Heat related illnesses: Diagnosis and Treatment Update

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ARTICLE INFO

Keywords: Heat cramp, Heat exposure, Heat stroke, Heat syncope, Multiorgan dysfunction

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All authors have reviewed and approved the final version of the manuscript.

https://doi.org/10.59345/sjfm.v1i2.60

ABSTRACT

The probability and intensity of symptoms linked to severe temperatures are contingent upon physiological and environmental factors. Environmental risk factors encompass fluctuations in weather conditions, insufficient attire or shelter (such as homelessness or homes lacking proper temperature regulation), and exposure in occupational or recreational settings. This review aimed to describe diagnosis and treatment update of heat related illnesses. Heat-related illnesses are commonly seen as environmental emergencies in emergency departments. The thermal energy accumulated in the body is influenced by internal metabolic processes and external factors such as temperature and humidity. Hyperthermia occurs when the body is unable to regulate its internal temperature and loses heat. Heat cramps refer to the occurrence of painful contractions and strong spasms in the skeletal muscles, which typically happen during or right after physical activity. The symptoms and clinical findings of heat exhaustion include a slightly elevated core body temperature that is still below 40°C, a rapid heartbeat, and damp skin. Brain dysfunction is a characteristic feature of heat stroke, occurring when the core body temperature exceeds 40°C. High mortality rates resulting from heat stroke are most commonly caused by multiorgan dysfunction. Patients are also at risk of experiencing rhabdomyolysis, ARDS, and inflammation even after their body temperature returns to normal. Optimal therapy for heat-related disease involves promptly identifying the condition, initiating immediate cooling measures, and preventing shivering during the cooling process.

1. Introduction

The human body regulates its temperature by maintaining an equilibrium between internal heat generation and external heat dissipation. The body and the environment engage in heat exchange through four fundamental mechanisms: radiation, evaporation, conduction, and convection. During periods of extreme temperatures, the body’s ability to regulate its temperature can malfunction, causing the core body temperature to approach the temperature of the surrounding environment. Exposure to extreme temperatures can lead to a range of conditions, ranging from moderate to potentially life-threatening and even fatal. Adequate education and strategic planning can avert a significant number of these conditions. Preventive actions should be enforced at both the individual and population levels.1-3

The probability and intensity of symptoms linked to severe temperatures are contingent upon physiological and environmental factors. Physiological risk factors include getting older, having cognitive problems, being physically weak, not being active or being sedentary, not being able to adapt to changes in temperature, being hurt at the same time, having been hurt at the same time last year, and
having a number of underlying medical conditions, especially those that affect cognition and thermoregulation. Pharmacological risk factors include the use of medications, holistic or alternative medicine, illicit drugs, tobacco, and alcohol. Some drugs, like peripheral vasoconstrictors or vasodilators, can make temperature-related diseases worse. These include drugs that change the central nervous system, sweating, and blood flow to the skin. Environmental risk factors encompass fluctuations in weather conditions, insufficient attire or shelter (such as homelessness or homes lacking proper temperature regulation), and exposure in occupational or recreational settings. This review aimed to describe diagnosis and treatment update of heat related illnesses.

**Heat-related illnesses**

Heat-related illnesses are commonly seen as environmental emergencies in emergency departments. The thermal energy accumulated in the body is influenced by internal metabolic processes and external factors such as temperature and humidity. Hyperthermia occurs when the body is unable to regulate its internal temperature and loses heat. Hyperthermia occurs when the body’s ability to get rid of heat or the generation of heat is disrupted, leading to an unusually high body temperature. Elevating the metabolic rate is the primary determinant of raising body temperature. The main mechanisms of heat dissipation include perspiration and peripheral vasodilation. The effectiveness of heat transfer from the skin to the surrounding air through convection or conduction decreases as the ambient temperature rises, particularly at 37.2 °C (the temperature at which heat transfer changes direction). Under typical conditions, around 20% of body heat loss is attributed to evaporation. However, at elevated temperatures, evaporation becomes the primary mechanism for dissipating heat. The efficacy of this mechanism diminishes with increasing humidity.

Heat stress can arise from the confluence of ambient heat and metabolic processes. Climate change might greatly enhance the likelihood of heat-related ailments. Various degrees of heat stress exist, which can be avoided, ranging from mild manifestations like hot cramps to more serious manifestations like heat stroke. Contributing factors encompass extended periods of physical exercise, high temperatures, insufficient adaptation, and a lack of hydration. Other risk factors include dermatological disorders or other medical conditions that impede perspiration or evaporation, obesity, prolonged seizures, hypotension, decreased blood flow to the skin, decreased cardiac output, the use of medications that enhance metabolism or muscle activity or disrupt sweating, and withdrawal. Illicit substances can induce heightened muscular activity, resulting in an elevated body temperature.

Classical heat-related sickness, which does not require physical exertion, can affect anyone in a hot and calm atmosphere. The severity of the illness is higher in those with the specified risk factors, even if they engage in minimum physical activity. Exercise-induced muscle cramps are painful involuntary spasms of the muscles that occur during or soon after physical activity. This condition is caused by dilutional hyponatremia, which occurs when lost sweat is replenished with water only. Heat exhaustion is defined by losing isotonic fluids, becoming dehydrated, or losing sodium. It is also linked to changes in the heart and lungs. This syndrome arises from prolonged and intense physical exertion in a hot climate without sufficient intake of water or salt.

A brief period of unconsciousness and then a spontaneous return to normal cognitive function are the hallmarks of heat syncope. This illness arises due to a decrease in blood volume and widening of blood vessels in the skin, leading to low blood pressure in the body and brain. Exercise-induced postural hypotension, which can occur either during or right after physical activity, is a common cause of heat syncope. Heat stroke is an intense type of heat-related sickness that causes brain malfunction when the body’s core temperature exceeds 40°C. It can manifest in either of two forms: classic or exertional. Classic heat stroke, which is not caused by physical activity, typically affects those with compromised
thermoregulatory functions or those exposed to severe climatic circumstances. Heat stroke during physical exertion can affect those who engage in intense activities in hot or humid conditions. The individuals who face the highest risk are those who are advanced in age, experiencing chronic debilitation, and using medications that hinder the body's ability to dissipate heat.\(^7\)\(^-\)\(^10\)

**Clinical finding**

In order to accurately diagnose and treat heat-related disorders, it is imperative to utilize an internal thermometer (such as rectal, Foley, or esophageal), as the temperature of the skin may not provide an accurate indication of the body's core temperature. Heat cramps refer to the occurrence of painful contractions and strong spasms in the skeletal muscles, which typically happen during or right after physical activity. The examination findings usually consist of stable vital signs, with the core body temperature being within the normal range or slightly increased. The skin is often damp and chilly, while the muscles are tender, rigid, lumpy, and painful and may exhibit twitching. The diagnosis is determined through clinical examination.\(^11\)\(^,\)\(^12\)

The symptoms and clinical findings of heat exhaustion include a slightly elevated core body temperature that is still below 40°C, a rapid heartbeat, and damp skin. The symptoms bear a resemblance to those of heat cramps and heat syncope. Other symptoms present are nausea, vomiting, general discomfort, muscle pain, excessive breathing, thirst, and a lack of strength. Common symptoms of the central nervous system include headaches, dizziness, exhaustion, anxiety, paresthesia (abnormal sensations like tingling or numbness), impaired judgment, and even psychosis (loss of contact with reality). If sweating ceases and the mental condition deteriorates, heat exhaustion can escalate into heat stroke.\(^9\)\(^,\)\(^10\)

Heat syncope typically manifests after episodes of intense physical exertion or prolonged standing in a hot and humid environment, often resulting in rapid loss of consciousness. A physical examination may indicate the presence of hypothermic skin, a feeble pulse, and reduced systolic blood pressure.

A heat stroke is a potentially fatal medical emergency. Brain dysfunction is a characteristic feature of heat stroke, occurring when the core body temperature exceeds 40°C. The symptoms encompass all the manifestations observed in heat exhaustion, accompanied by additional neurological symptoms including dizziness, weakness, emotional instability, disorientation, delirium, blurred vision, seizures, loss of consciousness, and syncope. The physical examination findings may exhibit variability, rendering them untrustworthy. Heat stroke after physical exertion may manifest as abrupt collapse and unconsciousness, subsequently accompanied by illogical conduct. An absence of perspiration may occur. Medical professionals must be diligent in observing and assessing for kidney damage, liver malfunction, metabolic abnormalities, breathing problems, blood clotting disorders, and reduced blood flow, as the initial test results may not provide precise indications.\(^11\)\(^,\)\(^12\)

**Therapy**

**Heat cramp, exhaustion, and syncope**

Transfer the patient to a cool, shaded area and provide them with oral isotonic or hypertonic rehydration solutions to replenish electrolytes and water. Oral salt pill administration is discouraged. Instruct patients to engage in a minimum of 2 days of rest while maintaining their intake of dietary supplements before resuming work or engaging in strenuous physical activity in hot weather.\(^13\)

**Heat stroke**

Firstly, it is important to prioritize and stabilize the patient's airway, breathing, and circulation (ABCs). Subsequently, the therapy should focus on promptly reducing the core body temperature within one hour while also providing support for circulation and perfusion. The patient should be monitored with a pulse oximeter and heart monitor while also regularly assessing core body temperature, fluid intake, and fluid output. Patients should be watched out for complications like low blood pressure or
cardiogenic shock, metabolic problems, heart rhythm problems, coagulopathy, acute respiratory distress syndrome, low blood sugar, rhabdomyolysis, seizures, organ failure, infections, and severe swelling that can lead to compartment syndrome.\textsuperscript{12,14}

The main cause of circulatory failure in heat-related diseases is mostly shock resulting from either relative or absolute hypovolemia. To guarantee sufficient urine production, it is necessary to administer fluids either orally or intravenously. Physicians must also evaluate and manage concurrent illnesses such as infection, trauma, and medicine side effects. The selection of the cooling technology is contingent upon its expeditious implementation while minimizing any detrimental impact on the overall provision of patient care. Evaporative cooling is the preferred method for treating non-exertional heat stroke, while conductive-based cooling is preferred for exertional heat stroke. Evaporative cooling is a non-invasive, efficient, rapid, and straightforward method for reducing temperatures. This procedure involves positioning the undressed patient in a lateral or elevated position on the hands and knees to expose the largest possible area of skin to air. The entire undressed body is then subjected to warm water (20°C) and cooled down using a large circulating fan that blows room air. Supplementing with cool air or breathed oxygen can assist in lowering temperature, but it should not be relied upon as the sole method. Conductive cooling methods include the injection of cold fluids, lavage of the stomach or bladder, application of ice packs, and immersion in ice or cold water. When ice water or cold water immersion is accessible in the field, it is the recommended method for cooling in cases of on-the-job heat stroke. Ice packs are most efficacious when applied to the whole body, as opposed to conventional treatments that simply target the armpits and groin. Successful methods for decreasing core body temperature include the use of intravascular heat exchange catheter devices and hemodialysis with cold dialysate (30-35°C). Avoid shivering, as it hampers the efficiency of cooling by promoting internal heat generation. Medications such as magnesium, fast-acting opioid analgesics, benzodiazepines, and fast-acting anesthetic drugs can be employed to inhibit shivering. Engaging in skin massage is advised as a means to avoid the narrowing of blood vessels in the skin, known as skin vasoconstriction. Antipyretics like aspirin and acetaminophen do not have any impact on hyperthermia caused by environmental factors and should not be used. The treatment should be maintained until the core body temperature reaches 39°C.\textsuperscript{13-15}

**Prevention**

Education is essential for enhancing the prevention and early detection of heat-related diseases. People can mitigate personal risk factors and progressively adapt to hot conditions. To prevent occupational heat-related illnesses, it is important to implement a thorough preventative program that evaluates individual risk factors, estimated wet bulb temperature, workload, acclimatization status, and early symptom recognition.\textsuperscript{9}

It is important to provide education to coaches, athletic trainers, athletes, and parents of young athletes regarding heat-related illnesses, with a particular focus on prevention, dangers, symptoms and indicators, and treatment. Medical assessment and surveillance should be employed to identify individuals and climatic situations that heighten the vulnerability to heat-related diseases. Individuals engaging in physical exertion in hot surroundings should augment their fluid intake prior to, during, and subsequent to their physical activity. Optimal fluid intake should consist of a harmonious combination of electrolytes and water. Excessive water intake can lead to electrolyte abnormalities, particularly hyponatremia. Administering salt tablets is not advisable due to the potential danger of hypertonic hypernatremia. It is advisable to closely monitor the intake of fluids and electrolytes and promptly intervene in situations that involve physical exertion or activity in a hot environment.\textsuperscript{10,11}

**Prognosis**

High mortality rates resulting from heat stroke are most commonly caused by multiorgan dysfunction.
Patients are also at risk of experiencing rhabdomyolysis, ARDS, and inflammation even after their body temperature returns to normal. After a heat stroke, direct exposure to heat should be avoided.\(^{10}\)

**Indications for referral**

Possible interdisciplinary consultations to consider involve a surgeon for suspected compartment syndrome, a nephrologist for renal injury, and a transplant surgeon for fulminant liver failure. It is imperative to admit all individuals suspected of having a heat stroke to a hospital equipped with intensive care facilities to ensure meticulous monitoring.\(^ {11,12}\)

2. **Conclusion**

The range of heat-related disorders that can be avoided includes heat cramps, heat exhaustion, heat syncope, and heat stroke. Optimal therapy for heat-related disease involves promptly identifying the condition, initiating immediate cooling measures, and preventing shivering during the cooling process. Any delays in cooling can lead to increased morbidity and death among individuals suffering from heat stroke.

3. **References**