Short Communication GMSMJ Greater Mekong Subregion Medical Journal

The Holistic Care for Heat Exhaustion Patients Associated with Excessive Body Mass Index: A Case Study

Charnwit Panthong, M.D.[1]

[1]Department of Family Medicine, Police General Hospital, Bangkok 10330, Thailand

Received 2 May 2024 • Revised 10 September 2024 • Accepted 20 September 2024 • Published online 1 January 2025

Abstract:

The world today is being greatly impacted by global climate change and warming. Extremely hot weather usually occurs in Asia during the summer months of April and May and is associated with high humidity. People who may be at risk from these conditions include occupations that require working outdoors, such as military and police occupations that require training in the sun and other occupations such as street sweepers and first responders. For factory workers who must work outdoors, heat exhaustion is a condition that is second only to heat stroke, which can be differentially diagnosed by the neurological symptoms and a core body temperature of more than 40^0C. However, if the person who provides initial aid does not think about heat exhaustion and does not provide the correct first aid the condition may increase in severity and become heat stroke, which can be life-threatening. Heat exhaustion is caused by a loss of body water and minerals. If the person is unable to cool down quickly this allows the heat to affect the brain and muscular function, leading to heat stroke. This leads to muscle breakdown (rhabdomyolysis) causing acute kidney injury and hyperkalemia. Severe cardiac arrhythmias can cause sudden death. Patients may have symptoms of vomiting, headache, dizziness, gasping for breath, shortness of breath from the various internal organ dysfunctions.

Keywords: Heat exhaustion, Excessive Body Mass Index

Introduction

Conditions of heat illness (heat-related illness) is a result of the body being unable to dissipate heat in good time. This causes more and more heat to accumulate in the body, resulting in the body's systems functioning abnormally, from the cellular level to various body systems, resulting in various organ systems failing.[1,2] Heat-related illness can be divided into three levels of severity:

1) Heating edema, which is the first sign of heat illness, the patients will experience swelling in the hands and feet. They can notice the tightness of wearing rings or shoes. It usually occurs in the first few days as a warning sign of the body. This

Corresponding author: Charnwit Panthong, M.D.
Department of Family Medicine, Police General Hospital Hospital, Bangkok 10330, Thailand
E-mail: pro_ple030@hotmail.com
GMSMJ 2025; 5 (1): 35-39

illness is caused by the dilation of blood vessels in the skin and fluid retention. Many patients may have painful muscle cramps or spasms in the abdomen, arms, or legs.

2) Heat exhaustion can include excessive sweating, clammy skin, a fever of over 38^{0}C (100.4^{0}F), dizziness, headaches, nausea, and a fast, weak pulse. Heat exhaustion can escalate to heat stroke if left untreated. Heat exhaustion is clinically similar to heat stroke, except heat exhaustion patients will have stable consciousness.

3) Heat stroke, is the most serious heat-related illness and requires immediate medical attention. Symptoms include a high body temperature of 39.4^{0}C (103°F) or higher, warm and dry skin, irritability, confusion, headaches, dizziness, staggering, slurred speech, agitation, nausea, vomiting, and a rapid heart rate along with symptoms from abnormal functioning of many organs such as muscular, digestive or circulatory system.[1,3,4] Seizures and loss of consciousness are possible. There are several risk factors for the development of heat stroke, including young age or the elderly, congenital heart disease, lung disease, obesity, and high body mass index or sedentary lifestyle, as well as being not used to hot weather. Certain medications such as diuretics, vasoconstrictors, antihypertensive drugs, (beta-blockers) and psychiatric drugs (antidepressants, antipsychotics and psychostimulants) including amphetamines and cocaine, also predispose to the likelihood of these conditions.

Management

The pathophysiology of heat-related illness occurs when the body is exposed to a sudden increase in temperature, such as in the case of working outdoor in extremely hot weather and high humidity. or during the extreme period of heat wave. The body is unable to adjust to the condition in time, causing heat exhaustion. If the patients receive initial treatment by rest, fluids and mineral supplement, such as ORS (oral rehydration salt), these measures can prevent the development of heat stroke which can be life-threatening. In cases of neurological symptoms such as confusion, seizures, or unconsciousness,[5] heat stroke is the most likely diagnosis. Immediate management is mandatory. Patients should be moved into the shade where the temperature is lower. The patient should be allowed to lie down with both feet elevated. The next step is to lower body temperature by using a cloth moistened with normal temperature water, wiping the body if the symptoms are mild. Be careful when drinking water without mineral salts, because this can cause water intoxication. Patients may experience dizziness or headache from the suddenly decreased concentration of extracellular mineral salts, while the intracellular levels are still concentrated. By osmosis this causes more water to permeate into the cells. Brain cells, in particular, will consequently become swollen (brain edema). To facilitate and increase blood flow back to the heart, patients should be allowed to lie with their feet elevated and their head lower than their body. In cases with muscle cramps, the patients should be placed in a cool place. and drink enough water and apply gentle heat compresses. Massage and stretching of muscles is also helpful.

When the patient is fully conscious, he should drink plenty of water (to 1 liter of drinking water add 1 teaspoon of table salt) to compensate for the salt lost from the body. If the patient is admitted to the hospital, blood electrolytes should be checked. Giving normal saline or 5% dextrose in normal saline intravenously can help patients recover faster. When the patient's symptoms subside, they should not return to working within a high heat environment immediately but should get rest for approximately

1-2 days. Patients should undergo a thorough physical examination and be taught to understand the effect of temperature of the air, especially the heat index value (air temperature and relative humidity, also often referred to as "wet bulb temperature") on the level of operation or exercise. The occurrence of heat exhaustion depends on the level of intensity and the time spent exposed to heat before symptoms of heat exhaustion occurs. This condition may not be caused by a lack of water and minerals, but may be caused by working in the heat alone. This is often found in people who are not accustomed to working in hot weather. Dehydration and salt loss may also be present, or it can be the underlying cause.[2,5] The important mechanism of the development of this disease is the dilation of blood vessels in the skin due to heat. This causes the blood volume in the arteries to be insufficient for adequate return to the heart. This prevents adequate blood pressure and reduced blood circulation to the brain.

Case report

A 27-year-old man, a military officer, was transported to hospital with a chief complaint of losing consciousness 30 minutes before being transferred to the hospital. Present illness: while standing in line for 3 hours, he began to feel restless, dizzy, had headache, sweating profusely, and began to pant. Then he fainted and lost consciousness. He received initial assistance by opening of his airway, wiping with wet towels, and was brought into the shade. He showed no improvement and was still unconscious. Past history: no known underlying diseases. Personnel history: no history of drug or food allergy. He had social drinking 2 times a month and did not drink during the previous week. He rarely smoked. There was no history of heat stroke in the family or a history of sudden death from heart disease in the family. At the hospital, physical examination revealed a young obese man who had regained consciousness and was fully co-operative. Body weight was 118 kg, height 176 cm with BMI of 38 kg/m^2. His vital signs showed rectal temperature of 38.5^{0}C, heart rate of 122/min, respiration 16/min and blood pressure 124/83 mmHg. Oxygen saturation (room air) 96%. He was not anemic, no icteric sclera. His chest, heart and abdominal examination was normal. Skin was remarkably red, dry and showed anhidrosis. He had warm extremities. Neurological examination, GCS was E4M6V5, pupils 3 mm both reacted to light. motor grade V/V all. Sensory and cerebellar signs were unremarkable. DTR 2+ all. Stiff neck was negative. Bedside investigation showed CBG 140 mg/dL, EKG: sinus tachycardia. Echocardiogram bedside: good LVEF. no LV D-shape. no pericardial effusion. IVC collapsibility index more than 50%.

The problem list was alteration of consciousness and hyperthermia. The differential diagnosis was 1) Heat-related illness [Heat stroke] 2) SIRS with sepsis 3) toxic synonym 4) Acute coronary syndrome

Initial investigation: CBC: Hct 48.4% WBC 10.2 x 10^9/L, PMN 45%, L 46%, M 5.1% Platelet 380 x 10^9/L. UA: Color yellow, appearance turbid, Sp.gr.1.020, Glucose negative, Ketone negative, Proteins 1+, Blood 1+, Bilirubin Negative, RBC 5-10 cells/HPF, WBC 1-2 cells/HPF, squamous epithelial 3-5 cells/HPF. PT 13.3 sec. PTT 18.0 sec. INR 1.11, Electrolyte: Na 145 mmol/L, K 3.3 mmol/LCl 102 mmol/L, CO2 22 mmol/L, BUN 14 mg/dL creatinine 1.2 mg/dL, calcium 10 mg/dL, (8.6-10.2) phosphorus 3.7 mg/dL (2.7-4.5), magnesium 1.8 mg/dL (1.7-2.55), LFT: total protein 8.1 g/dL, albumin 5.2 g/dL, total bilirubin 0.48 mg/dL, direct bilirubin 0.17 mg/dL, alkaline phosphatase 93 U/L, CPK 270 U/L,

lactate 3.2 mmol/L, urine amphetamine, marijuana negative, CSF analysis: WBC 2 cells/cu.mm. protein 27 mg/dL glucose 81 mg/dL. Gram stain: No organism found. CSF culture: no growth. Hemoculture: no growth

Emergency room treatment

He received initial cooling with strategic ice packs in the armpit area and neck, which are areas with many blood vessels passing through. Then body cooling by evaporation with a spray, using water at a temperature of 15^0C, and convection by blowing a fan at 45^0C, measuring core body temperature regularly, giving broad spectrum antibiotics because sepsis could not be ruled out, so ceftriaxone 2 gm IV was started after hemoculture, measuring lactate clearance level, and a retained Foley catheter. Initially, the patient felt better when the core temperature was measured at 38.2^0C. Therefore, he was only diagnosed with heat exhaustion, which is second in severity to heat stroke. Then, he was admitted to regular ward for observation. Patients diagnosed with heat stroke, should be admitted to the ICU for close evaluation because this is potentially an emergency and may cause life-threatening complications.

Discussion

This patient was diagnosed with heat exhaustion. The severity of which is secondary to heat stroke. which fits the following diagnostic criteria: core temperature more than 38.3^0C or more, history of exposure to high heat for a long period of time, symptoms including rapid heart rate, headache, dizziness, fainting, loss of consciousness. However, if the disease cannot be confirmed, treatment should be given as for heat stroke. Then a quick diagnosis can be made by measuring the core temperature through the rectum and try to reduce the core temperature as 1-2^0C can reduce the risk of brain damage.[6] In empirical evidence, a method that works well was to immerse patients in ice water. A study by Demartini et al. and colleagues was conducted on marathon athletes. Soaking in cold water at a temperature of 10^0C was not found to have survival benefit.[6] This procedure was not performed in this patient because preparation for a bath or bath is difficult in the emergency room. This patient had the procedure done using the strategic cold pack method, placing ice in areas lot of blood supply such as neck, armpits, and outer legs. He also got the evaporations spray method, spraying cool water at 15^0C followed by fan assisted drying at 45^0C, causing the water to evaporate and carry away the heat.[7,8] There is no empirical evidence of benefit from performing body lavage and cold intravenous infusions.

This patient has a BMI of 38 kg/m^2, which was very high and at risk for heat stroke.[9] Chung studied in soldiers and found that a BMI over 30 had an odds ratio of 4.29 times the chance of heat stroke, and this patient was not familiar with it. Although having a light work only one day, his body was unable to acclimatize, therefore heat exhaustion occurred. The heat environment on that day was 40^0C and relative humidity was 75, putting him at risk due to the high wet bulb temperature. Although this patient's symptoms did not reach the level of heat stroke, it was still necessary for him to stay in the hospital in order to monitor for any late complications.[1]The main life-threatening complication is a heart attack, even in young patient who was in good health.

Elevated body temperature causes pulmonary edema, brain swelling, liver injury and elevated liver enzymes. Liver function will begin to deteriorate until the condition of alopecia occurs or hypoglycemia. Within 24 hours, elevated body temperature can damage the blood

coagulation system and blood vessel walls. Thrombocytopenia, hypoprothrombinemia, hypofibrinogenemia may be detected. These can cause bleeding in various organs.

Higher body temperature causes dehydration along with the destruction of muscle cells (Rhabdomyolysis), causing skeletal muscle to break down so much that kidney failure can occur. Blood flow to the kidneys is also reduced. Therefore, acute tubular necrosis may occur, which may occur several days after injury. The amount of blood that feeds the digestive system (Splanchnic system) decreases, causing loose stools. or bleeding in the digestive tract. During the hospital stay, this patient had a low blood potassium level. A small amount had been corrected orally with potassium elixir and there was no evidence of muscle breakdown with normal CPK values following admission. It was probably caused by heat radiation alone. After 4 days in the hospital, the patient was able to return home. He was advised to lose weight and begin with light work and avoid working with heat exposure because he was at increased risk.

After returning home, he was to refrain from exercising and make an appointment to follow up in 7 days to check that the physical examination and blood results remained normal. He was advised to start exercising in the cold first, then to gradually increase intensity and temperature over 2 weeks. In cases where symptoms recur within 4 weeks, heat tolerance testing may be done to assess return to work where there is a risk of heat exposure. It should be noted that brain's heat regulation mechanism remains dysfunctional for several weeks. Therefore, heat exhaustion can reoccur if the person is still in a hot environment with inappropriate exercise.

Summary

Heat exhaustion is a disease that is second in severity to heat stroke, which can be differentially diagnosed from the symptoms of neurological symptoms and core body temperature lower than 40^0C. If the person providing first aid does not think about heat exhaustion and provide first aid according to general symptoms the condition may develop in severity and become heat stroke, which can be life-threatening.

References

1. Glazer JL. Management of heatstroke and heat exhaustion. Am Fam Physician. 2005; 71 (11): 2133-40.
2. Bouchama A, Knochel JP. Heat stroke. N Engl J Med. 2002; 346 (25):1978-88.
3. Yeo TP. Heat stroke: a comprehensive review. AACN Adv Crit Care. 2004; 15 (2): 280-293.
4. Bureau of information, Ministry of Public Health; Monday 7 March 2016. (in Thai).
5. Chaikan A, Nanna U. Heat stroke and heat exhaustion. Thammasat Medical Journal. 2007; 7 (4): 384-91.
6. Demartini JK, Casa DJ, Stearns R, Belval L, Crago A, Davis R, et al. Effectiveness of cold water immersion in the treatment of exertional heat stroke at the Falmouth Road Race. Med Sci Sports Exerc. 2015; 47 (2): 240-5.
7. Smith JE. Cooling methods used in the treatment of exertional heat illness. Br J Sports Med. 2005; 39 (8): 503-7.
8. Horowitz BZ. The golden hour in heat stroke: use of iced peritoneal lavage. Am J Emerg Med. 1989; 7(6): 616-9.
9. Chung NK, Pin CH. Obesity and the occurrence of heat disorders. Mil Med. 1996; 161 (12):739-42.