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Review Article

HEAT STROKE AND ITS MANAGEMENT: A BRIEF REVIEW**N. R. Livingston Raja^{1,2*}, N. Balakrishnan¹, S. Antony Selvi², I. Gayathri fathima², L. Benita Mary² and M. Soundhararajan¹**¹S A Raja Pharmacy College Vadakkangulam - 627 116, Tamilnadu²Central Research Laboratory, Rajas Medical Institutions Kavalkinaru 627 116, Tamilnadu**Article Received:** May 2019**Accepted:** May 2019**Published:** June 2019**Abstract:**

When environment temperature increases that affect the body temperature due to dysfunction of physiologic adaptation mechanisms to cause heat stroke. Heat stroke is a critical issue in our life which is characterized by high core body temperature more than 40°C affects the central nervous system that results in disorientation, convulsions, heat edema, heat cramps, and heat syncope. Even though lowering the body temperature by insistent treatment, heat stroke is over and over again fatal. Mostly elder people, less than 4 years old children, who have chronic illness people, are affected by heat stroke at hot summer climate in the tropical countries. If not treated early may cause multi-organ failure by series changes of metabolic effect, coagulopathy, and death. Mortality rate increased from 10 to 75% in heat stroke if delay treatment. In United States more than hundreds of people died every year. In the year from 1979 to 1997, Centers for Disease Control and Prevention illustrate the data for deaths rate was 7000. In 2015, according to the statistics are available in the Centers for Disease Control and Prevention, heat stroke postulated 335 lives. In this article to make awareness for early recognition, prevention and early treatment by rapidly cooling techniques such as immersion in water at different temperatures, evaporative cooling, ice pack application, pharmacological treatment and invasive techniques are available. It is concluded that most of the heat illness is preventable, manageable and treatable also to reduce the death.

Key words: Mortality, Disorientation, Convulsions, Heat Edema, Heat Cramps, Coagulopathy.

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INTRODUCTION:**Definition and its types:**

Heat stroke conversationally called sunstroke and formerly, solar stroke or heat stroke, heat apnea (sun stroke - heat apoplexy / heat apnea) is a corporate term of serious disorders that develop when, environment temperature becomes high and metabolic dysfunctions exceeding the core body temperature above 40°C (1). Our body having thermoregulatory system which is not controlling the abnormal increased body temperature through exercise, continuous physical acts and sport activities in hot environment because of that fluid and salt balance will be disrupted. Normally, when body temperature increases immediately the regulatory system response that blood vessels of peripheral areas expand through autonomic nervous system to enhance the distribution of blood in skin. Due to that increased body temperature become lowering via conducted to the air. Moreover, sweating mechanism maintain the heat generate and heat loss from our body through loss of water and salt (sodium, etc.), which is also maintained by autonomic nervous system. If our bodies internal regulatory system to failure to maintain the body temperature to cause our muscle cramp and cerebral anemia which blood flow to the brain restricted temporarily cause faint(2). This state is called as stroke. Heat stroke may be characterized by exertional and non-exertional.

Non-exertional (Classic) (3):

In this type of heat stroke affect specifically very young and elderly people during high intensity and frequency of heat waves. The very old people, particularly who are having chronic illness such as cardiovascular diseases, dementia etc., physical inability, staying in non-ventilated rooms are prone to heat stroke. Very young children possible to dispose the heat stroke owing to not well developed sweat glands, their high surface-to-volume ratio and the status of dependent. Furthermore, who are using drugs such as diuretics, anti-parkinsonian medications, anticholinergics, alcohol are dispose to heat strokes. That non-exertional type of people respond leisurely to treatment and this kind of patients need to admit in the hospital for further treatment.

Exertional heat stroke:

This type of heat stroke occurs in manual laborers, soldiers in training and athletic competitors are exercised in warm temperature particularly when humidity is high. Still, in healthy individual's dehydration, whose are using antihistamines with anticholinergic medications may be to cause heat strokes.

Epidemiology:

Heat stroke is an evolved disorder that affect the most of the countries, which is having data for death rate in each year due to pollution, frequent climate changes, natural disasters etc. they are having huge reports that projected out heat related illness increasing the mortality rate in specifically Middle East and parts of Europe (4). Heat stroke is a central condition worldwide with a reported mortality rate of between 10-50%. The National Institute of Ecology, conducted 3rd National Communication to the Framework Convention of the United Nations on Climate Change was held on October 2006, in Mexico that produced the data above 65 years old people susceptible to co-occurrence diseases. In north Mexico has highest mortality rate with 1.2% to 1.3%. According to the climate and mortality rate, year from 1979-2003, 1998 was the warmest year in the period of time. In that period, the south- southeast Veracruz is placed the 2nd state has high mortality with 14-55 cases. In 2008, Mexico has 30 deaths (5). In United States, Centers for Disease Control and Prevention was reported that from the year 1979-1999, 8015 heat-induced fatalities were occurred. In Chicago the year 1995, 700 deaths happened by the heat waves (6). In India, the states of Andhra Pradesh and Telangana have about 1600 deaths due to current heat waves.

Pathophysiology:

Unrestrained heat is a harmful agent that causes cell injury directly in fever itself (7). Excess heat is transfer to environment by conduction, convection, radiation and evaporation. Usually, out of these evaporation is an effective method to cool the body through sweating. But when ambient temperature increased abnormally that evaporation method become failing to cool leads to direct cell injury takes place. Generally, the body adapting mechanism during hot environment worked through the sweat glands, increased glomerular filtration rate, enhance the plasma volume. When thermoregulatory mechanisms are inundated, because of that heat stroke and heat related illness occur. During sport activities decrease the thermal threshold for heat stroke that blood flow away from the organs cause gut ischemia because of blood shunt towards active muscles. Because of this reason multiorgan-dysfunction occur through acute increased metabolic demand, hypoxia and ischemia. In which condition, coagulation pathway activated by releasing of cytokines, bacterial polysaccharides, tumor necrosis factor α , interleukin1, interleukin-6, and interleukin-10, E-selectin, L-selectin, and intercellular adhesion molecule1 [ICAM-1] with decreased levels of

proteins C and S and antithrombin III and inhibition of fibrinolysis, heat shock proteins from activated leucocytes and muscles (8). According to that vasodilation and disseminated intravascular coagulation cause hypotension. Brain is a very sensitive organ to heat stress, which produced the first signs and symptoms for heat stroke. In animal model

showed that widespread apoptosis in spleen, intestines, lungs and hematopoietic cells due to activated caspase-3 interact with tissue factor. Most of the research suggested that microvascular injury, thrombosis, inflammation and apoptosis are occurred in hyperthermia (9).

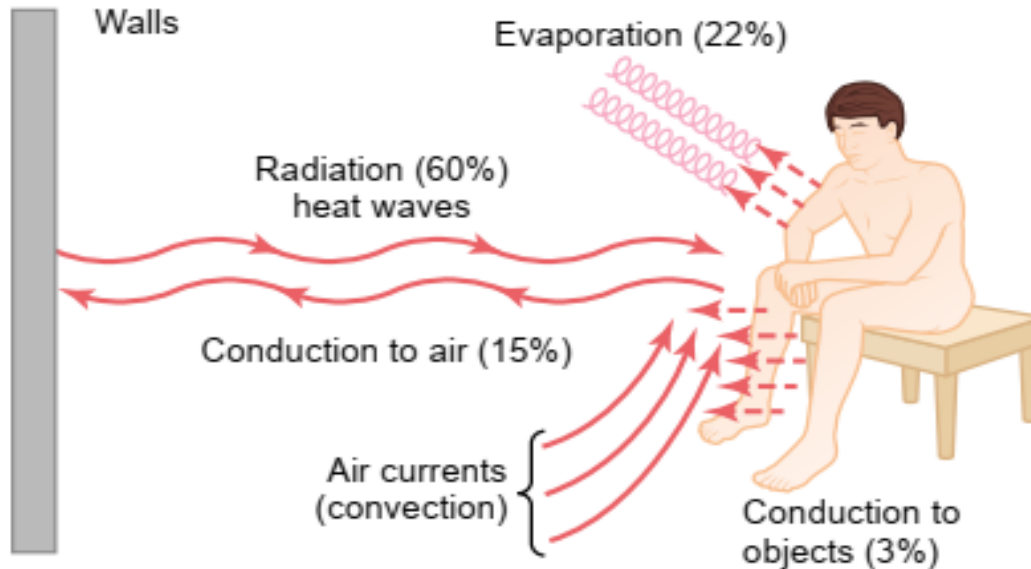


Fig1: Mechanism of heat loss from the body (Reproduced from Text book of Medical Physiology by – Arthur C. Huyton and John E. Hall 10th edition page number 824)

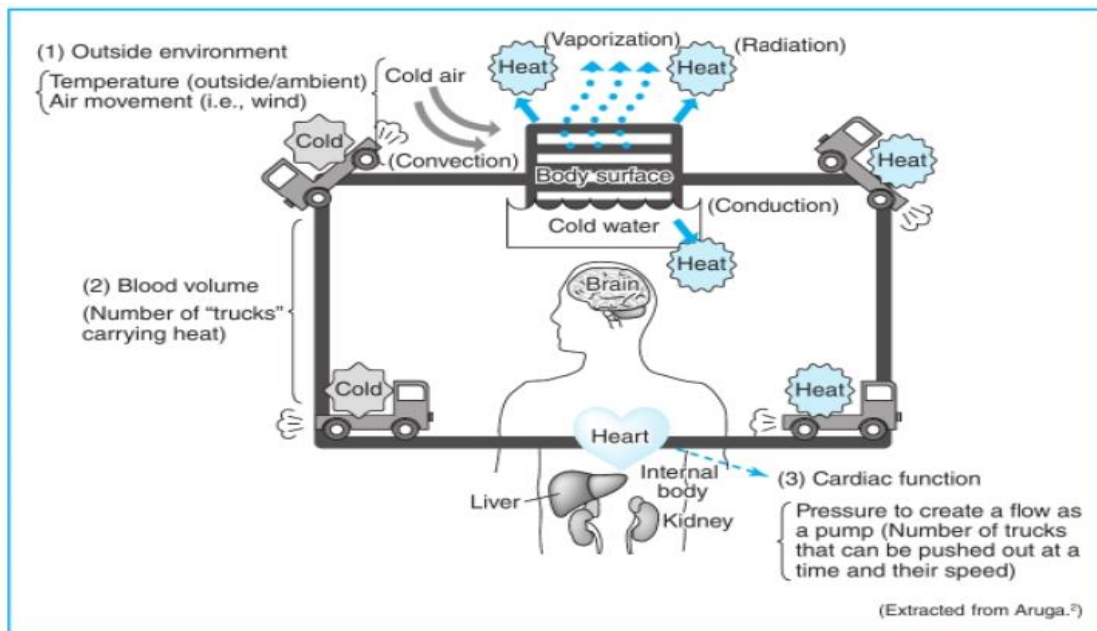


Fig.2 Regulation of the human body temperature, and the 3 elements that can cause heat illness (Reproduced from JMAJ 56(3): 167–173, 2013 by Yasufumi MIYAKE)

Signs and symptoms (10, 11):

The trademark symptom of heat stroke is a core body temperature above 104 degrees Fahrenheit. But fainting may be the first sign

Other symptoms may include:

- ✓ Throbbing headache
- ✓ Dizziness and light-headedness
- ✓ Lack of sweating despite the heat
- ✓ Red, hot, and dry skin, dry tongue
- ✓ Muscle weakness or cramps
- ✓ Nausea and vomiting
- ✓ Rapid heartbeat, which may be either strong or weak
- ✓ Rapid, shallow breathing
- ✓ respiratory alkalosis
- ✓ Behavioral changes such as anxiety, confusion, agitation, disorientation, or staggering
- ✓ Seizures
- ✓ Unconsciousness.
- ✓ Ataxia
- ✓ Reduced urine output
- ✓ Sunken eyes

Complications (12):

- ✓ Hypotension,
- ✓ shock,
- ✓ pulmonary crepitations,
- ✓ Bleeding from multiple sites (epistaxis, intravenous site etc.)

Signs of hepatic failure, renal failure, rhabdomyolysis, encephalopathy, acute respiratory distress syndrome, myocardial injury, intestinal ischemia or infarction, pancreatic injury, and hemorrhagic complications, especially disseminated intravascular coagulation, with pronounced thrombocytopenia.

Diagnosis:

It's usually apparent to doctors if you have heatstroke, but laboratory tests can confirm the diagnosis, rule out other causes for your symptoms and assess organ damage. These tests include:

Rectal temperature:

- ✓ To check your core body temperature. A rectal temperature is the most accurate way of determining your core body temperature and is more accurate than mouth or forehead temperatures.

A blood test:

- ✓ To check blood sodium or potassium and the content of gases in your blood to see if there's been damage to your central nervous system.
- ✓ Serum hemoglobin, electrolytes, creatinine, coagulation parameters (PT, APTT, Platelet count), Creatine Kinase, Liver function tests,

Blood culture, Test for Malaria parasite, Dengue etc. according to geographical area.

A urine test:

- ✓ To check the color of your urine, because it's usually darker if you have a heat-related condition, and to check your kidney function, this can be affected by heatstroke.

Muscle function tests:

- ✓ To check for serious damage to your muscle tissue (rhabdomyolysis).

X-rays and other imaging tests:

- ✓ To check for damage to your internal organs.
- ✓ Chest x-ray to look for ARDS
- ✓ Ultrasound abdomen if clinically indicated to rule out infections.

Treatment (13):

Heatstroke treatment centers on immediate cooling your body to a normal temperature to prevent or reduce damage to your brain and vital organs. To do this, your doctor may take these steps:

Immerse you in cold water (14):

- ✓ A bath of cold or ice water has been proved to be the most effective way of quickly lowering your core body temperature. The quicker you can receive cold water immersion, the less risk of death and organ damage.

Use evaporation cooling techniques (15):

- ✓ If cold water immersion is unavailable, health care workers may try to lower your body temperature using an evaporation method. Fanning the undressed patient at room temperature (20-22°C). Spraying the uncovered patient with lukewarm water with continuous fanning. Use of a body-cooling unit - a special bed that sprays. Atomized water at 15°C admixed with warm air at 45°C over the whole body surface to keep the temperature of wet skin between 32°C and 33°C

Pack you with ice and cooling blankets (16):

- ✓ Another method is to wrap you in a special cooling blanket and apply ice packs to your groin, neck, back and armpits to lower your temperature.

Techniques based on conductive cooling External:

- ✓ Cold water immersion or ice water bath i.e. placing the patient in a tank of iced water. Shivering and agitation are quite common in iced baths and can be treated with slow IV diazepam
- ✓ Application of cold packs or ice slush over part or whole of body.
- ✓ Use of cooling blankets. Concomitant vigorous massaging is recommended with all measures

of external cooling to counter cutaneous vasoconstriction.

Internal (not frequently used):

- ✓ Iced gastric lavage or iced peritoneal lavage.

Pharmacological induced cooling method (17):

Dantrolene has been mostly used in the treatment of various hyperthermic syndromes such as malignant hyperthermia and neuroleptic malignant syndrome.

Give you medications to stop your shivering:

- ✓ If treatments to lower your body temperature make you shiver, your doctor may give you a muscle relaxant, such as a benzodiazepine. Shivering increases your body temperature, making treatment less effective.
- ✓ **IV Lorazepam**- up to 0.1 mg/kg (4 mg, repeat 2mg after 5-10 mins in adults if necessary) **or** **IV Diazepam** up to 0.25–0.4 mg/kg (5mg, repeat 5mg after 5- 10 mins in adults if necessary).

Management (3):

- ✓ Remove patient from the hot area and transfer to a cool room immediately. Continue cooling to core temp of 38°-39°C (101-102.2oF)
- ✓ Initiate cooling measures immediately. Investigations should not be at the expense of cooling the patient.
- ✓ Supportive treatment – manage dehydration by administration of fluid such as Normal Saline or Ringer’s Lactate through oral or IV, blood pressure, urine output, cardiovascular function, coagulopathy, seizures.
- ✓ Agitated delirium: Short acting benzodiazepines such as Midazolam (2.5mg-5mg) can be given.
- ✓ Antibiotics: It is cautious to mull over broad spectrum antibiotics in the course of blood cultures in older patients with hyperthermia if infection is a possible etiology.

Prevention:

Prevention is most important to avoid heat induced illness. During summer climate or hot environment should wear white or light color clothes with loose which reflects radiant energy, always maintain the hydration of our body to take adequate water and salt is essential, avoid strenuous physical activities because it enhance metabolic activity to increase the body temperature. Over hydration causes severe hyponatremia in women and slow runners due to excessive fluid consumption (18). With the aim of to prevent heat stroke the persons should take balanced diet with necessary protein and vitamins in routine

basis. The subject should be sleep properly to recover from faint (19). TV and newspaper to give awareness of risk factors for frequent heat wave in hot weather to prevent from heat injuries. In hot weather elderly patients, weak physical strength, who are overweight, are susceptible to heat stroke often.

Medications and other agents that can predispose to heat stroke:

- ✓ Anti-cholinergic,
- ✓ Anti-histamines,
- ✓ Benzodiazepines,
- ✓ Alcohol,
- ✓ Anti-hypertensives (Beta blockers, calcium channel blockers, Diuretics)
- ✓ Phenothiazine,
- ✓ Thyroid agonists,
- ✓ Tricyclic antidepressants. These kinds of drugs we should avoid in hot weather condition.

CONCLUSION:

Heat related illness are enhancing due to increased global warming. Providing early diagnosis and treatment for heat stroke through familiarity of emergency and primary physicians using available cooling methods is central to prevent morbidity and mortality. Finally concluded that, heat stroke may produce with several organ dysfunction and raise of cytokines and chemokines levels, these things are develop a resistant to conventional cooling therapies, endovascular cooling effect and Heat stroke is preventable by consuming balanced diet, adequate fluid, electrolytes and awareness about potential risk factors. Public education is also important to the reduction of body temperature and, possibly, avoided a fatal effect.

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