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DANGERS OF PREHOSPITAL COOLING: A CASE REPORT OF AFTERDROP IN A PATIENT WITH EXERTIONAL HEAT STROKE

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☐ **Abstract—Background: Exertional heat stroke is a potentially life-threatening disease with varying clinical presentations and severity. Given the severe morbidity that can accompany the disease, the immediate management often begins in the prehospital setting. It is important to have not only a comprehensive understanding of the prehospital cooling methods in addition to hospital management strategies, but an understanding of their potential complications as well. Case Report: A 32-year-old male presented to a San Antonio hospital in March 2014 with progressive confusion, nausea, nonbloody emesis, and ataxia. Initial presentation was concerning for exertional heat stroke, as the patient was recorded in the field to have a temperature of 42.1°C (106.2°F). The patient, on arrival to the emergency department, was found to have a core body temperature of 38.1°C (100.6°F). All active cooling measures were terminated and active rewarming was initiated. Despite adequate resuscitation and rapid identification of the patient's overcorrection in core body temperature, the lowest recorded temperature was 36.0°C (96.8°F). *Why Should an Emergency Physician Be Aware of This*? This case represents the dangers associated with exertional heat stroke, overcorrection of core body temperature, and the potentially lethal complication of afterdrop. It also represents the need for immediate recognition of the condition and initiation of appropriate medical care. Although this patient's clinical outcome was good, the event could have caused serious morbidity or could have potentially been fatal. © 2015 Elsevier Inc.**

☐ **Keywords—exertional heat stroke; exertion heat illness; afterdrop; cooling; multiorgan failure; core body temperature; thermoregulation**

INTRODUCTION

Exertional heat illness (EHI) and the more severe form of exertional heat stroke (EHS), are emergency medical condition with potentially life-threatening complications. Despite significant increases in public awareness and education, EHI continues to remain a significant danger to individuals who participate in strenuous physical activity. Many complications of EHS necessitate rapid cooling measures, which are commonly initiated in the field with limited thermoregulatory monitoring capability. As a result, overzealous corrections of core body temperature can occur before arrival in the emergency department. An overview of the thermoregulatory process, prehospital cooling methods, and management, as well as hospital management, is provided here.

CASE REPORT

A 32-year-old male with unknown medical history was transferred to a large academic teaching hospital via emergency medical services (EMS) after developing progressive confusion, nausea, nonbloody emesis, and ataxia

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during a 17 km (10.56 mile) march. EMS personnel obtained vitals signs rapidly and the patient was found to have an oral temperature of 42.1°C (106.2°F) and a rectal temperature of 42.27°C (108.1°F). All equipment and excess clothing were removed in the field and the patient's axillae and groin were packed with ice. The patient was transported to the closest hospital, however, given the remote location of the medical emergency, approximately 34 min elapsed before arrival in the emergency department. Supplemental oxygen and two large-bore peripheral IV catheters were placed en route and the patient was given 1 L of room temperature normal saline before arrival.

On arrival to the emergency department, the patient was placed on continuous hemodynamic monitoring and a rapid examination of the patient's airway, breathing, and circulation was performed. A continuous rectal thermistor was obtained and the patient was found to have a core body temperature of 38.1°C (100.6°F). All active cooling measures were terminated and the patient was dried and a forced-air warming blanket (Bair Hugger; 3M, St Paul MN) was applied. The patient's volume status was assessed by ultrasound (inferior vena cava collapse with inspiration >50% diameter) and appropriate fluid resuscitation was undertaken with warmed normal saline (43.0°C or 109.4°F). An initial chest x-ray study, electrocardiogram, and laboratory testing, including a comprehensive metabolic panel, complete blood count, urinalysis, creatinine kinase, and coagulation panel, were obtained. Continuous core body temperature measurements were obtained during the course of the emergency department stay, with the lowest recorded at 36.0°C (96.8°F).

DISCUSSION

Core body temperature is maintained by a delicate balancing act between the body's heat load, a combination of metabolism and environmental factors, and ability to dissipate the acquired heat load (1). As the core temperature rises, the anterior hypothalamus increases stimulation to the autonomic nervous system, with subsequent increases in perspiration and cutaneous vasodilatation. These alterations in perspiration and vasodilatation effectively increase the body's capability for evaporative cooling, which is the primary mechanism by which humans dissipate heat to the environment. Additional methods of cooling, such as radiation (emission of electromagnetic waves), convection (heat transfer via liquid or gas medium), and conduction (direct heat transfer), cannot occur when environmental temperature is greater than skin temperature (37.0°C or 98.6°F) (2).

Exertional heat stroke is defined as a combination of core temperature >40.0°C (104.0°F) and central nervous system (CNS) dysfunction. CNS dysfunction can present as a myriad of symptoms, such as headache, confusion, lethargy, irritation, disorientation, loss or altered level of consciousness, and even seizure. A direct correlation between the morbidity and mortality due to EHS can be seen with any delay in cooling if the core body temperature is elevated >40.5°C (105.0°F) (3).

Limited high-quality research (i.e., randomized controlled studies) is available for evaluation of the best method for achieving rapid cooling of patients with EHI and the more severe form of EHS. The most current data suggest that cold-water immersion is currently the most effective method available (4–7). In addition, cold-water immersion is a technique that is easily applied in a hospital setting with limited resources, or with limited technical experience with newer interventions, such as IV cooling (8). At the time of this writing, there are no published trials on primary IV cooling vs. cold-water immersion in the setting of EHI or EHS.

Often, management with cold-water immersion is not feasible and alternatives should be used without delay. Contraindications to immersion include aggressive medical intervention (e.g., compromised airway, seizure), suspicion of impending medical complication, and aggressive hemodynamic monitoring. A reasonable alternative to ice-water immersion is undressing the patient and applying ice packs to the neck, axillae, and inguinal regions, while simultaneously spraying tepid water over the patient's body and using fans to blow air over the moist skin. Water should be continually reapplied as needed and fanning performed continuously. In the prehospital setting with limited or absent core body temperature measurement capability, it is acceptable to cool until the patient begins to shiver. Alternatively, one can treat with cold-water immersion for 15 min; both provide reasonable clinical endpoints to help guide medical management. These approaches to EHI and EHS assume that the majority of symptomatic patients will have a core body temperature between 41.0°C and 43.5°C (106.0°F to 110.0°F) at initial presentation. Treatment with cold-water immersion therapy assumes a reduction in core body temperature by 1°C every 5 min or 1°F every 3 min (9–11).

Once the patient arrives in the hospital setting, the initial management begins with careful examination of the patient's airway, breathing, and circulation, as well as continuous reassessment during resuscitation. If cold-water immersion or reasonable alternatives have been initiated in the prehospital setting, but have been unable to achieve appropriate reduction in core body temperature (goal core body temperature 38.9°C or 102.0°F), then appropriate cooling measures should be continued (12). A continuous rectal thermistor should be used, as it provides superior information with regard to the delta