejo, CA 92656. Phone, (800) 899-1712 or (949) 362-2050 (ext 532); fax, (949) 362-2049; e-mail, reprints@aacn.org.

Table 1 Therapeutic hypothermia evidence

Reference	Year	Subject	Conclusions
Bernard et al ²	2002	Randomized controlled study from Melbourne, Australia, where 77 patients were treated with hypothermia (33°C) and maintained at that temperature for 12 hours	Treatment with moderate hypothermia appears to improve outcomes in patients with coma after resuscitation from out-of-hospital cardiac arrest; 21 of 43 patients treated with hypothermia (49%) were discharged to home or a rehabilitation facility
The Hypothermia After Cardiac Arrest Group ³	2002	Multicenter randomized controlled trial comparing the effects of hypothermia vs normothermia in patients resuscitated after cardiac arrest	Inpatients who received therapeutic hypothermia after cardiac arrest had an increased rate of favorable neurological outcomes and reduced mortality; 75 of 136 patients (55%) had a favorable neurological outcome compared with 54 of 137 patients (39%) in the normothermia group
Nolan et al ⁴	2003	Advisory statement by the Advanced Life Support Task Force of the International Liaison Committee on Resuscitation on the use of therapeutic hypothermia after cardiac arrest	Unconscious adult patients with spontaneous circulation after out-of-hospital cardiac arrest should be cooled to 32°C-34°C for 12-24 hours when the initial rhythm is ventricular fibrillation (VF)
Oddo et al ⁷	2006	Prospective study comparing outcome of a total of 74 patients who received therapeutic hypothermia after a VF cardiac arrest (38) and non-VF cardiac arrest (36)	Time from collapse to return of spontaneous circulation (ROSC) is strongly associated with outcome after VF and non-VF cardiac arrest treated with hypothermia
Bader et al ⁸	2007	Case study used to demonstrate the effectiveness coordination of cardiopulmonary resuscitation, diagnosis and treatment of potential complications, and immediate use of hypothermia after cardiopulmonary resuscitation to prevent potential adverse neurological outcomes	Hypothermia should occur as soon as possible after ROSC and be maintained for at least 18 hours at a target temperature of 33°C; evidence related to hypothermia and elements of a written protocol are presented
Banks and Marotta ⁹	2007	Systematic literature review that provides information on the structure, validation, scoring, and psychometric properties of the modified Rankin Scale	Evidence attests to the validity and reliability of the modified Rankin Scale
Neumar et al ⁵	2008	A consensus statement from the International Liaison Committee of Resuscitation	Therapeutic hypothermia should be part of a standardized treatment strategy for comatose survivors of cardiac arrest
Gaieski et al ¹	2009	Prospective and historical study comparing patients treated with hypothermia by using an early goal-directed hemodynamic optimization (EGDHO) protocol with historical patients treated with hypothermia without the EGDHO	Use of algorithmic protocols and EGDHO improves hemodynamic and temperature goal optimization for patients after cardiac arrest; further clinical trials are needed to determine if EGDHO combined with therapeutic hypothermia improves outcome when compared with therapeutic hypothermia alone
Kupchik ¹⁰	2009	Steps and considerations in developing and implementing a therapeutic hypothermia protocol are discussed by using evidence and 1 institution's process	A collaborative team approach with a formalized protocol support the critical care required for patients being treated with hypothermia after cardiac arrest
Peberdy et al ⁶	2010	2010 American Heart Association guidelines for cardiopulmonary resuscitation and emergency cardiovascular care	Care after cardiac arrest should optimize systemic perfusions, restore metabolic homeostasis, support organ system function, and include multidisciplinary involvement of cardiology, neurology, and critical care providers to increase the likelihood of complete neurological recovery

Continued

for return of spontaneous circulation; lack of clearly defined neurological outcomes; large deviation in temperature ranges in both groups of patients; neurological

examination at 72 hours, a time too early for drug clearance in patients in the 33°C group; and lack of measurement of hemodynamic parameters, leading to further

Table 1 *Continued*

Reference	Year	Subject	Conclusions
Mooney et al ¹¹	2011	Observational study presenting case series outcomes for unresponsive adults who had an out-of-hospital cardiac arrest with a ROSC <60 minutes who were treated with hypothermia regardless of cardiac rhythm, hemodynamic stability, or presence of ST-segment elevation myocardial infarction and were transferred to a central hospital capable of providing therapeutic hypothermia	56% of patients survived to hospital discharge and 51% had positive neurological outcomes; no difference in survival between patients transferred to a central hospital capable of providing therapeutic hypothermia and patients not transferred to a second hospital
Nair and Lundbye ¹²	2011	Discussion of pathophysiology of neurological injury in cardiac arrest survivors and review of various process steps of hypothermia based on evidence	The use of therapeutic hypothermia in VF survivors has become the standard of care and continues to evolve as an essential therapy in cardiac arrest patients
Wang et al ¹³	2011	Case series outlining the lessons learned related to development and implementation of a therapeutic hypothermia program at an urban academic medical center	Discloses difficulty of organization and coordination of complex interventions; the authors outline the need for midcourse corrections, overcoming workplace culture, physician-based rapid response system development, and evaluation and use of technology in successfully implementing a therapeutic hypothermia program
DeLia et al ¹⁴	2012	Survey of 73 acute care hospitals in New Jersey to solicit information about adoption, application, and methods used for therapeutic hypothermia	68.4% of New Jersey hospitals had a therapeutic hypothermia program in place, with an additional 13.6% indicating plans to begin one; limited numbers of cases of out-of-hospital cardiac arrest per hospital and lack of uniformity on how the guidelines are implemented raise new questions about the effectiveness of current practice
Lantry et al ¹⁵	2012	Discussion of pathophysiology of neurological injury in cardiac arrest survivors and review of various process steps of hypothermia based on evidence	Therapeutic hypothermia is the only intervention shown to improve neurological outcomes after cardiac arrest
Storm et al ¹⁶	2012	Prospective observational study of 387 patients admitted to a university hospital; control group n=186, hypothermia group n=201; 175 patients had initial rhythm identified as nonshockable (asystole, pulseless electrical activity) rhythm (control n=88; hypothermia n=87)	Hypothermia treatment was not associated with significantly improved neurological outcome in patients resuscitated from non-VF cardiac arrest; 90-day analysis revealed no significant benefit for the hypothermia group
Jolly and Sherrod ¹⁷	2013	Retrospective review of patients' charts at one institution who received induced therapeutic hypothermia compared with patients who did not receive induced therapeutic hypothermia and compare mortality rate between the 2 populations	Results indicated a decrease in mortality rates of patients who had a cardiac arrest and received induced therapeutic hypothermia when compared to patients who received only Advanced Cardiac Life Support
Nielsen et al ¹⁸	2013	An international trial, 950 unconscious adults after out-of-hospital cardiac arrest of presumed cardiac cause randomly assigned to targeted temperature management at either 33°C or 36°C	In unconscious survivors of out-of-hospital cardiac arrest of presumed cardiac cause, hypothermia at a targeted temperature of 33°C did not confer a benefit as compared with a targeted temperature of 36°C
Scirica ¹⁹	2013	Physiological consequences of therapeutic hypothermia are reviewed through one institution's process and mention of evidentiary findings	Care requires established guidelines of care, standard orders, goal-directed algorithms, and education of staff to deliver efficient, coordinated, and effective postresuscitation care

questions about the benefit of temperature management.¹ The study¹⁸ differed from other studies by actively controlling the patients' body temperature during the intervention period and intended to prevent fever during the first 3 days of treatment.

In 2007, Bader et al⁸ published a case report on use of hypothermia after resuscitation. They reported that the rapid coordination of care via use of a multidisciplinary protocol improved the patient's outcome. Bader et al credited ongoing communication among the interprofessional team as a key factor to ensure timely modifications in the treatment plan. Likewise, in 2009, Kupchik¹⁰ detailed the benefits of a collaborative team approach in successfully developing and implementing a protocol for therapeutic hypothermia at a medical center in Seattle, Washington.

Recognizing the challenges associated with therapeutic hypothermia, the Joint Commission issued a call for participation in performance measurement initiatives, specifically use of therapeutic hypothermia in patients after cardiac arrest.¹³ One article published in response to the request detailed the initiation of therapeutic hypothermia at the University of Alabama, Birmingham, Alabama. Spearheaded solely by the emergency medicine attending physicians and with no protocols for care beyond the emergency department, the therapeutic hypothermia program was stopped after just 1 week. Concerns related to the exclusion of key stakeholders led to an internal decision to stop and restructure the program.

Program revisions began with formation of an interprofessional team representing physicians and nurses of relevant specialties, pharmacists, and information services. One key intervention was to ensure that a physician expert in therapeutic hypothermia was always available as a resource to facilitate consistent care practices. This step led to development of a formal physician consulting service on therapeutic hypothermia and a rapid multidisciplinary response team. During a 21-month period, 36% of patients (n = 93) treated with therapeutic hypothermia survived to discharge from the hospital. Of those, 73% had good neurological outcome according to scores less than 3 on a modified Rankin Scale.^{9,13}

Interprofessional collaboration was also a factor addressed by Mooney et al.¹¹ These authors challenged the current practice that after cardiac arrest, various treatments, including therapeutic hypothermia, should be offered in all hospitals. They advised developing cardiac resuscitation centers of excellence, which would

offer more intensive, interprofessional services beyond the initial Advanced Cardiac Life Support efforts after resuscitation. Mooney et al implemented a process that facilitated early cooling at the local level with immediate transport to a regional center to initiate complex therapies. Their research illustrates use of established cardiac care networks with refined patient transfer mechanisms as a model to enhance access to and outcomes of therapeutic hypothermia.

In summary, published results support the notion that timely resuscitation and implementation of a therapeutic hypothermia protocol (< 30-60 minutes from start of resuscitation to return of spontaneous circulation) in patients after cardiac arrest are tied to improved neurological outcomes and return to home.^{12,14,17,19} Further, an interprofessional team involving providers, nurses, and ancillary staff is essential for success.

Guideline Development and Continuous Evaluation

Therapeutic hypothermia had been used within the Lehigh Valley Health Network, Allentown, Pennsylvania, as a treatment option for neurological protection in patients with large hemispheric stroke since 2002. Initially, oversight for this treatment was the responsibility of neuroscience physicians and clinical nurse specialists. In 2005, prompted

by new information, therapeutic hypothermia was initiated to preserve neurologi-

Therapeutic hypothermia can improve neurological outcomes after cardiac arrest.

cal function in patients who had had cardiac arrest. This expanded use of therapeutic hypothermia was the impetus to develop a formal clinical practice guideline and assemble an interprofessional team of experts to oversee implementation and ensure ongoing evaluation.

Therapeutic Hypothermia Committee

The initial purpose of the interprofessional team was to develop an evidence-based clinical practice guideline and associated processes to support implementation of the therapy. The committee consisted of representatives from providers responsible for the care of patients treated with therapeutic hypothermia. Specific members included physicians from emergency medicine, cardiology, and neurology; critical care intensivists; nurse managers, educators, clinical specialists, and direct care

nurses; pharmacists; respiratory therapists; and prehospital personnel.

Clinical Practice Guideline

The original guideline addressed general care practices and treatment interventions specific to the stages of induction, maintenance, and rewarming. Over time, the guideline has been revised to include enhancements within each stage. The goal remains as it was originally conceived: to provide evidence-based recommendations to be used by emergency medicine physicians, neurologists, cardiologists, intensivists, and nurses who provide care for patients who have had an anoxic injury and who meet inclusion criteria for therapeutic hypothermia. Figures 1 to 3 detail the most recent clinical practice guideline for the 3 phases of therapeutic hypothermia: induction, maintenance, and rewarming.

Evaluation and Quality Assurance

Over time, the purpose of the therapeutic hypothermia committee has evolved from development and refinement of a guideline to identification of care quality issues requiring further action. The committee also discusses new evidence. Any new information can trigger revisions to the current clinical practice guideline and further education of staff members. Each member of the interprofessional team is charged with disseminating com-

Interprofessional involvement is critical to successful implementation and continued utilization.

mittee outcomes to colleagues in his or her designated specialty. Other committee actions and

practice improvements include ongoing review of criteria for inclusion and exclusion; medication management; ventilation protocols; optimization of management of hemodynamic parameters; and ethical dilemmas associated with patients who have had cardiac arrest.

The monthly, 90-minute meeting begins with clinical nursing leaders' presenting therapeutic hypothermia cases to the interdisciplinary team. The presentation includes a brief patient history, clinical course, and any variances from the clinical practice guideline. Discussion by team members further identifies any performance, quality, or interdepartmental problem that may require attention. Collaboration between disciplines and interdepartmental relations has been enhanced by this clinical case review. An unexpected benefit of these reviews

has been identification of ongoing educational needs of clinical team members and opportunities to reinforce adherence to the practice guideline.

Critical Elements for Success

Interprofessional Stakeholders

The number of stakeholders in the guidelines for therapeutic hypothermia has increased from 3 clinical champions (2 neuroscience clinical specialists and a neurologist) to a highly effective interprofessional care delivery team dedicated to optimizing therapeutic hypothermia. From the onset, members of the team were influenced by their commitment to improve the care of patients receiving this therapy. Physicians' knowledge and acceptance of and willingness to actively support the guidelines were critical to incorporate therapeutic hypothermia as an option for clinical practice. Initial strategies to gain physicians as stakeholders included formal presentations of current evidence on therapeutic hypothermia and review of the institution's temperature management guideline at department-specific physicians' grand rounds. Presenters included the 2 neuroscience clinical nurse specialists and a physician intensivist. During this period, as physicians became acquainted with the therapy, nurses were early adapters and champions. They became patient advocates for therapeutic hypothermia, often raising the option with physician colleagues.

As more patients received therapeutic hypothermia, the need for medical care for the patients beyond that provided by the originating neurologist was necessary. For example, as the therapy was used with patients with more complex conditions, multiorgan system optimization required strategic recruitment of defined medical specialists as stakeholders. Each physician chief (cardiology, neurology, and critical care medicine) was requested to designate a minimum of 1 staff member to become the physician expert on therapeutic hypothermia in the member's specialty. Other professional stakeholders whose involvement was garnered via membership on the committee included pharmacists, respiratory therapists, pastoral care staff, palliative care staff, nurse coordinators of the stroke and acute coronary syndrome services, and the cardiology nurse administrator.

Coordination of Care Delivery

Initially, because of the neuroprotective benefits of therapeutic hypothermia, patients who received the

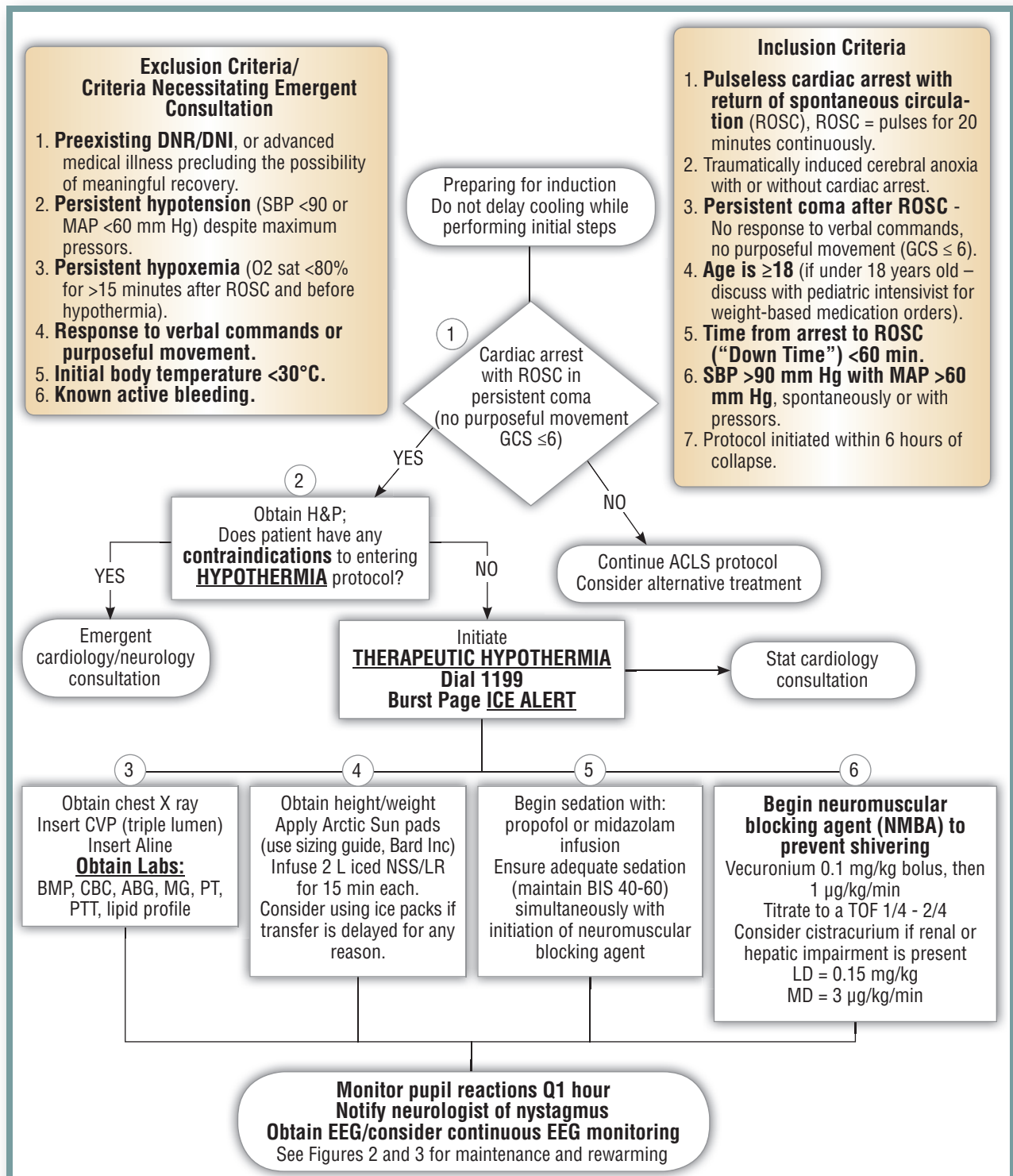
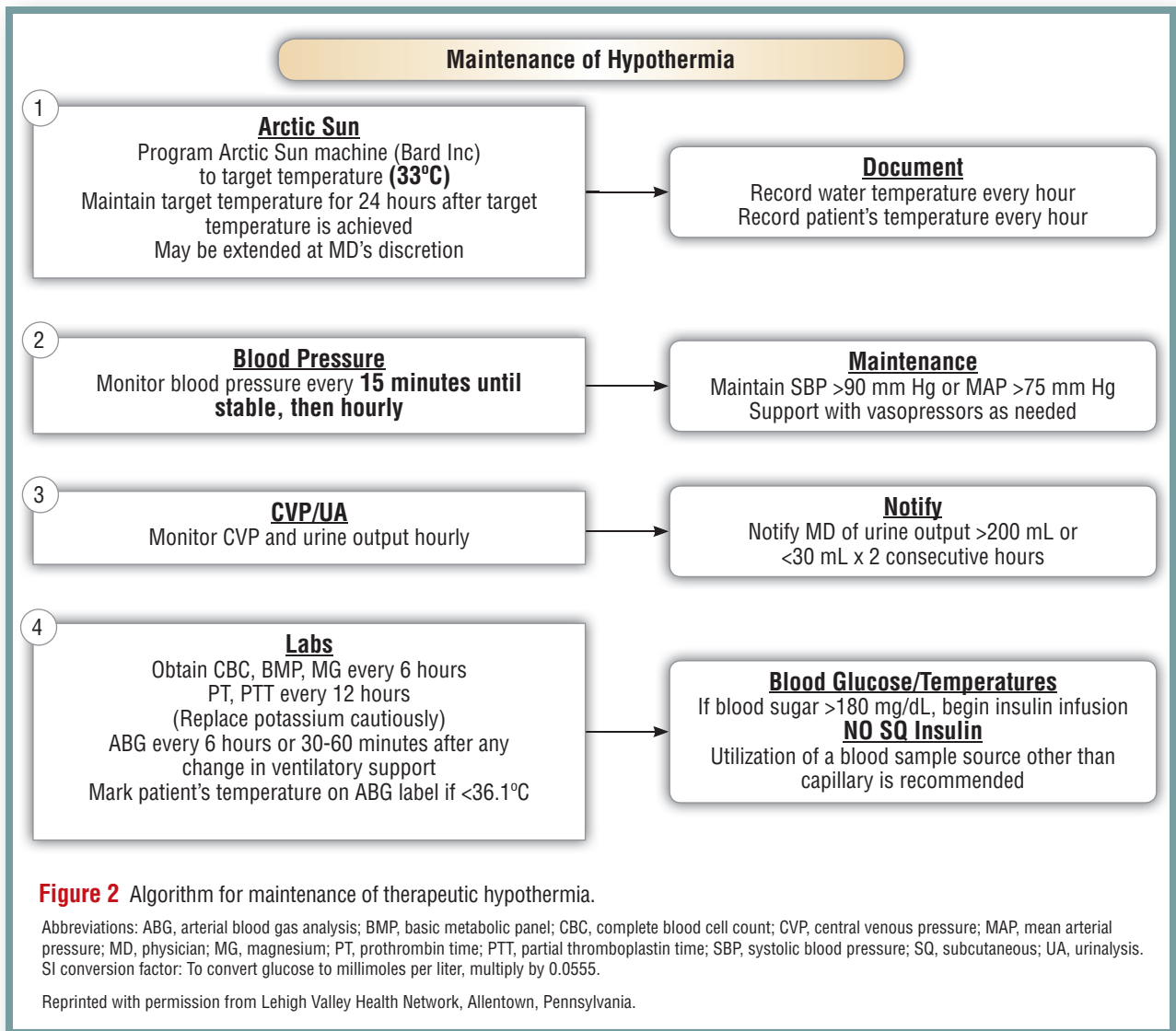


Figure 1 Therapeutic hypothermia algorithm for after cardiac arrest: induction.

Abbreviations: ABG, arterial blood gas analysis; ACLS, Advanced Cardiac Life Support; Aline, arterial catheter; BIS, bispectral index; BMP, basic metabolic panel; CBC, complete blood cell count; CVP, central venous pressure; DNI, do not intubate; DNR, do not resuscitate; EEG, electroencephalogram; GCS, score on Glasgow Coma Scale; H&P, medical history and results of physical examination; LR, lactated Ringer solution; LD, lowest dose; MAP, mean arterial pressure; MD, maximum dose; MG, magnesium; NSS, normal saline solution; O2, oxygen; PT, prothrombin time; PTT, partial thromboplastin time; Q, every; sat, saturation; SBP, systolic blood pressure; TOF, time of flight.

Reprinted with permission from Lehigh Valley Health Network, Allentown, Pennsylvania.



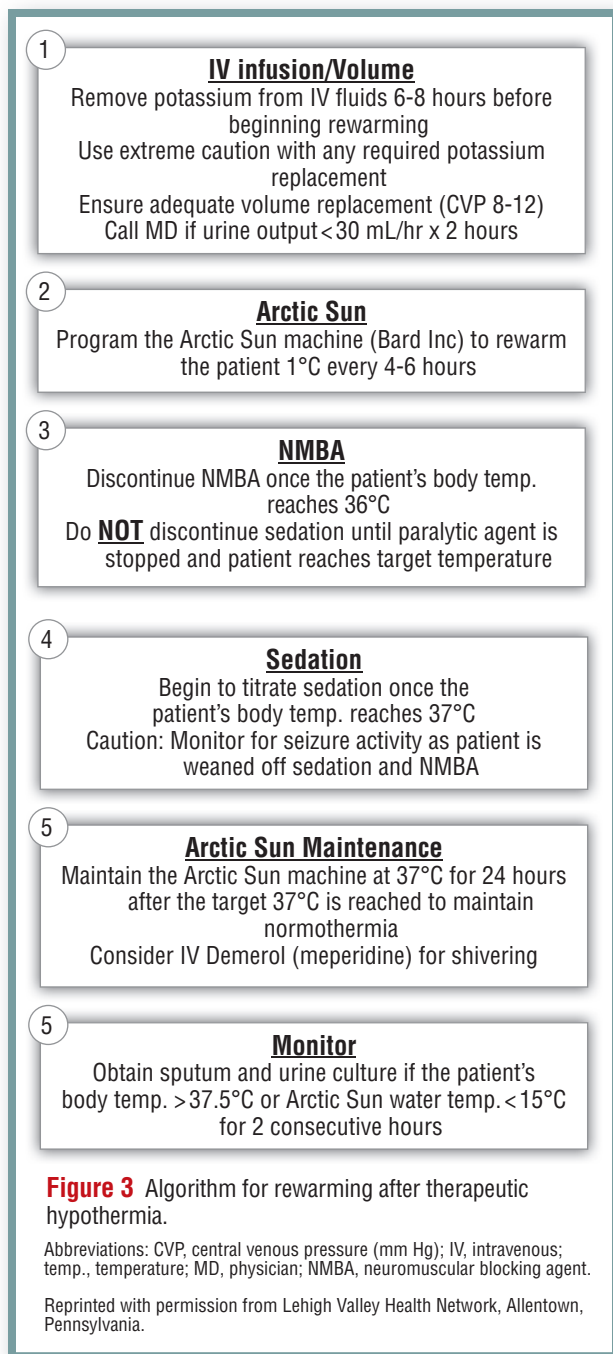
therapy were treated in the neuroscience intensive care unit (ICU). As our understanding of the care needed after resuscitation evolved, we realized that patients who receive therapeutic hypothermia often require advanced cardiac interventions and support. Thus, the decision was made for these patients to be managed in a cardiac-focused ICU. The continually updated clinical practice guidelines have offered bedside staff, regardless of the setting, the information to ensure best practice.

One of the critical components the therapeutic hypothermia committee devised and implemented is rapid deployment of resources, termed ICE Alert, to extend resuscitation after cardiac arrest. Specially trained staff familiar with therapeutic hypothermia respond to the alert and actively assist in accelerated triage of patients to the ICU, with rapid initiation of cooling. The ICE Alert

was modeled on the existing efficient flow used to treat patients with acute myocardial infarction. An ICE Alert is initiated via the hospital's paging system for both emergency department admissions and in-house cardiac arrests. An ICU nurse responds immediately with 2 L of iced physiological saline and the external cooling pads while other ICU staff members prepare the patient room for the patient's arrival. Figure 4 shows the ICE Alert algorithm.

Education

A vital component for successful therapeutic hypothermia was to identify, plan, and ensure delivery of education and training, including both prehospital and acute care interprofessional stakeholders. Initial teaching strategies included didactic offerings with case scenarios



to stimulate critical thinking and simulations of technical and psychomotor skills. Targeted audiences were prehospital personnel; emergency department, ICU, and invasive cardiology nurses and technical staff; respiratory therapists; medical residents and cardiology fellows; and cardiologists, neurologists, and critical care intensivists. Education involved regularly occurring forums: orientation; grand rounds; "lunch and learn"; unit staff meetings; and formal continuing education programs, such as the annual nursing research day, medical specialty

symposiums, and an electronic learning curriculum. In addition, 2 half-day symposia with nationally renowned experts in therapeutic hypothermia were offered.

Because ICU nurses are the team members who provide round-the-clock care for patients who receive therapeutic hypothermia, clinical nurse educators developed a multifaceted educational plan. After unit orientation and assessment of staff readiness, ICU nurses undergo 3 hours of didactic offerings, including pathophysiology of sudden cardiac death and needs after resuscitation, an overview of techniques of therapeutic hypothermia, and management of complications. Table 2 outlines objectives, content, time frame, and methods of the educational plan. Emphasis is placed on prevention of arrhythmias, potential issues with altered vital signs, skin problems, fluid and electrolyte disturbances, hyperglycemia, clotting issues, infection, seizures, shivering, and the decrease in clearance of medications.

The next step is coassignment with a preceptor to a patient treated with therapeutic hypothermia as long as necessary, until competency is demonstrated. In order to ensure ongoing proficiency, annual demonstration of knowledge of therapeutic hypothermia is required. Case-based reviews have continued to provide learning opportunities that have further improved both collaboration among the clinical team and the delivery of care.

Resources available to nurses caring for a patient treated with therapeutic hypothermia include 24-hour availability of clinical experts, a hard-copy resource manual, the clinical practice guideline, manufacturers' equipment manuals, and current evidence-based literature. These published articles are summarized within Table 1 as an evidence table. Nursing staff are also encouraged to seek out presentations on therapeutic hypothermia at local, regional, and national conferences and to share learning with colleagues after the presentations.

Interprofessional Case Analysis

Although acceptance of therapeutic hypothermia was developing, formal case review enhanced use of the therapy. Real-time case review by the interprofessional care team occurs daily at the bedside of patients treated with therapeutic hypothermia. Each patient's progress over the preceding 24 hours is assessed, and decisions for the prospective plan of care are made.

In addition to these interprofessional reviews, the unit educator or manager reviews each patient receiving

Exclusion Criteria/Criteria Necessitating Emergent Consultation

STEMI

- No arterial access
- Patient refusal
- Patient is not a candidate – requires a review of old records
- Active bleeding
- Not mentally competent to consent for procedure
- ED physician uncertain of best course of care

HYPOTHERMIA PROTOCOL

1. **Preexisting DNR/DNI**, or advanced medical illness precluding the possibility of meaningful recovery
2. **Persistent hypotension** (SBP <90 or MAP <60 mm Hg) despite maximum pressors
3. **Persistent hypoxemia** (O2 sat <80% for >15 minutes after ROSC and before hypothermia)
4. **Response to verbal commands or purposeful movement**
5. **Initial body temperature <30°C**
6. **Known active bleeding**

Inclusion Criteria

STEMI

- Chest pain for 12 hours or less
- ST elevation in 2 or more contiguous EKG leads
- New LBBB in setting of angina
- NO contraindications for inclusion in the “MI Alert” protocol

Hypothermia Protocol

1. **Pulseless cardiac arrest with return of spontaneous circulation (ROSC)**, ROSC = pulses for 20 minutes continuously
2. Traumatically induced cerebral anoxia with or without cardiac arrest
3. **Persistent coma after ROSC**— No response to verbal commands and no purposeful movement (GCS ≤6)
4. Age is ≥18 (if under 18 years old— discuss with pediatric intensivist for weight-based medication orders)
5. **Time from arrest to ROSC (“down time”) <60 min**
6. **SBP >90 mm Hg with MAP >60 mm Hg**, spontaneously or with pressors
7. Protocol initiated within 6 hours of collapse

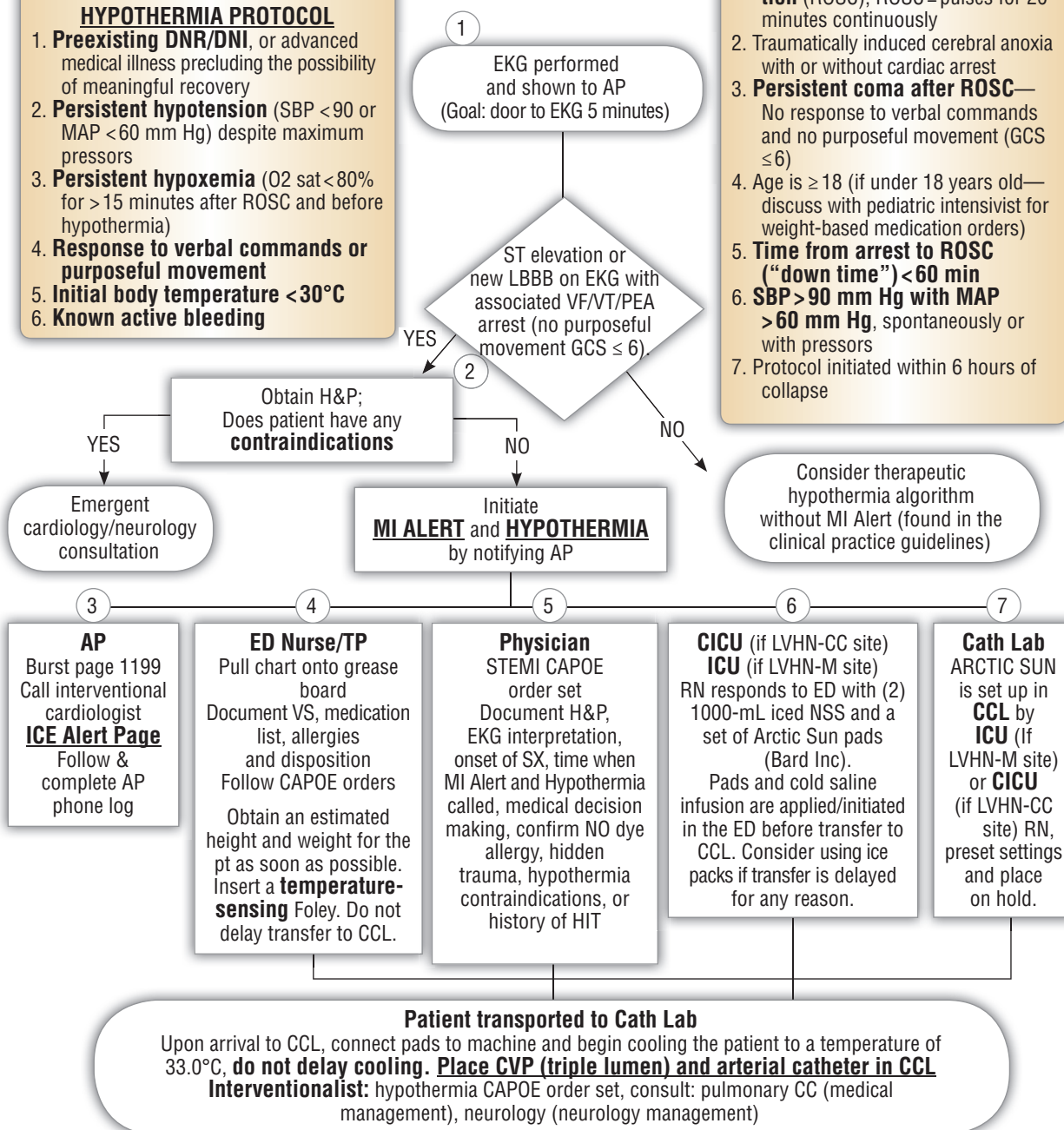


Figure 4 Protocol for simultaneous alerts for myocardial infarction and rapid deployment of resources to extend therapeutic hypothermia after cardiac arrest (“ICE alert”).

Abbreviations: AP, attending physician; CAPOE, computer-assisted physician order entry; CCL, cardiac catheterization laboratory; CICU, cardiac intensive care unit; CVP, central venous pressure; DNI, do not intubate; DNR, do not resuscitate; ED, emergency department; EKG, electrocardiography; GCS, score on Glasgow Coma Scale; HIT, heparin-induced thrombocytopenia; H&P, medical history and results of physical examination; LBBB, left bundle branch block; LVHN, Lehigh Valley Health Network, Muhlenberg (M) or Cedar Crest (CC); MAP, mean arterial pressure; MI, myocardial infarction; NSS, normal saline solution; PEA, pulseless electrical activity; pt, patient; RN, registered nurse; sat, saturation; SBP, systolic blood pressure; STEMI, ST-elevated myocardial infarction; SX, symptoms; TP, trauma physician; VF, ventricular fibrillation; VS, vital signs; VT, ventricular tachycardia.

Reprinted with permission from Lehigh Valley Health Network, Allentown, Pennsylvania.

Table 2 Educational plan on therapeutic hypothermia for nurses

Objectives	Content (topics)	Time Frame, min	Methods
1. Discuss the benefits of therapeutic hypothermia as a neurological protective technique in select patient situations	1. History of therapeutic hypothermia 2. Postcardiac arrest syndrome a. Brain injury b. Systemic ischemia/reperfusion response c. Preexisting/precipitating abnormality	60	PowerPoint presentation, hand-out, questions and answers
2. Identify the physiological implications of therapeutic hypothermia	3. Clinical practice guidelines 4. Inclusion/exclusion criteria 5. Algorithms 6. Three phases of hypothermia a. Induction b. Maintenance c. Rewarming	60	PowerPoint presentation, hand-out, case study, questions and answers
3. Describe risks and/or possible complications of this therapy	7. Risks associated with therapeutic hypothermia 8. Potential complications associated with therapeutic hypothermia	30	PowerPoint presentation, hand-outs, questions and answers
4. Become familiar with application of Arctic Sun pads and use of the machine (Bard Inc)	9. Technology a. Traditional b. New 10. Pad placement 11. Machine connection 12. Function of the Arctic Sun machine	30	Demonstration of equipment, questions and answers

therapeutic hypothermia with the primary nurse throughout the shift to foster critical thinking that translates the scientific evidence to the patient's specific needs. At the monthly meeting of the therapeutic hypothermia committee, case reviews are offered by using a standard communication template (situation, background, assessment, and recommendation). Care processes and outcomes are reviewed, and opportunities for improvement are identified.

Participation in a Global Database

From the onset, the therapeutic hypothermia committee recognized the necessity to use data to improve the processes and outcomes of the therapy. After beginning with process metrics and rudimentary patient scales, evaluation and analysis have progressed to participation in an international therapeutic hypothermia data registry known as the International Cardiac Arrest Registry. Originally, the registry did not include data from North America. When it was expanded to North America, a goal was to develop cardiac end points that would further define use of therapeutic hypothermia after cardiac arrest. Lehigh Valley Health Network is 1 of 6 centers submitting data to develop these end points. Case abstraction allows comparison of internal data with registry data aggregates to enhance therapeutic

hypothermia practices. Table 3 compares our recent data with those of the international registry.

Conclusion

At this time, we have used therapeutic hypothermia for more than 200 adult patients during an 8-year period. Our experience matches published outcomes for patients with ventricular tachycardia and fibrillation treated with therapeutic hypothermia: approximately 50% patient survival with minimal disability. Use of therapeutic hypothermia after resuscitation for other causes, such as pulseless electrical activity, asystole, and secondary cardiac arrests due to such conditions as drug overdose and asphyxiation, has had limited success.

A decade ago, families of patients who had had a cardiac arrest were told to "watch and wait" regarding their loved ones' survival; the common belief was that recovery, if it were to occur, takes time and interventions were aimed at basic supportive care. Therapeutic hypothermia has redefined care after resuscitation and provides an aggressive intervention that may mitigate postresuscitation syndrome.

Use of therapeutic hypothermia is still in its infancy. For continued development of the therapy, clinicians must continue to learn and enhance the evidence with each patient. First and foremost, use must be in

Table 3 Data on therapeutic hypothermia submitted by Lehigh Valley Health Network compared with data of the International Cardiac Arrest Registry

Characteristic	Hospital	Registry
Age, median, y	63	63
Female sex, % of patients	44	38
Total ischemic time, median, min	22	20
Initial rhythm ventricular fibrillation/ventricular tachycardia, % of patients	34	42
Bystander cardiopulmonary resuscitation, % of patients	38	40
Out-of-hospital cardiac arrest, % of patients	82	73
Time from cardiac arrest to initiation of temperature management, median, min	140	112.5
Computed tomography of the head for patients with unwitnessed cardiac arrest, % of patients	25	41
Urgent cardiac catheterization, % of patients		
In patients with ST-segment elevation myocardial infarction	74	82
In patients with ventricular fibrillation/ventricular tachycardia initial rhythm	62	68
Goal temperature achieved, % of patients undergoing temperature management	94	97
Fever in first 72 hours after cardiac arrest, % of patients	22	24
Early onset pneumonia, % of patients	16	30
Electroencephalographic monitoring, % of patients	5	24
Hypotension in first 24 hours of care, % of patients	29	22
Withdrawal of life support because of neurological futility < 48 hours after cardiac arrest, % of patients	15	19
Survival to hospital discharge, % of patients	26	38
Good neurological function at follow-up, % of patients	56	76

accordance with established evidence-based protocols. Our experience has shown that, beyond a protocol, the critical elements of success we detailed have enhanced translation of the evidence on therapeutic hypothermia into practice. **CCN**

Acknowledgments

We acknowledge the editorial assistance of Kim S. Hitchings, RN, MSN, NEA-BC, manager, Center for Professional Excellence, Lehigh Valley Health Network.

Financial Disclosures

None reported.

References

- Gaieski DF, Band R, Abella B, et al. Early goal-directed hemodynamic optimization combined with therapeutic hypothermia in comatose survivors of out-of-hospital cardiac arrest. *Resuscitation*. 2009;80(4):418-424.
- 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.
- Hypothermia After Cardiac Arrest Study Group. Mild therapeutic hypothermia to improve the neurologic outcome after cardiac arrest [published correction appears in *N Engl J Med*. 2002;346(22):1756]. *N Engl J Med*. 2002;346(8):549-556.
- Nolan JP, Morley PT, Vanden Hoek TL, Hickey RW; Advanced Life Support Task Force of the International Liaison Committee on Resuscitation. Therapeutic hypothermia after cardiac arrest: an advisory statement by the Advanced Life Support Task Force of the International Liaison Committee on Resuscitation. *Resuscitation*. 2003;57(3):231-235.
- Neumar RW, Nolan JP, Adrie C, et al. Post-cardiac arrest syndrome: epidemiology, pathophysiology, treatment, and prognostication: a consensus statement from the International Liaison Committee on Resuscitation (American Heart Association, Australian and New Zealand Council on Resuscitation, European Resuscitation Council, Heart and Stroke Foundation of Canada, Inter American Heart Foundation, Resuscitation Council of Asia, and the Resuscitation Council of Southern Africa); the American Heart Association Emergency Cardiovascular Care Committee; the Council on Cardiovascular Surgery and Anesthesia; the Council on Cardiopulmonary, Perioperative, and Critical Care; the Council on Clinical Cardiology; and the Stroke Council. *Circulation*. 2008;118(23):2452-2483.
- Peberdy MA, Callaway C, Neumar RW, et al; American Heart Association. Part 9: post-cardiac arrest care: 2010 American Heart Association guidelines for cardiopulmonary resuscitation and emergency cardiovascular care [published corrections appear in *Circulation*. 2011;123(6):e237 and 2011;124(15):e403]. *Circulation*. 2010;122(18)(suppl 3):S768-S786.
- Oddo M, Schaller MD, Feihl F, Ribordy V, Liaudet L. From evidence to clinical practice: effective implementation of therapeutic hypothermia to improve patient outcome after cardiac arrest. *Crit Care Med*. 2006;34(7):1865-1873.
- Bader MK, Rovzar M, Baumgartner L, Winokur R, Cline J, Schiffman G. Keeping cool: a case for hypothermia after cardiopulmonary resuscitation. *Am J Crit Care*. 2007;16(6):632-636.
- Banks JL, Marotta CA. Outcomes validity and reliability of the modified Rankin scale: implications for stroke clinical trials: a literature review and synthesis. *Stroke*. 2007;38(3):1091-1096.
- Kupchik NL. Development and implementation of a therapeutic hypothermia protocol. *Crit Care Med*. 2009;37(7)(suppl):S279-S284.
- Mooney MR, Unger BT, Boland LL, et al. Therapeutic hypothermia after out-of-hospital cardiac arrest: evaluation of a regional system to increase access to cooling. *Circulation*. 2011;122(2):206-214.
- Nair SU, Lundbye JB. The use of hypothermia therapy in cardiac arrest survivors. *Ther Hypothermia Temp Manag*. 2011;1(1):9-21.
- Wang HE, Thomas JJ, James D, et al. Post-cardiac arrest therapeutic hypothermia: overcoming the barrier of workplace culture and other implementation lessons. *Jt Comm J Qual Patient Saf*. 2011;37(9):425-432.
- DeLia D, Wang HE, Kutzin J, Merlin M, Cantor JC. Post-cardiac arrest therapeutic hypothermia in New Jersey hospitals: analysis of adoption and implementation. *Ther Hypothermia Temp Manag*. 2012;2(2):78-88.
- Lantry J, Dezman Z, Hirshon JM. Pathophysiology, management and complications of hypothermia. *Br J Hosp Med (Lond)*. 2012;73(1):31-37.
- Storm C, Nee J, Roser M, Jörres A, Hasper D. Mild hypothermia treatment in patients resuscitated from non-shockable cardiac arrest. *Emerg Med J*. 2012;29(2):100-103.
- Jolley J, Sherrod RA. How effective is "code freeze" in post-cardiac arrest patients? *Dimens Crit Care Nurs*. 2013;32(1):54-60.
- Nielsen N, Wetterslev J, Cronberg T, et al; TM Trial Investigators. Targeted temperature management at 33°C versus 36°C after cardiac arrest. *N Engl J Med*. 2013;369(23):2197-2206.
- Scirica B. Therapeutic hypothermia after cardiac arrest. *Circulation*. 2013;127(2):244-250.

