Heat Stroke Management Updates: A Description of the Development of a Novel In-Emergency Department Cold-Water Immersion Protocol and Guide for Implementation

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The growing prevalence of heat stroke as a public health issue, exacerbated by climate change and increasing global temperatures, demands an immediate and strategic response to prevent weather-related morbidity and mortality. Heat stroke results from the body's inability to cope with excessive heat, leading to systemic inflammatory responses, cellular apoptosis, and potential multiorgan dysfunction or failure. However, little information explicitly outlines how to perform cold-water immersion in the emergency department (ED), including potential patient selection, how much water or ice to use, target temperatures, when to stop, and complications or challenges with the process. This narrative explores implementing a comprehensive protocol for total-body cold-water immersion developed in an ED setting, a method proven effective in rapidly reducing core body temperatures, with the goal of reducing mortality and morbidity rates associated with heat-related illnesses. The protocol involves immediate temperature assessment, followed by cold-water immersion for patients with altered mental status and core temperatures above 40 °C. Discussion about the development of the process and results from applying the protocol during the summer of 2023, including cooling rates and patient outcomes, is also included. Additionally, the article addresses challenges and lessons learned during the protocol's implementation, emphasizing the importance of multidisciplinary collaboration, staff education, and the adaptation of ED infrastructure to support this lifesaving treatment based on its use during the last 3 years. The successful resolution of the presented cases, along with the protocol's potential for widespread adoption, illustrates the critical role of cold-water immersion in enhancing ED responses to heat stroke, offering a blueprint for future research and the development of similar protocols across health care settings. This work contributes to the evolving landscape of emergency medicine and aligns with the global effort to combat the adverse health effects of climate change. [Ann Emerg Med. 2025;85:43-52.]

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INTRODUCTION

Defining the Problem

Heat stroke and other heat-related emergencies are steadily becoming a significant public health issue within the context of global climate change, with record-breaking temperatures, an increasing frequency and severity of heat waves, and global extreme heat events becoming progressively more common.[1] According to the National Oceanic and Atmospheric Administration, recent years have ranked among the hottest in recorded history, with July 2023 being the hottest month ever recorded globally. Elevated temperatures, extreme heat events, and heat waves are among the leading causes of weather-related deaths in the United States.[2] According to the Centers for Disease Control and Prevention, from 2004 to 2018, there were 67,512 emergency department (ED) visits, 9,235 hospitalizations, and 702 deaths owing to heat-related illness on average per year.[3] This upward trend in temperatures has correlated with a significant increase in heat-related illnesses and fatalities, underscoring the urgent need for effective treatment strategies.

These weather-mediated changes have created an unprecedented challenge to our health care system in Phoenix, Arizona, demanding immediate attention and comprehensive strategies for effectively managing heat-related illnesses. July 2023 in Phoenix was the hottest month ever recorded in a US city, with an average temperature of 102.7°F, a record-breaking 31-day streak of highs at or above 110°F, and a maximum temperature of 119°F.[4] The Maricopa County Department of Public Health has recorded increased heat-associated deaths from 61 in 2014 to 425 in 2022. As a result of the incredibly hot year, in 2023 there were 645 confirmed heat-related deaths in Arizona, reflecting a 52% increase from 2022, with the first death occurring on April 11th.[5] These statistics do not account for the many more patients suffering from additional environmental and heat-related conditions.

Case 1. A 27-year-old male adult presented via emergency medical services with altered mental status after being found in a parking lot. Initial vital signs included a blood pressure level of 119/46 mmHg, a pulse rate of 151 beats/min, a respiratory rate of 45 breaths/min, a pulse oximetry rate of 95% on room air, and a rectal temperature of 42.1°C. On initial examination, the patient was ill appearing, groaning but withdrawing from pain, and with hot and dry skin. There were no obvious signs of trauma, and the patient's airway and breathing were intact.

Case 2. A 76-year-old homeless male adult was found unresponsive by emergency medical services, lying on the ground under a tree with a Glasgow Coma Scale (GCS) rating of 8. Out-of-hospital vitals were notable for a pulse rate of 100 beats/min, blood pressure level of 193/100 mmHg, respiratory rate of 24 breaths/min, and temperature of 41.6°C. The patient had a complex medical history, including uncontrolled type II diabetes mellitus, coronary artery disease with a pacemaker, atrial fibrillation on apixaban, diastolic heart failure, a prior cerebrovascular accident, and schizoaffective disorder. Initial vital signs included a pulse rate of 122 beats/min, blood pressure level of 202/103 mmHg, respiratory rate of 13 breaths/min, rectal temperature of 41.1°C, and glucose level of 324 mg/dL. Physical examination showed no signs of trauma, and the patient's airway and breathing were intact. The patient was altered with a GCS rating of 9, with no focal neurologic deficits.

Background

Heat-related illness occurs when the environmental and metabolic heat burden outpaces an individual's thermoregulatory mechanisms for heat transfer, ultimately leading to an increase in core temperature.[6] The body maintains homeostasis by balancing heat production and exogenous accumulation with heat dissipation through conduction, convection, evaporation, and radiation. As body temperature increases, sweat production increases, and peripheral vasodilation in the skin occurs to augment and hasten heat transfer.[7] Continued repetitive exposure to heat stress results in heat acclimation and heat tolerance, which increase an individual's ability to withstand elevated temperatures and improve thermoregulation. These adaptations include improved sweating, vasodilation, lowered body temperatures, reduced cardiovascular strain, improved fluid balance, altered metabolism, and enhanced cellular protection.[8]

Populations at a higher risk of developing heat emergencies include those at the extremes of age (old and young), pregnant women, obese patients, outdoor workers, and athletes.[1,6] Factors that limit heat loss through the skin may lead to heat retention. Dehydration and hypohidrosis, extensive scars, and chronic medical conditions, including psychiatric and mental health disorders, cardiovascular disease, stroke, respiratory disease, diabetes, and kidney disease, can also impair heat exchange through primary impairment of heat management or may worsen during the period of high heat stress.[1,6] Certain medications predispose someone to heat injury by either increasing heat production (amphetamines, illicit drugs, thyroid agonists, and weight loss supplements) or compromising the function of thermoregulatory mechanisms by altering sweat or hydration response (anticholinergics, phenothiazines, diuretics, and laxatives), blunting vasodilation or tachycardia (β-blockers, calcium channel blockers, α-adrenergic medications, antihistamines, and tricyclic antidepressants), or directly interfering with hypothalamic thermoregulation (antipsychotics and serotonin-reuptake inhibitors).[1,6,9] When these cooling mechanisms fail or are impaired owing to continued heat absorption, the core temperature rises, leading to pathologic changes.

Heat stroke, defined by a core body temperature exceeding 40°C (104°F) and central nervous system dysfunction, is the most severe form of heat-related illness.[9] Mortality rates associated with classic heat stroke, characterized by prolonged high-ambient temperatures and underlying chronic conditions, approach 80%. In comparison, exertional heat stroke presents a 33% mortality rate in the absence of prompt medical intervention.[1]

The most significant risk factors for heat-related mortality through multisystem organ dysfunction or worsening pre-existing medical conditions are the amount of time the body is exposed to elevated temperatures and continued prolonged heat exposure.[10] Hyperthermia treatment hinges on rapid and early patient cooling to decrease exposure to extreme heat and address other concomitant or related systemic emergencies. Techniques used include applying ice or cold packs to the groin or axilla, wet gauze sheets, cooled intravenous fluids, cooling blankets, gastric, colonic, bladder, or peritoneal lavage, and fans alone or in combination to enhance evaporative cooling.[11] Cold-water immersion is a technique performed by rapidly placing a patient's trunk and extremities in cold water to reduce core body temperature. This technique takes advantage of the high thermal conductivity of water, which is 24 times greater than that of air, and the high thermal gradient between cold water and skin, allowing for a greater capacity for heat transfer.[6]

Different modalities have varying cooling rates, with the recommended cooling rate at 0.15°C/min.[12] Techniques using evaporative cooling strategies range from 0.01 to 0.079°C/min.[13,14] Cold intravenous fluids can cool a patient at a rate of 0.039°C/min and have demonstrated no benefit when compared with passive cooling (ie, resting in the shade).[15] The cold shower cooling rate is 0.08°C/min.[16] Tarp-Assisted Cooling Oscillation, a technique in which a person is placed in a folded and held tarp containing cold water, had a rate of 0.14 to 0.16°C/min.[17,18] Cold-water immersion reduces temperature at a rate of 0.2 to 0.36°C/min.[19,20]

Multiple medical societies,[6,12,21,22] and various journal publications,[1,23-27] have recognized and recommended cold-water immersion as a quick and effective treatment for heat stroke in guidelines and position statements. However, implementing the technique in the ED in a formalized structure has been limited. A literature search revealed 3 descriptive case reports outlining cold-water immersion for in-ED management of heat stroke,[28-30] 2 discussing cold-water immersion for drug-induced hyperthermia[31,32] and 1 article describing synchronized cardioversion while undergoing immersive cooling, as well a response letter with a brief visual description of the ED hyperthermia treatment.[33,34]

Adopting such a treatment modality necessitates addressing potential barriers to implementation, including logistical challenges and the need for specialized equipment, ensuring patient safety and comfort during the procedure, and preventing harm to the treatment team for successful application. The following protocol provides an example of a cold-water immersion treatment protocol used in more than 60 heat stroke cases over the last 3 years, including 37 heat cases in the summer of 2023. With the growing impact of extreme temperatures on public health, the need for practical, rapid interventions like cold-water immersion in emergency medicine is more critical than ever.

EMERGENCY DEPARTMENT PROTOCOL AND DEVELOPMENT

This article presents a cold-water immersion protocol that can be easily implemented in any ED. Two EDs in our system currently use the cold-water immersion protocol. One is a 32-bed ED with an average annual volume of approximately 67,000 patients, houses an emergency medicine residency, and is in a historical county-style hospital with American College of Surgeons level 1 trauma capabilities. The other is a free-standing 30-bed ED with an average annual volume of approximately 38,000 patients. Our ED first implemented a cold-water immersion protocol for heat stroke in early 2021, initially in the larger center and then the free-standing facility.

The cold-water immersion protocol involves placing a patient suffering from suspected heat stroke in a body bag filled with a slurry of ice water rapidly upon arrival to the ED and performing continuous resuscitation, patient monitoring, and management. Any patient with suspected heat stroke receives an immediate rectal temperature upon arrival in the ED. The cold-water immersion protocol is started if the patient meets the criteria of altered mental status with a core temperature of >40°C. The protocol is best implemented with 1 physician providing resuscitation direction, 1 technician dedicated to materials and supplies, 1 nurse documenting, and at least 1 bedside nurse. A second physician to assist with procedures, including airway and dedicated cold-water immersion process supervision, is usually present but may not be available owing to staffing or location constraints. A dedicated cold-water immersion package in the resuscitation bay includes a body bag and an invasive temperature-monitoring device of either a temperature-sensing Foley catheter or a rectal probe (Figure 1). A rapid primary survey is conducted to identify a need for airway management in patients with respiratory failure or distress, as well as severely altered mental status, and for any obvious traumatic injuries that will trigger a trauma activation response. Cooling is not delayed for airway management and is performed simultaneously. The patient is immediately placed in an ice bath inside the white, front-zipped, liquid impermeable body bag. In parallel, they are attached to the cardiopulmonary monitor, a temperature-sensing Foley catheter capable of continuous measurement is placed, and intravenous access is established (Figure 1). Repeat primary and secondary surveys and any additional necessary interventions are performed in concert with rapid cooling. The patient's temperature is monitored and removed from the ice bath once the core temperature is 39°C. The body bag can be cut in a dependent corner and free water removed into an appropriate receptacle. The patient is log rolled out of the body bag and dried. Figure 2 shows images from a video of the protocol in Video E1 (available at http://www.annemergmed.com) outlining the protocol steps.

OUTLINE OF COLD-WATER IMMERSION PROTOCOL

1. Rapid active cooling—the goal is to cool the patient rapidly to <39°C
   a. Staff personal protective equipment
      i. For all the health professionals: masks, gloves, gowns, and eye protection
   b. Initiate core temperature assessment—must be done before active cooling

Figure 1. ED resuscitation bay with the bag open and material prepared for patient treatment.

i. A Foley catheter or rectal probe capable of providing a continuous temperature is recommended as the primary monitoring device during cooling
ii. Esophageal probe (if intubated)

c. Rapid assessment for any obvious traumatic injuries
d. Advanced cardiac life support or advanced trauma life support as indicated
   i. Intubate as needed for respiratory failure or airway protection against aspiration or vomiting
   ii. Active cooling should not be delayed for procedures like intubation or vasopressor support, as this can be done simultaneously
   iii. Mental status and hemodynamics may improve as the patient is cooled
   iv. Consider medication to aid with sedation as needed for agitation
   v. If a patient is actively in cardiac arrest with an unknown time of pulselessness before arrival, initiate advanced cardiac life support without cooling
      1. Continue cooling if initiated before cardiac arrest
         a. Ensure staff safety with the above-listed precautions, especially in wet environments
         b. Single–case report evidence suggests cardioversion is safe in cold-water immersion[33]; however, device manufacturers do not recommend this practice
      2. Initiate cooling immediately if there is out-of-hospital or in-ED return of spontaneous circulation
e. Log roll patient into a body bag
   i. Pack the patient with ice, add water to make an ice slurry, and zip up the bag to mid-chest
      1. Two 22-quart square food storage containers of ice (from nutrition services) will be stocked in the ED freezer
      2. After emptying the ice into the bag, add water to the bag
         a. Fill 1 to 2 of these 22-quart containers with room-temperature tap water
      3. If the patient is too large for the bag, start by placing the lower extremities in the bag and leaving the head or upper torso exposed
   ii. The patient's chest and arms can be exposed for access to procedures (eg, electrocardiogram, intravenous infusion, and blood draws)
      1. Intravenous access is to be obtained in the antecubital area of the arm if possible to allow for at least 18 gauge catheters to be placed bilaterally
      2. May use a smaller size catheter or place it in the forearm or hand if unable to obtain vascular access
   iii. Vital signs are to be documented every 2 minutes after that
f. Remove the patient from the bag once the temperature is $\leq$39°C
   i. Place the patient in the reverse Trendelenburg position
   ii. Cut the bag at the bottom and drain any liquid into a large basin
   iii. Log roll the patient out of the body bag and dry with towels

2. Ice replenishment
   a. The unit clerk will notify nutrition services for ice resupply once the protocol is initiated
      i. This will allow for immediate resupply in the case of multiple hyperthermic patients

Figure 2. Sequential steps illustrating patient progression through the cold-water immersion protocol.

3. Imaging concerns
   a. Altered hyperthermic patients will almost certainly require head computed tomography (CT) imaging
   b. Patients should ideally be cooled and removed from the body bag before CT imaging
   c. Imaging should be expedited if the patient remains altered after cooling
   d. If there is a delay in cooling, it is possible to obtain head CT imaging while the patient is still actively cooled in the body bag
4. Family
   a. If the family is already present on arrival, please have a discussion with them regarding the body bag as a tool to cool the patient and contain ice/water
   b. If the family is initially absent, avoid bringing the family back until the patient is cooled and removed from the body bag
5. Disposition
   a. The patient is to be removed from the body bag before leaving the ED for admission or transfer
   b. Discuss hospitalization plan with the admitting team to determine the most appropriate level of care
      i. A large majority of patients are to be admitted to the intensive care unit for continued medical management and monitoring of concomitant illness or injury
      ii. The patient may be appropriate for an intermediate-level of care if vital signs and mentation improve during cooling

INITIAL IMPLEMENTATION

Before the cold-water immersion protocol, the treatment and management of heat stroke were variable, with no standard of care, resulting in a broad practice variation of patient management. As a result, cooling times varied significantly based on identification and treatment strategy and were frequently delayed. Treatments included evaporative cooling, in which water was sprayed on the patient, and a fan was placed at their feet to enhance airflow, placing chemical cold packs around the groin, neck, and axilla, and using a body surface–cooling device usually reserved for targeted temperature management in post–cardiac arrest patients. In addition, aside from treatment variations, patient care documentation was inconsistent, with no uniform system for recording serial temperatures or reevaluation.

After reviewing these limitations, a quality improvement project was initiated at the end of 2020 to standardize heat illness treatment in our ED. Cold-water immersion was selected after reviewing primary literature and society recommendations and was developed with multiple stakeholders, including ED and nursing leadership. The process was implemented in the summer of 2021, and on June 16, the first patient in our department was treated with cold-water immersion. In the first year, the cold-water immersion protocol was used in 11 cases. A primary goal was to record the initial core temperature, the core temperature on removal from cold-water immersion, the cooling rate, and the lowest recorded temperature (to identify instances of overcooling). However, we rapidly discovered inconsistent documentation of temperature-associated vital signs during treatment, making analysis challenging. In subsequent years, a significant effort was made in collaboration with nursing and department leadership to improve the charting of these measures.

Issues encountered early on were associated with the novel nature of this technique, which was unfamiliar to most staff, and the need for background teaching on heat stroke, as well as practice and instruction. However, the protocol was ultimately well received as providers and nursing staff became more familiar and adept at running the process. Additionally, we initially had challenges with patients suffering from heat stroke and other medical emergencies, including concomitent trauma and contact burns from the hot asphalt.

Although the goal of the initial quality improvement project was to review the protocol in 2021, we continue to evaluate the process and are constantly developing additional insights. The cold-water immersion process is still in place at our hospital system, and the protocol was implemented in more than 20 cases in 2022 and 37 cases in 2023. There have been modifications and changes owing to feedback, observation, and input from physicians, ancillary staff, and allied medical specialty services. Developing an order set in our hospital's electronic medical record, including nursing direction and suggested laboratories, was a step that aided in initial management and documentation. We also found that the improved documentation resulted in more accurate temperature recording, prompt identification of heat stroke patients, early identification of target cooling temperature, and initiation of removing the patient from the body bag. Streamlined protocol development with specific instructions and demonstration of the protocol with real-time training for physicians and ancillary staff have also been developed and improved. For example, we observed staff make statements like "place the patient in the body bag," but through staff interviews and increased experience with running the protocol, the educational language was explicity clarified.

The early focus of the quality improvement initiative was to identify barriers to implementation and develop strategies for process improvement. During the summer of 2023, patient characteristic and outcome data reporting became a focus of this period and are reported in the Table. The team completed a retrospective observational review of heat-associated individual adult ED visits between June 1, 2023, and August 31, 2023. Adult patients greater than 18 years old who presented to the ED with heatstroke were included for review. Pediatric patients less than 18 at the time of ED presentation and those with presentations that could not be attributed to heatstroke or heat-associated illness after chart review were excluded before analysis. Patient demographics, and out-of-hospital, ED, and hospitalization course information, were collected through chart extraction.

CHALLENGES AND LESSONS LEARNED

A comprehensive approach involving the development of precise steps for implementation is essential to successfully integrating a cold-water immersion protocol in the ED. The development of this protocol was completed in Arizona, where elevated ambient temperatures predispose our patient population to heightened rates of heat-related illness. However, as the rate of heat-related issues will likely increase, maintaining a protocol for patient management is imperative, even in locations with a lower prevalence of heat stroke, to ensure proper treatment when these patients present to the ED. Additionally, its development must be thoroughly discussed and approved with all appropriate stakeholders, including physician and nursing leadership, ancillary support services such as imaging and respiratory therapy, nutrition services, and ED unit clerks, as they play crucial roles in executing the treatment protocol and patient care. Their insights can help tailor the implementation process to meet individual EDs' unique needs and constraints.

Materials

A benefit of the protocol is the relatively few low-cost items that need to be maintained, which should allow wide application to EDs of various sizes and capabilities. Body bags were initially chosen as the containment method for cold-water immersion after attempting to identify an inexpensive and rapidly available tool with the advantages of being waterproof, light, and an appropriate size for most adults. During the initial discussion, communication around using "body bags" was met with concern, and multiple conversations with the administrative and nursing staff occurred to ensure comfort with the concept. Pre-filled

Table. Patient characteristics and outcome data from summer 2023.

Patient Characteristics and Outcomes	All Patients (n = 54)	Cooling Therapy: Cold-Water Immersion Cooling (n = 37)	Cooling Therapy: Non-Immersion Cooling (n = 10)	Cooling Therapy: No Cooling (n = 7)
Age (y), mean	46.6	42.9	55.2	54
Sex				
Male, n (%)	42 (77.8)	30 (81.1)	8 (80)	4 (57.1)
Female, n (%)	8 (14.8)	5 (13.5)	2 (20)	1 (14.3)
Unknown, n (%)	4 (7.4)	2 (5.4)	0	2 (28.6)
Housing				
Domiciled, n (%)	13 (24.1)	8 (21.6)	3 (30)	2 (28.6)
Homeless, n (%)	33 (61.1)	25 (67.6)	6 (6)	2 (28.6)
Unknown, n (%)	8 (14.8)	4 (10.8)	1 (10)	3 (42.9)
Emergency severity index, median	1	1	2	1
GCS, median	4	3	13	3
Heat stroke				
Classic, n (%)	10 (18.5)	5 (13.5)	3 (30)	2 (28.6)
Exertional, n (%)	1 (1.9)	0	1 (10)	0
Unknown, n (%)	43 (79.6)	32 (86.5)	6 (6)	5 (71.4)
Out-of-hospital cooling, n (%)	32 (59.3)	25 (67.6)	4 (40)	3 (42.9)
Out-of-hospital arrest, n (%)	10 (18.9)	4 (10.8)	0	6 (85.7)
Intubation, n (%)	41 (75.9)	32 (86.5)	3 (30)	6 (85.7)
Out-of-hospital temperature, median	41.8 °C	41.6 °C	40.2 °C	40.7 °C
ED temperature maximum, median	41.8 °C	41.89 °C	40.97 °C	41.8 °C
ED cooling rate (°C per min), mean	N/A	0.13 °C	0.05 °C	N/A
Urine drug screen (positive), n (%)	34 (63.0)	30 (81.1)	3 (30)	1 (14.3)
Outcome				
Emergency department discharge, n (%)	3 (5.6)	0	3 (30.0)	0
Post–hospitalization discharge, n (%)	30 (55.6)	25 (67.6)	4 (40.0)	1 (14.3)
Emergency department death, n (%)	13 (24.1)	6 (16.2)	1 (10.0)	6 (85.7)
Post–admission death, n (%)	8 (14.8)	6 (16.2)	2 (20.0)	0
Neurologically intact at discharge, n (%)	26 (78.8)	19 (51.4)	6 (60.0)	1 (14.3)

ED, Emergency department; *GCS*, Glasgow Coma Scale; *N/A*, not applicable.

cold-water tubs used in out-of-hospital and sporting event applications are usually unfeasible owing to continued energy use and material waste. Various commercial products may also be used; however, they are an expensive option in an ED that may see multiple cases daily. We did attempt to use an inflatable bathtub but found that there were challenges in appropriate patient monitoring as well as a decrease in body surface area covered in ice water.

Early on, we found that we were rapidly exhausting the supply of ice in our ED ice machines. We now always store 2 22-quart buckets of ice in the department freezers that are checked and restocked daily (Figure 3). Usually, 1 bucket of ice is sufficient for 1 patient. However, a second may be used with prolonged treatment or excessive spillage. Through collaboration with nutrition services, their department quickly and in real time replenishes the supply in a nearby freezer during resuscitation. This is important given that some patients may require more ice than can be stored in the freezer and because of the possibility of multiple cases of heat stroke simultaneously.

Patient Care and Staff Safety

Containing the water without significant spillage and protecting the treatment team from bodily fluid exposure was an early challenge. As the staff became more familiar with the protocol, the spillage decreased. Appropriate personal protective equipment is always required, including masks, gowns, gloves, and eye protection equipment, and significant care is taken to prevent excessive splashing. We

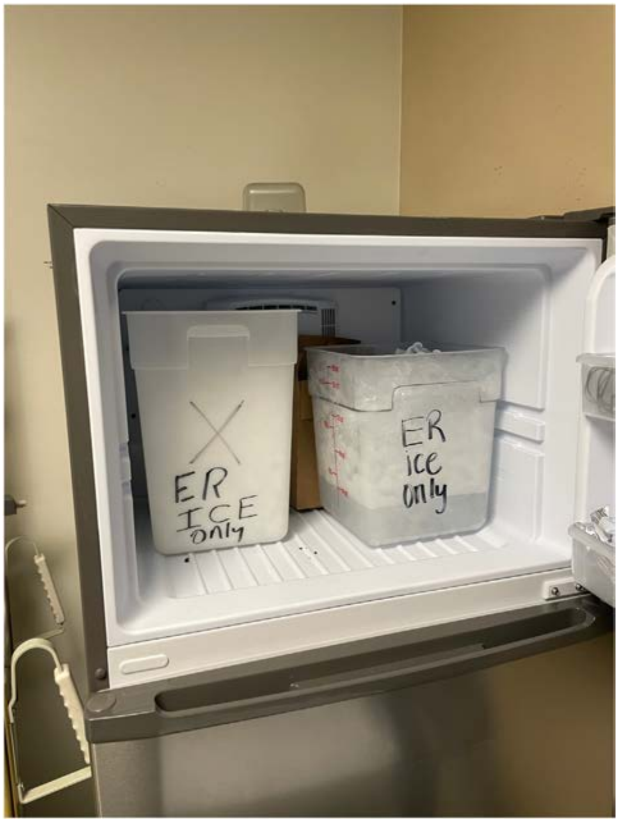

Figure 3. Large ED-only ice buckets in storage.

have found that placing towels on the ground before patient arrival helps with water containment and decreases slipping hazards. This is particularly challenging with cases that require advanced resuscitation, invasive procedures, or cardiopulmonary arrest. Removal of the patient from the body bag can also pose a challenge. We found that placing the patient in a reverse Trendelenburg position and cutting the bottom corner of the bag, allowing the ice and water to drain into the buckets intended for disposal, is an efficient and effective way to dispose of the used ice slurry. If the buckets used for initial ice storage are used to collect the waste slurry, these should be disposed of.

The decision to remove the patient at a body temperature of 39°C rather than 37°C was made to prevent overcooling. We found that even with rapid removal from the ice water, there was still some continued decrease in temperature. We have found that when the patient is removed from the ice slurry and dried and covered, they reach a normal physiologic temperature.

It is important to note that although we prioritize rapid cooling, we also ensure that other causes of hyperthermia and altered status are being addressed. A detailed history, physical examination, imaging, and laboratory assessment are used to diagnose and possibly treat potential sepsis, toxicologic emergencies, endocrine abnormalities, and medication side effects. We have also found that many patients suffering from heat stroke may have contact burns from lying on hot pavement or asphalt. The importance of airway management is also an ongoing consideration. Although some patients need advanced airway management, we do not empirically intubate all patients undergoing cold-water immersion, as we have found that some patients dramatically improve their mental status after cooling. Additionally, investigation for the end-organ damage effects of heat stroke is evaluated, including assessment for rhabdomyolysis, renal, hepatic, cardiac, and neurologic sequelae.

Education/Collaboration

Appropriate protocol dissemination is essential and is a significant barrier to successful implementation each year. Ongoing staff and physician education is vital to ensure that all team members are proficient in the latest evidence-based practices for heat stroke treatment, including the correct application of cold-water immersion techniques. Every spring, we host physician and nursing training sessions to review and practice the necessary steps as this is a seasonal disease. Updates are also sent to other hospital departments to remind them of the process or provide additional education if they are new to our system. A video description, including a process demonstration, was recorded and distributed. Video E1 titled "Hyperthermia CWI Protocol" is an educational supplement used to educate the staff, showing necessary steps and instructions. We also have a written practice guideline that is distributed electronically.

Multidisciplinary physician specialty integration and inclusion are imperative to foster a collaborative approach, ensuring that treatment protocols are comprehensive and consider all aspects of patient care. We found that involving other medical and surgical specialties with further protocol development and treatment plans strengthened the cold-water immersion process. The critical care team is usually contacted early and assists with additional care and management. The trauma surgery team has worked with us on incorporating the protocol into the advanced trauma life support workflow and has been an active collaborator in multisystem trauma resuscitations. Finally, discussions have occurred with the radiology department about the potential for CT to be performed if a patient is being actively cooled. However, our current practice is to cool rapidly and remove the patient from the bag before obtaining CT imaging.

Future Directions

As we continue to develop and hone our process, we are also implementing additional research, including definitive outcome measurement and specific time interval description, educating other hospitals on our process, and assisting in its development. Further research, including specific ED outcomes, is being assessed with plans for upcoming research and outcome measurement in our center.

CASE RESOLUTION

Case 1

Owing to severe hyperthermia and altered mental status, the ED cold-water immersion protocol was initiated, and the patient was submerged in ice water with continued fluid resuscitation and symptom control. The patient was removed from ice at a recorded temperature of 38.4°C, with an improved pulse rate, and did not require intubation. Initial laboratory assessment showed acidosis, acute kidney injury, mild rhabdomyolysis, and urine drug screen positive for methamphetamine and fentanyl. The patient was admitted for management of persistent encephalopathy and metabolic abnormalities. The patient was admitted for <24 hours and ultimately discharged with normal mentation and resolved acute kidney injury.

Case 2

Within 1 minute of obtaining triage vital signs, the cold-water immersion protocol was initiated. Thirteen minutes after being placed in the body bag with the ice water slurry, his mental status improved to a GCS rating of 15, his temperature was recorded at 38.6°C, and he complained of being cold. His tachycardia normalized, and his hypertension improved. He was discharged 8 days after the initial presentation, neurologically intact, and at baseline mental status. Five months later, clinical notes did not indicate any sequelae related to the hyperthermic event or hospital stay.

Implementing total-body cold-water immersion as a method for hyperthermia management for patients with heat stroke in the ED is a critical advancement in patient care, particularly in the face of rising global temperatures and more frequent heat waves. This method is essential to rapidly reduce core body temperature, minimizing the mortality and morbidity associated with heat stroke. Its significance is underscored by its efficiency and speed compared with other cooling methods. Cold-water immersion can be pivotal in the time-sensitive context of heat stroke treatment, in which every minute counts. Moreover, integrating this method into emergency care protocols aligns with best practices for heat stroke management, ensuring patients receive the most effective treatment based on current evidence.

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