Exertional Heat Stroke in a Male High School Runner with Disordered Eating: A Disablement Model Case Study

Brittni G. Hoover, MS, LAT, ATC*; Rebecca M. Hirschhorn, PhD, ATC, NRAEMT†; Allison B. Smith, PhD, LAT, ATC‡; Amy F. Hand, PhD, SCAT, ATC**
*University of North Carolina at Charlotte, Charlotte, NC; †Louisiana State University, Baton Rouge, LA; ‡University of Louisiana at Lafayette, Lafayette, LA; ** University of South Carolina, Columbia, SC

ABSTRACT

A 16-year-old male high school cross country athlete collapsed at the end of an afternoon 5K cross country meet. The patient was unable to stand, and after outwardly displaying confusion and agitation, his coaches sought assistance from the athletic trainers (ATs). The patient consumed one cup of water and a granola bar on the day of the meet. The ambient air temperature was 90°F with 69% humidity. Differential diagnoses included exertional heat stroke (EHS), exertional heat exhaustion, exertional collapse associated with sickle cell trait, heat syncope, dehydration, malnutrition, and hypoglycemia. Approximately 20 minutes passed between activation of the emergency action plan (EAP), initial collapse, and cold-water immersion. Assessment of rectal temperature did not occur until after submersion due to waiting for parental consent. The patient was removed from the water after 12 minutes with a rectal temperature of 100.5°F. He was transported to the hospital, received 2 liters of intravenous normal saline among multiple other tests, with no significant findings, and was released approximately 9 hours later. It was later learned that the athlete dealt with disordered eating. The patient was asked to complete a seven-day food and drink log and was provided nutrition guidance by the ATs. This patient's disordered eating habits could have contributed to the development of EHS. The ATs were unaware of his eating patterns until after the EHS event. Athletes need to be educated on how to properly fuel themselves for athletic competition in anticipation of adverse environmental conditions. If a patient is already prone to disordered eating, this individual will not have the proper intake of nutrients to sustain athletic competition, nor to sustain everyday living. Athletic trainers should be aware of all potential medical concerns in their patients, including those not often discussed, to accurately diagnose conditions and avoid any potential sequelae.

Correspondence
Brittni G. Hoover, 1300 Wheat Street, Columbia, SC 29208.
E-mail: bghoover@email.sc.edu
Twitter: @BrittHoover2

Full Citation
Hoover BG, Hirschhorn RM, Smith AB, Hand AF. Exertional heat stroke in a male high school runner with disordered eating: A disablement model case study. *Clin Pract Athl Train.* 2022;5(2): 45-51. https://doi.org/10.31622/2022/0005.02.8.

Submitted: May 4, 2021 **Accepted**: July 26, 2021.

INTRODUCTION

Exertional heat stroke (EHS) is the most severe exertional heat illness (EHI) characterized by a core body temperature exceeding 105°F, the presence of central nervous system (CNS) dysfunction, and multiple organ system failure.[1-5] When the metabolic heat produced by muscle during activity outpaces body heat transfer to the surroundings, the core temperature rises to levels that disrupt organ function, unless correctly recognized and treated in a timely manner.[2,5] Care should begin within 30 minutes of initial collapse to include cooling from the neck down.[6] Relevant to this case study, high school boys' cross country has been found to have an EHI incidence rate at 0.52 per 10,000 athlete-exposures per cross country season, during competition, and 0.50 per 10,000 athlete-exposures in practice, the second-highest EHI rate following boys' American football.[8] Exertional heat stroke is one of the leading causes of sudden death during activity.[1,2]

Risk factors for EHS include lack of heat acclimatization, cardiovascular dysfunction, fever, illness, dehydration, and hypokalemia, among others.[2] Some of these factors can also be directly associated with eating disorders.[5] Eating disorders can be determined by using questionnaires such as the Eating Disorder Examination (EDE). This questionnaire includes questions related to eating disorder (ED) risk. These questions are specific to sport and are related to being diagnosed.[6] If an individual is not consuming enough nutrients, it can result in low energy availability, health risks, and ultimately affects bone mineral density.[5] Disordered

eating behaviors are similar to eating disorders, but they do not meet the criteria for diagnosis.[7] Relevant risk factors pertaining to this case include that the patient struggled with disordered eating (DE).[7] If not addressed appropriately or in a timely manner, DE can result in physiological and psychological effects. Some of these include inadequate energy availability, decreased bone mineral density, and for females specifically, menstrual disorders and the female athlete triad.[6] In athletes who completed the EDE-12 questionnaire, body dissatisfaction, drive for thinness, and body mass index were found to contribute to their DE habits.[8] In males specifically, body dissatisfaction has been found to be linked to muscularity and weight concerns.[6] In this case, the patient's family was previously aware of his nutritional habits; however, the ATs at his school were not.

PATIENT INFORMATION

The patient in this case study is a 16-year-old male high school cross country athlete that collapsed at the conclusion of an afternoon 5K cross country meet. At the time of the incident, the patient was in the 11th grade and had been participating on the cross-country team since middle school. There was no documented family history of heart disease, diabetes, ED, or mental health disorders. He had no previous history of ED, injury, or other illness. On the day of the meet, which started at 4 pm, the patient had only consumed one cup of water and one granola bar. At the time of the collapse, the ambient air temperature was 90°F with 69% humidity, which is in the dangerous percentile and increases the risk of EHI.[9] These measures were not determined until after the collapse occurred.

Differential Diagnosis and Evaluation

The differential diagnoses were EHS, exertional heat exhaustion, exertional collapse associated with sickle cell trait, heat syncope, dehydration, malnutrition, and hypoglycemia.[2] When the patient first collapsed at the finish line, the ATs decided for the patient to drink water and sit down since he was conscious, alert, and oriented. Due to the patient's fatigue, he was assisted to the team tent by his coaches and teammates. The patient's presentation drastically changed after arrival at the team tent, which is when the coaches called the ATs for assistance. The most notable changes included signs of CNS dysfunction (confusion, inability to form speech, unaware of date, place, time, personality change/aggression), feeling of extreme overheating of the body that could not be cooled with water, and extreme fatigue (inability to walk or stand). The patient was transported from the team tent to the athletic training facility where cold water immersion and a rectal thermometer were available. At this time, emergency medical services were called. Since the patient was a minor, the AT's policy was to get parental consent prior to the use of rectal thermometry and immediately initiated cold water immersion. The patient's parents were not at the race and were called to receive permission to utilize the device. After the patient was immersed for 12 minutes and showed obvious signs of improved CNS function, the ATs removed him from the cold-water immersion tub and assessed his rectal temperature after receiving parental consent. At this time, his rectal temperature was 100.5°F, and it was determined that the patient was now able to be safely transported. Emergency medical services then transported him to the hospital, where he received further evaluation and care.

Body Structure and Function

The body function most affected was his CNS, as shown through his delirium. When talking to the patient after the event, he recalls that he felt an out-of-body experience. The patient expressed that he knew something was wrong, but he did not know what was going on. The best practice, or gold standard, of immediate treatment for EHS is the assessment of rectal temperature and cold-water immersion.[1,3]

 ISSN Online 2577-8188

Activity and Participation

At nine months since the event, there are no documented long-term negative effects on the patient's health as a result of his EHS event. The incident made the ATs aware of the patient's DE behaviors. Additionally, the patient expressed that it made him realize the drastic effects that his DE can have on his body, and he began to change his eating habits. This event shows clinicians that DE presents in males as well as females. He has worked with his parents to improve his DE. The patient took time off from running to help his body heal. It is important to note that DE is not an overnight fix and takes months and sometimes years to get to a healthy place.

Environmental and Personal Factors

The patient expressed that the nature of the sport of cross country and associated physical appearance standards, the overwhelming media push to "look skinny," and the myth shared throughout his high school that you should not eat too much as an athlete, were all factors that led up to his DE. He shared that his teammates' support had a huge hand in the difference between him having a successful and unsuccessful recovery. Parental involvement was a key factor in his recovery process, as well, due to their constant support without judgment. This patient, in particular, expressed that the encouragement that he received from his teammates and family is what helped him face his DE and get on a path to recovery and healing.

INTERVENTIONS

Due to the patient's personality changes and aggressive behavior, indicative of CNS dysfunction, the ATs initiated the emergency action plan, which was to call emergency medical services and immerse the patient in cold water. The cold tub was not located at the cross-country course, and the patient had to be transported to the athletic training facility for cold-water immersion, resulting in approximately 20 minutes passing between initial collapse and cold-water immersion. The patient had partial consciousness and was unaware of the events happening during the cold-water immersion. After 12 minutes of cold-water immersion, the patient's cognitive function improved, so he was removed from the water, and his rectal temperature was assessed. At that time, his core temperature (100.5°F) was determined to be safe for transportation by emergency medical services, who arrived shortly after his immersion. At the hospital, he received two liters of intravenous normal saline and was administered multiple tests, including an electrocardiogram and blood panel, with no significant findings. He was released approximately 9 hours after arriving at the emergency department following the resolution of symptoms.

The patient followed up with his AT the following day, who had since been informed of possible DE by a concerned peer. The patient was asked to complete a 7-day food and drink log and was provided nutrition guidance where he logged everything he ate and drank each day. In the mornings, he reported to the athletic training facility prior to school to review what he ate prior to practice the night before and to report his breakfast intake prior to school for the day. He also reported to the athletic training facility at the end of each day, where the log was reviewed. If he did not consume adequate calories based on the recommended daily intake values, he was not permitted to practice.[10,11] On the days that he was not in school, he contacted the head AT to report his documented intake electronically.

OUTCOMES

The only quantitative data, or validated outcome measures that were taken, were taken during the initial incidence. Based upon conversation, his body has returned to normal function, and he is now able to

participate in full activity. In addition to completing the 7-day food log and daily check-ins with the AT, the patient's return to play included an evaluation of the nutrients that he took in every day and if that fulfilled his requirements to participate in sport. If he did not meet this threshold, he was not allowed to practice that day. His running mileage was also greatly lowered. He began his return to play with biking and walking in the athletic training facility, to progressing to walking with a friend and a mile of light running. After 7 days, he had built up enough nutrient intake as well as mileage increase to return to full practice. Due to concerns over the patient running alone, it was decided to have a friend run with the patient during his return-to-play in case another situation occurred while they were out on the course. The patient has continued to address his DE behavior, but the family has kept the continued process personal.

DISCUSSION

Certain aspects of this case that are important to note, such as the delay in assessing rectal temperature to confirm an EHS diagnosis, wet-bulb globe temperature (WBGT), which had not been used prior to or during the event, and the lack of immediate on-site access to cold water immersion. Rectal thermometry is the gold standard of care to assess core body temperature during a heat illness event.[9,11-14] Methods such as oral or temporal temperature assessment are inaccurate.[15] However, recent literature still demonstrates that most secondary school ATs do not assess a rectal temperature during suspected cases of EHS.[9,11-14] Less than half of surveyed ATs reported that they were comfortable using a rectal thermometer to assess for EHS.[15] In this situation, the ATs wanted to protect themselves in case the parents did not give consent. However, rectal thermometry is the standard of care for athletic training for heat-related illness emergencies, as stated by the NATA,[2] and therefore, it is the required practice of care, regardless of parental consent or the patient being a minor.[1,2] Barriers to implementing the use of rectal thermometers have been found to be lack of training with equipment, misunderstandings of use and cost, and the possibility of legal issues.[16] There are also extrinsic factors that negatively impact ATs use of rectal thermometry. For example, in some cases, school administrators may express concerns with the use of rectal thermometry on minors. This has especially been noted by ATs that work in private school settings.[4] Recommendations to overcome these barriers include proper education of these devices explaining the importance of understanding the efficacy of the temperature measurement compared to other tools.[17] Ultimately, it is the AT's responsibility to ensure meetings with administrators are held prior to such events so that all individuals are on the same page when it comes to emergency action plans and protocols. In this case, the ATs had not gotten prior permission from the parents to utilize this standard of care. This should be explained to parents prior to sport participation, and a form signed that gives the ATs the right to care for their student-athletes using rectal temperature if the parents are not present at the time of the incident.[2] There is a heat stroke treatment authorization form that is created by the NATA that clearly lists out the proper evidence and the definitions of the AT's scope of practice that parents and guardians can sign at the beginning of every season.[18]

The day of the patient's EHS event was one of the hottest days within the first few weeks of the cross-country season. The team was only a few weeks into regulated practices and had not gone through a low to high increase in practice mileage/intensity or regulated acclimatization period during those weeks, nor did they have any regulated summer practices. This day, in particular, was too hot for participation in sports (90°F and 69% humidity) based on the ambient temperature and relative humidity.[3] According to the heat stress risk temperature and humidity graph,[19] if the relative humidity is between 50-60% ambient temperature should not exceed 86-90°F for safe sport participation.[16] However, there were no modifications to the competition based on the extreme environmental conditions. Ideally, a WBGT device should have been utilized, and the event delayed or postponed until the conditions were more favorable; however, a WBGT reading was not utilized prior to that day's events.[3] WBGT is preferred to ambient temperature and radiant

heat alone due to differences in weather effects within various regions of the country.[2] WBGT is calculated by completing a mathematical equation including wet-bulb temperature, black-globe temperature, and dry-bulb temperature.[2] Lastly, the facilities where the cold tub was located, were a 5 to 8-minute walk from the finish line and team tents. Precious time was lost during the commute from the team's tents to the place where the cold tub was utilized. Since the patient was being carried, this also added to the time that he could have been in the cold tub. Rectal thermometry and cold-water immersion were utilized within the 30-minute recommendation after the start of treatment, supported by the NATA position statement for standard of care for EHS.[2,19]

CLINICAL BOTTOM LINE

It is important for ATs to ensure they are up to date on the standard of care that is expected of the profession. Emergency action plans for situations like this should be implemented and practiced prior to an event occurring. ATs should be in contact with emergency personnel to make sure that the standard of care is continued during and after transportation to a hospital. EHS can be avoided if prevention and recognition are practiced correctly. Individuals presenting with EHS must be cared for within a short amount of time to prevent serious injury or death. It is the AT's responsibility to ensure all important personnel are trained and ready for any emergencies that may occur.[2] With the proper training, pre-participation examinations, and weather precautions in place, EHS can be avoided and potentially completely prevented.

This case is important due to the rise of EHS in both the high school and college athlete populations.[10] Rectal thermometry has been the gold standard of practice since 2002, yet many ATs still do not feel comfortable performing it if they did not learn this in their schooling.[1,12] Since this information was published 18 years ago, this standard of care should be fully accepted and administered across the athletic training world. Athletic trainers are responsible for learning and implementing new athletic training competencies into their practice, even after obtaining their initial certification.[20] State, regional, and national conferences should provide opportunities for ATs to learn and practice these skills to help facilitate implementation to practice.

ATs should be aware of other factors that could affect and increase risk of EHS. In this scenario, disordered eating was a factor that led to the patient's EHS. Other factors of this EHS event included lack of supplies, AT preparation, and difficulty accessing emergency equipment. It is important for athletes to have a basic understanding of proper nutrition guidelines for their sport participation and how environmental conditions may further compound.[8,21] Outdoor sport athletes need to be especially careful due to potential exposure to adverse environmental conditions.[4] It is suspected that the patient's DE had a key effect on his dehydration and lack of nutrients to be able to successfully compete in his race.

The authors recommend three important take-a-ways from the experience. One of the most important things that an AT can do with their staff is to review and practice their EAPs, annually.[2,4,5,16,19] This plan includes instructions on what to do in case of an emergency, and more specifically, a heat related illness event. Rectal thermometry should be available to all ATs at every level, even including secondary schools. [1,2,4,16,17] There are certain forms and parameters that can be navigated to gain permission from parents in regard to minors. ATs should consider screening athletes for nutritional concerns prior to sport participation through pre-participation exams (PPEs) and throughout the season utilizing validated risk assessments, such as the EDE-Q and EDE-12 questionnaires.[6,8] ATs should be aware of all potential medical concerns in their patients, identified through PPEs, to properly refer to physicians or specialists and diagnose conditions to avoid any potential sequelae. If ATs adopt the regular use of EAPs, rectal temperature, and PPEs in their practice,

 ISSN Online 2577-8188

incident rates of fatal heat related illnesses should drastically decrease due to the awareness gained through these three avenues.

REFERENCES

1. Miller KC, Hughes LE, Long BC, Adams WM, Casa DJ. Validity of core temperature measurements at 3 rectal depths during rest, exercise, cold-water immersion, and recovery. *J Athl Train*. 2017;52(4):332-338. https://doi.org/10.4085/1062-6050-52.2.10.
2. Casa DJ, DeMartini JK, Bergeron MF et al. National Athletic Trainers' Association position statement: exertional heat illnesses. *J Athl Train*. 2015;50(9):986–1000. https://doi.org/10.4085/1062-6050-50-9-07.
3. Casa DJ, Armstrong LE, Kenny GP, O'Connor FG, Huggins RA. Exertional heat stroke. *Curr Sports Med Rep*. 2012;11(3):115-123. https://doi.org/10.1249/jsr.0b013e31825615cc.
4. Adams WM, Hosokawa Y, Belval LN. Factors involved in the onsite management and care of exertional heat stroke in secondary school athletics. *Athl Train Sports Health Care*. 2019;11(5):206-209. https://doi.org/10.3928/19425864-20181010-01.
5. Armstrong LE, Casa DJ, Millard-Stafford M, Moran DS, Pyne SW, Roberts WO. Exertional heat illness during training and competition. *Med Sci Sports Exerc*. 2007;39(3):556-572. https://doi.org/10.1249/mss.0b013e31802fa199.
6. Martinsen M, Bahr R, Børresen R, Holme I, Pensgaard AM, Sundgot-Borgen J. Preventing eating disorders among young elite athletes. *Med Sci Sports Exerc*. 2014;46(3):435-447. https://doi.org/10.1249/mss.0b013e3182a702fc.
7. First MB. Diagnostic and statistical manual of mental disorders, 5th edition, and clinical utility. *J Nerv Ment Dis*. 2013;201(9):727-729. https://doi.org/10.1097/nmd.0b013e3182a2168a.
8. Raevuori A, Keski-Rahkonen A, Hoek HW. A review of eating disorders in males. *Curr Opin Psychiatry*. 2014;27(6):426-430. https://doi.org/10.1097/yco.0000000000000113.
9. Ganio MS, Brown CM, Casa DJ et al. Validity and reliability of devices that assess body temperature during indoor exercise in the heat. *J Athl Train*. 2009;44(2):124-135. https://doi.org/10.4085/1062-6050-44.2.124.
10. Kerr ZY, Yeargin SW, Hosokawa Y, Hirschhorn RM, Pierpoint LA, Casa DJ. The epidemiology and management of exertional heat illnesses in high school sports during the 2012/2013–2016/2017 academic years. *J Sport Rehabil*. 2020;29(3):332-338. https://doi.org/10.1123/jsr.2018-0364.
11. Nedimyer AK, Chandran A, Hirschhorn RM et al. Exertional heat-stroke management practices and intentions among secondary school football athletic trainers. *J Athl Train*. 2020;55(10):1081-1088. https://doi.org/10.4085/1062-6050-474-19.
12. Casa DJ, Becker SM, Ganio MS et al. Validity of devices that assess body temperature during outdoor exercise in the heat. *J Athl Train*. 2007;42(3):333-42.
13. Miller KC, Casa DJ, Adams WM et al. Roundtable on preseason heat safety in secondary school athletics: prehospital care of patients with exertional heat stroke. *J Athl Train*. 2021;56(4):372–382. https://doi.org/10.4085/1062-6050-0173.20.
14. Mazerolle SM, Scruggs IC, Casa DJ et al. Current knowledge, attitudes, and practices of certified athletic trainers regarding recognition and treatment of exertional heat stroke. *J Athl Train*. 2010;45(2):170-180. https://doi.org/10.4085/1062-6050-45.2.170.
15. McLean DR, Scarneo-Miller SE, Lopez RM. Perceptions of secondary school athletic trainers in the diagnosis of exertional heat stroke. *J Athl Train*. 2020;55(10):1070-1080. https://doi.org/10.4085/1062-6050-0247.19.
16. Casa DJ, Anderson S. NATA's heat-illness consensus statement. *Athl Ther Today*. 2003;8(5):35. https://doi.org/10.1123/att.8.5.35.
17. Mazerolle SM, Ganio MS, Casa DJ, Vingren J, Klau J. Is oral temperature an accurate measurement of deep body temperature? a systematic review. *J Athl Train*. 2011;46(5):566-573. https://doi.org/10.4085/1062-6050-46.5.566.

18. Kerr ZY, Casa DJ, Marshall SW, Comstock RD. Epidemiology of exertional heat illness among U.S. high school athletes. *Am J Prev Med*. 2013;44(1):8-14. https://doi.org/10.1016/j.amepre.2012.09.058.
19. Casa DJ. Almquist J, Anderson S. Inter-Association Task Force on exertional heat illnesses consensus statement. *NATA News*. June;2003:24–29.
20. Certification maintenance requirements for athletic trainers: reporting period ending December 31, 2021. Accessed July 20, 2021. https://online.flowpaper.com/7f6907b2/202021CertMaintenanceRequirements/#page=1.
21. Belval LN, Casa DJ, Adams WM et al. Consensus statement- prehospital care of exertional heat stroke. *Prehosp Emerg Care*. 2018;22(3):392-397. https://doi.org/10.1080/10903127.2017.1392666.