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. 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.

Research 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. 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

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Literature Review

Therapeutic hypothermia involves purposely lowering the core body temperature to 32°C to 34°C for 12 to 24 hours. 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 in 2002. Bernard et al and the Hypothermia After Cardiac Arrest Study Group 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. The positive outcome ratios of Bernard et al and the Hypothermia After Cardiac Arrest Study Group 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. 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 al 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 al 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 al 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...
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  Therapeutic hypothermia evidence

<table>
<thead>
<tr>
<th>Reference</th>
<th>Year</th>
<th>Subject</th>
<th>Conclusions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bernard et al²</td>
<td>2002</td>
<td>Randomized controlled study from Melbourne, Australia, where 77 patients were treated with hypothermia (33°C) and maintained at that temperature for 12 hours</td>
<td>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</td>
</tr>
<tr>
<td>The Hypothermia After Cardiac Arrest Group³</td>
<td>2002</td>
<td>Multicenter randomized controlled trial comparing the effects of hypothermia vs normothermia in patients resuscitated after cardiac arrest</td>
<td>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</td>
</tr>
<tr>
<td>Nolan et al⁴</td>
<td>2003</td>
<td>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</td>
<td>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)</td>
</tr>
<tr>
<td>Oddo et al⁷</td>
<td>2006</td>
<td>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)</td>
<td>Time from collapse to return of spontaneous circulation (ROSC) is strongly associated with outcome after VF and non-VF cardiac arrest treated with hypothermia</td>
</tr>
<tr>
<td>Bader et al⁸</td>
<td>2007</td>
<td>Case study used to demonstrated 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</td>
<td>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</td>
</tr>
<tr>
<td>Banks and Marotta⁹</td>
<td>2007</td>
<td>Systematic literature review that provides information on the structure, validation, scoring, and psychometric properties of the modified Rankin Scale</td>
<td>Evidence attests to the validity and reliability of the modified Rankin Scale</td>
</tr>
<tr>
<td>Neumar et al⁵</td>
<td>2008</td>
<td>A consensus statement from the International Liaison Committee of Resuscitation</td>
<td>Therapeutic hypothermia should be part of a standardized treatment strategy for comatose survivors of cardiac arrest</td>
</tr>
<tr>
<td>Gaiési et al¹¹</td>
<td>2009</td>
<td>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</td>
<td>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</td>
</tr>
<tr>
<td>Kupchik¹²</td>
<td>2009</td>
<td>Steps and considerations in developing and implementing a therapeutic hypothermia protocol are discussed by using evidence and 1 institution’s process</td>
<td>A collaborative team approach with a formalized protocol support the critical care required for patients being treated with hypothermia after cardiac arrest</td>
</tr>
<tr>
<td>Peberdy et al¹⁰</td>
<td>2010</td>
<td>2010 American Heart Association guidelines for cardiopulmonary resuscitation and emergency cardiovascular care</td>
<td>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</td>
</tr>
<tr>
<td>Reference</td>
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<td>Conclusions</td>
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<tr>
<td>Mooney et al</td>
<td>2011</td>
<td>Observational study presenting case series outcomes for unresponsive adults who had an out-of-hospital cardiac arrest with a ROSC &lt;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</td>
<td>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</td>
</tr>
<tr>
<td>Nair and Lundbye</td>
<td>2011</td>
<td>Discussion of pathophysiology of neurological injury in cardiac arrest survivors and review of various process steps of hypothermia based on evidence</td>
<td>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</td>
</tr>
<tr>
<td>Wang et al</td>
<td>2011</td>
<td>Case series outlining the lessons learned related to development and implementation of a therapeutic hypothermia program at an urban academic medical center</td>
<td>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</td>
</tr>
<tr>
<td>DeLia et al</td>
<td>2012</td>
<td>Survey of 73 acute care hospitals in New Jersey to solicit information about adoption, application, and methods used for therapeutic hypothermia</td>
<td>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</td>
</tr>
<tr>
<td>Lantry et al</td>
<td>2012</td>
<td>Discussion of pathophysiology of neurological injury in cardiac arrest survivors and review of various process steps of hypothermia based on evidence</td>
<td>Therapeutic hypothermia is the only intervention shown to improve neurological outcomes after cardiac arrest</td>
</tr>
<tr>
<td>Storm et al</td>
<td>2012</td>
<td>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)</td>
<td>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</td>
</tr>
<tr>
<td>Jolly and Sherrod</td>
<td>2013</td>
<td>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</td>
<td>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</td>
</tr>
<tr>
<td>Nielsen et al</td>
<td>2013</td>
<td>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</td>
<td>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</td>
</tr>
<tr>
<td>Scirica</td>
<td>2013</td>
<td>Physiological consequences of therapeutic hypothermia are reviewed through one institution’s process and mention of evidentiary findings</td>
<td>Care requires established guidelines of care, standard orders, goal-directed algorithms, and education of staff to deliver efficient, coordinated, and effective postresuscitation care</td>
</tr>
</tbody>
</table>
questions about the benefit of temperature management. The study 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 al 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, Kupchik 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. 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.

Interprofessional collaboration was also a factor addressed by Mooney et al. 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. 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 neurological 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.

**The 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

**Therapeutic hypothermia can improve neurological outcomes after cardiac arrest.**
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 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 committee 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, multigorgan 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.

**Exclusion Criteria/ Criteria Necessitating Emergent Consultation**

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**

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, 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.

**Preparing for induction**

Do not delay cooling while performing initial steps.

**Initiate THERAPEUTIC HYPOTHERMIA**

Dial 1199
Burst Page ICE ALERT

**Obtain H&P;**
Does patient have any contraindications to entering HYPOTHERMIA protocol?

**YES**
Emergent cardiology/neurology consultation

**NO**
Continue ACLS protocol
Consider alternative treatment

**Cardiac arrest with ROSC in persistent coma (no purposeful movement GCS ≤6)**

**YES**
Obtain &P; Does patient have any contraindications to entering HYPOTHERMIA protocol?

**YES**
Emergent cardiology/neurology consultation

**NO**
Continue ACLS protocol
Consider alternative treatment

**Obtain Labs:**
BMP, CBC, ABG, MG, PT, PTT, lipid profile

**Obtain height/weight**
Apply Arctic Sun pads (use sizing guide, Bard Inc) Infuse 2 L iced NSS/LR for 15 min each. Consider using ice packs if transfer is delayed for any reason.

**Begin sedation with:**
propofol or midazolam infusion
Ensure adequate sedation (maintain BIS 40-60) simultaneously with initiation of neuromuscular blocking agent

**Begin neuromuscular blocking agent (NMBA) to prevent shivering**
Vecuronium 0.1 mg/kg bolus, then 1 µg/kg/min
Titrate to a TOF 1/4 - 2/4
Consider cistricurium if renal or hepatic impairment is present
LD = 0.15 mg/kg
MD = 3 µg/kg/min

**Monitor pupil reactions Q1 hour**
Notify neurologist of nystagmus
Obtain EEG/consider continuous EEG monitoring
See Figures 2 and 3 for maintenance and rewarming

**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; LT, 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.

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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

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**Table 1** Algorithm for rewarming after therapeutic hypothermia.

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>IV infusion/Volume: Remove potassium from IV fluids 6-8 hours before beginning rewarming. Use extreme caution with any required potassium replacement. Ensure adequate volume replacement (CVP 8-12). Call MD if urine output &lt; 30 mL/hr x 2 hours.</td>
</tr>
<tr>
<td>2</td>
<td>Arctic Sun: Program the Arctic Sun machine (Bard Inc) to rewarm the patient 1°C every 4-6 hours.</td>
</tr>
<tr>
<td>3</td>
<td>NMBA: Discontinue NMBA once the patient’s body temp. reaches 36°C. Do <strong>NOT</strong> discontinue sedation until paralytic agent is stopped and patient reaches target temperature.</td>
</tr>
<tr>
<td>4</td>
<td>Sedation: Begin to titrate sedation once the patient’s body temp. reaches 37°C. Caution: Monitor for seizure activity as patient is weaned off sedation and NMBA.</td>
</tr>
<tr>
<td>5</td>
<td>Arctic Sun Maintenance: Maintain the Arctic Sun machine at 37°C for 24 hours after the target 37°C is reached to maintain normothermia. Consider IV Demerol (meperidine) for shivering.</td>
</tr>
<tr>
<td>6</td>
<td>Monitor: Obtain sputum and urine culture if the patient’s body temp. &gt; 37.5°C or Arctic Sun water temp. &lt; 15°C for 2 consecutive hours.</td>
</tr>
</tbody>
</table>

**Abbreviations:** CVP, central venous pressure (mm Hg); IV, intravenous; temp., temperature; MD, physician; NMBA, neuromuscular blocking agent.
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.

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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.

**Table 2. Educational plan on therapeutic hypothermia for nurses**

<table>
<thead>
<tr>
<th>Objectives</th>
<th>Content (topics)</th>
<th>Time Frame, min</th>
<th>Methods</th>
</tr>
</thead>
<tbody>
<tr>
<td>3. Describe risks and/or possible complications of this therapy</td>
<td>7. Risks associated with therapeutic hypothermia 8. Potential complications associated with therapeutic hypothermia</td>
<td>30</td>
<td>PowerPoint presentation, handouts, questions and answers</td>
</tr>
</tbody>
</table>

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

Acknowledgments
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Financial Disclosures
None reported.

References

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

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Hospital Registry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, median, y</td>
<td>63</td>
</tr>
<tr>
<td>Female sex, % of patients</td>
<td>44</td>
</tr>
<tr>
<td>Total ischemic time, median, min</td>
<td>22</td>
</tr>
<tr>
<td>Initial rhythm ventricular fibrillation/ventricular tachycardia, % of patients</td>
<td>34</td>
</tr>
<tr>
<td>Bystander cardiopulmonary resuscitation, % of patients</td>
<td>38</td>
</tr>
<tr>
<td>Out-of-hospital cardiac arrest, % of patients</td>
<td>82</td>
</tr>
<tr>
<td>Time from cardiac arrest to initiation of temperature management, median, min</td>
<td>140</td>
</tr>
<tr>
<td>Computed tomography of the head for patients with unwitnessed cardiac arrest, % of patients</td>
<td>25</td>
</tr>
<tr>
<td>Urgent catheterization, % of patients</td>
<td>74</td>
</tr>
<tr>
<td>In patients with ST-segment elevation myocardial infarction</td>
<td>62</td>
</tr>
<tr>
<td>In patients with ventricular fibrillation/ventricular tachycardia initial rhythm</td>
<td>68</td>
</tr>
<tr>
<td>Goal temperature achieved, % of patients undergoing temperature management</td>
<td>94</td>
</tr>
<tr>
<td>Fever in first 72 hours after cardiac arrest, % of patients</td>
<td>22</td>
</tr>
<tr>
<td>Early onset pneumonia, % of patients</td>
<td>16</td>
</tr>
<tr>
<td>Electroencephalographic monitoring, % of patients</td>
<td>5</td>
</tr>
<tr>
<td>Hypotension in first 24 hours of care, % of patients</td>
<td>29</td>
</tr>
<tr>
<td>Withdrawal of life support because of neurological futility &lt;48 hours after cardiac arrest, % of patients</td>
<td>15</td>
</tr>
<tr>
<td>Survival to hospital discharge, % of patients</td>
<td>26</td>
</tr>
<tr>
<td>Good neurological function at follow-up, % of patients</td>
<td>56</td>
</tr>
</tbody>
</table>
CE Test  Test ID C1553: Caring for Patients Treated With Therapeutic Hypothermia

Learning 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

1. Current published results from numerous studies support which of the following practices in treating patients with return of spontaneous circulation?
   a. Implementation of hypothermia protocols within 60 to 90 minutes from start of resuscitation to return of spontaneous circulation
   b. Using a nurse and physician team to help drive the protocol
   c. Instituting hypothermia treatment in the critical care setting only
   d. Promoting ongoing interdisciplinary communication in treating patients with hypothermia interventions

2. Which of the following are the goals of developing clinical practice guidelines for therapeutic hypothermia?
   a. To outline the program that all acute care facilities should adopt
   b. To provide evidence-based recommendations for physicians and nurses who care for patients with an anoxic injury
   c. To provide guidelines for the 3 phases of therapeutic hypothermia
   d. B and C

3. Which of the following are included in the 3 phases of therapeutic hypothermia?
   a. Induction, maintenance, resuscitation
   b. Resuscitation, induction, maintenance
   c. Assessment, planning, intervention
   d. Induction, maintenance, rewarming

4. Coordination of delivery of care includes all except which of the following?
   a. Development of an alert system for emergency department and in-house cardiac arrest
   b. Partnership with payer sources to fund programs
   c. Education for the team members on the protocol process
   d. Evaluation of program metrics by participating in a national database

5. The main learning objectives for nursing education on therapeutic hypothermia include all except which of the following?
   a. Review the benefits of therapeutic hypothermia as a neurological protective treatment.
   c. Certify nursing staff in the use of the hypothermia protocol.
   d. Gain exposure to special equipment used for therapeutic hypothermia.

6. Therapeutic hypothermia protocol inclusion criteria include all except which of the following?
   a. Pulseless cardiac arrest with return of spontaneous circulation
   b. Persistent hypoxemia with oxygen saturation less than 80%
   c. Persistent coma after return of spontaneous circulation
   d. Systolic blood pressure greater than 90 mm Hg with mean arterial pressure greater than 60 mm Hg

7. Steps in the initiation process of implementing the therapeutic hypothermia algorithm include which of the following?
   a. Apply of arctic sun pads
   b. Maintain the bispectral index score at 40-60
   c. Begin sedation
   d. All of the above

8. Maintenance of hypothermia include which of the following?
   a. Administer insulin drip for blood sugar greater than 180 mg/dL
   b. Monitor blood pressure every hour
   c. Maintain target temperature for 24 hours after target is achieved
   d. A and B

9. Rewarming interventions include all except which of the following?
   a. Ensure adequate volume replacement to maintain a central venous pressure of 8-12 mm Hg
   b. Monitor for seizure activity
   c. Discontinue sedation once rewarming phase begins
   d. Administer Demerol (meperidine) for shivering

10. Exclusion criteria for initiating the hypothermia protocol include all except which of the following?
    a. Preexisting do not resuscitate/do not intubate order
    b. Persistent coma after return of spontaneous circulation
    c. Persistent hypotension with systolic blood pressure less than 90 mm Hg
    d. Response to verbal commands

Program evaluation

Objective 1 was met
Objective 2 was met
Objective 3 was met
Content was relevant to my nursing practice
My expectations were met
This method of CNE is effective for this content
The level of difficulty of this test was:
  □ easy □ medium □ difficult
To complete this program, it took me _______ hours/minutes.

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