Case Study

MEDICO-LEGAL UPDATE
Volume 25 No. 2, April - June 2025

Silent Scorcher: A Case of Heat Stroke Fatality-Case Report

Arjun Rajeev[1], Sujith Sreenivas C[2]

[1]Junior Resident Medical Officer, [2]Professor and Police Surgeon, Department of Forensic Medicine and Toxicology,Government Medical College, Kozhikode, Kerala, India

How to cite this article: Rajeev A, Sreenivas SC Silent Scorcher: A Case of Heat Stroke Fatality - Case Report. 2025;25(2):1-5.

ABSTRACT

Background: Heat stroke is a life-threatening condition resulting from prolonged exposure to high temperatures, often exacerbated by physical exertion and inadequate hydration. Despite being preventable, it can lead to fatal outcomes if not promptly identified and treated. This case study highlights a fatal instance of heat stroke to emphasize its clinical manifestations, risk factors, and forensic importance.

Case Presentation: A 65-year-old male was found unresponsive after prolonged outdoor activity in extreme heat. Initial assessment revealed hyperthermia, altered mental status, and multi-organ dysfunction. Despite aggressive cooling measures and critical care interventions, the patient succumbed to complications arising from heatstroke, including rhabdomyolysis and acute kidney injury. The autopsy confirmed findings consistent with severe hyperthermia-induced organ damage.

Discussion: This case underscores the importance of early recognition and immediate management of heat stroke. Key contributing factors, such as environmental conditions, individual susceptibility, and delayed medical attention, are explored. The study also highlights the need for public awareness, preventive strategies, timely interventions to reduce the incidence of heat-related fatalities and diagnostic aspects in forensic.

Conclusion: Heat stroke remains a silent yet significant public health concern, particularly in regions experiencing rising temperatures. This case serves as a critical reminder of the deadly consequences of heat exposure and the urgent need for preventive action and how to diagnose such a case.

Keywords: Heat stroke, hyperthermia, rhabdomyolysis, acute kidney injury.

Introduction

Heat stroke is a life-threatening medical condition characterized by an elevated core body temperature typically over 40°C, accompanied by central nervous system dysfunction[1]. It occurs in two forms: classic heatstroke, commonly seen in the elderly or very young, and exertional heat stroke, more prevalent in physically active individuals[2]. Between 2000-2019 approximately 489,000 heat related deaths occur each year globally, with 45% of these in Asia and 36% in Europe.

According to India's crime record bureau, of 8060 accidental deaths attributable to natural causes in 2022,9.1% were attributed to "Heat stroke". In 2021 India had reported 374 deaths due to heatstroke, which rose to730 in 2022.

The case study presented here explores a fatal incident of heat stroke in a middle-aged individual, highlighting the critical role of forensic pathology in identifying the cause of death and the importance of this condition.

Corresponding author: Arjun Rajeev, Junior Resident Medical Officer, Department of Forensic Medicine and Toxicology, Government Medical College, Kozhikode, Kerala, India

E-mail: arjunmrajeev97@gmail.com

Submitted: Jan 25, 2025; **Accepted:** Apr 2, 2025 **Published:** April-17-2025

Case Report

We report a 65-year-old male who had a sudden episode of collapse at a construction site where he was working presented to the emergency department. Upon arrival, his core body temperature was recorded at 42.1°C. Aggressive cooling measures were initiated, but the patient's condition rapidly deteriorated, leading to cardiovascular collapse and eventual death.

Autopsy Findings

Postmortem examination revealed no underlying medical conditions that could have predisposed the individual to heat stroke. Rectal temperature was measured using a thermometer measuring 40 deg C. The core body temperature within the pelvic region after opening the body seen to be elevated even after refrigeration. Other findings- The scalp showed petechial hemorrhages within the loose areolar tissues. Brain stem was softened with hemorrhages within the pons, medulla and caudate nucleus (Fig:1). The white matter of the cerebral hemispheres were markedly softened with multiple hemorrhages**.** There were no signs of raised intracranial pressure.

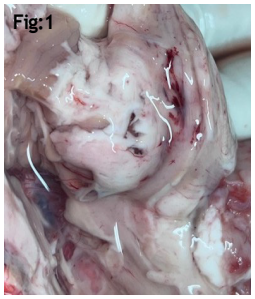

Fig. 1: Hemorrhages within the white matter

Petechial hemorrhages were seen on epicardial surface of heart. Subendocardial hemorrhages seen involving the papillary muscles and subaortic region (Fig:2)

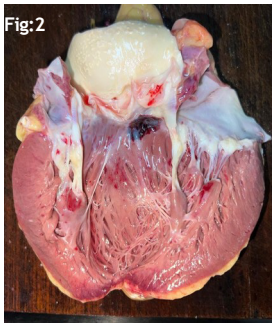

Fig. 2: Subendocardial hemorrhages

Myocardium of left ventricle appeared pale. Focal areas of pulmonary hemorrhages. were seen (Fig:3). Both kidneys were pale, swollen and had loss of corticomedullary differentiation (Fig:4). Surface of liver showed slippage of capsule

(Fig:5). Mucosa of intestines showed petechial hemorrhages. Urinary bladder contained 3- 5ml reddish brown colored urine. All internal organs appeared congested.

Fig. 3: Focal pulmonary hemorrhages

Fig. 4: Loss of CMD

Fig. 5: Sliippage of capsule

Histopathological Examination

Dermis showing hemorrhages and congested vessels(fig:6). Skeletal muscle showed congestion with areas of muscle necrosis (fig:7) Heart showed multiple foci of cardiac myocyte necrosis (fig:8). Kidneys showed acute tubular necrosis(fig:9). Lungs showed pulmonary oedema and intraalveolar hemorrhage(fig:10).

Histopathological Findings

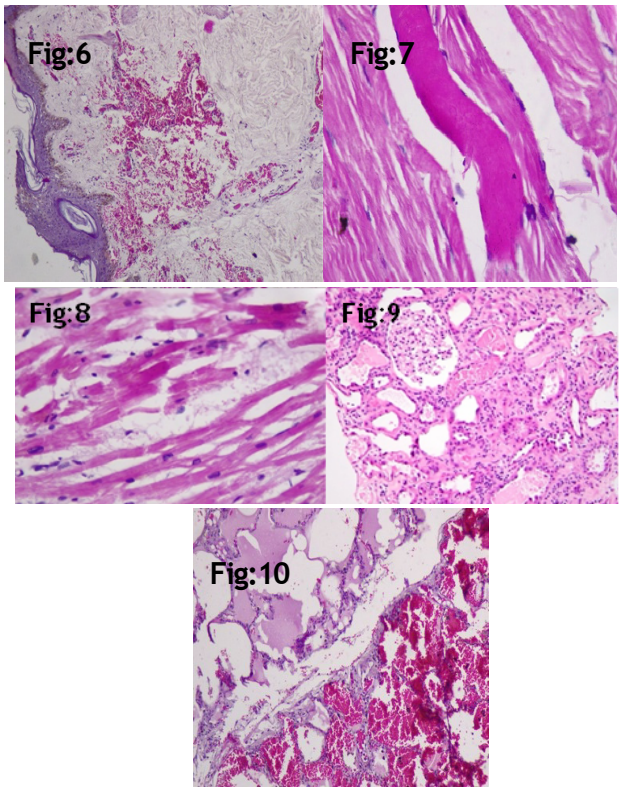

Fig. 6: Dermis showing hemorrhages and congested vessels; Fig. 7: Skeletal muscle showed congestion with areas of muscle necrosis; Fig. 8: Heart showed multiple foci of cardiac myocyte necrosis Fig. 9: Kidneys showed acute tubular necrosis; Fig. 10: Lungs showed pulmonary oedema and intraalveolar hemorrhage

Urinalysis report revealed RBCs were detected in large numbers; Myoglobin detected in urine (Myoglobinuria). Other culture and serology reports were unremarkable

The cause of death was determined to be exertional heat stroke, with the immediate trigger being the prolonged physical exertion and environmental heat exposure during possible construction work.

Discussion

Heat Stroke in Forensic Medicine Patho-physiology of Heat Stroke

The pathophysiology of heat stroke involves a complex cascade of events, including impaired thermoregulation, increased metabolic heat production and a breakdown of the body's homeostatic mechanism.[3] During heatstroke, the body's core temperature rises rapidly, typically exceeding 40deg C, accompanied by central nervous dysfunction, organ failure and tissue damage. This physiological response is triggered by prolonged exposure to high ambient temperatures, often exacerbated by physical exertion and lack of adequate hydration.[5]

The pathophysiology of heat stroke is characterized by the inability of the body to dissipate heat effectively. As described in the literature, heat is gained from metabolic activities and the environment, and the body typically dissipates heat through sensible loss (conduction, convection and radiation) and insensible loss (evaporation of sweat).[4]. However, in heat stroke, one or more of the mechanisms may become impaired, leading to a rapid rise in body temperature.[9]

Importance of Comprehensive Forensic Analysis in Diagnosing Heat Stroke

A thorough and comprehensive forensic analysis is crucial in accurately diagnosing heat stroke. Due to the complex pathophysiology and the potential for heat stroke to mimic other causes of death, a multifaceted approach is necessary to differentiate heat stroke from other conditions. This comprehensive analysis involves a detailed examination of the circumstances surrounding the incident, a comprehensive autopsy, and comprehensive toxicological, histopathological and environmental assessments. By considering all available evidence and ruling out other potential causes of death, forensic experts can make a definitive diagnosis of heat stroke, which is essential for determining the cause and manner of death.

Differentiating Exertional Heat Stroke and Classic Heat Stroke

Heat stroke can be classified into two main types: exertional heat stroke and classic heat

stroke. Understanding the key differences between these two subtypes is essential for accurate diagnosis and appropriate management.

Exertional heat stroke typically occurs in individuals engaged in strenuous physical activity, such as athletes, laborers, or military personnel, who are exposed to high ambient temperatures and high humidity. In these cases, the increased metabolic heat production from exercise, combined with the environmental heat load, overwhelms the body's thermoregulatory mechanisms, leading to a rapid rise in core body temperature.

In contrast, classic heat stroke is more commonly observed in the elderly, young children, or individuals with underlying medical conditions, such as cardiovascular or neurological disorders. This type of heatstroke is often associated with prolonged exposure to high environmental temperatures, without the significant physical exertion seen in the exertional form.[9]

The clinical presentation and pathophysiological mechanisms underlying these two subtypes of heat stroke can differ, which may influence the diagnostic approach and the management strategies employed by forensic experts and healthcare professionals.

Acute Organ Damage in Heat Stroke Victims

Heat stroke can lead to rapid and severe damage to multiple organ systems.[8] The elevated core body temperature and associated physiological disturbances can result in acute organ dysfunction, including:

- **Central nervous system:** Encephalopathy, seizures, coma
- **Cardiovascular system:** Myocardial injury, arrhythmias, hypotension
- **Respiratory system:** Acute respiratory distress syndrome, pulmonary edema
- **Renalsystem:** Acute kidney injury, rhabdomyolysis
- **Hepaticsystem:** Acute liver injury, coagulopathy
- **Gastrointestinal system:** Intestinal ischemia, gastrointestinal bleeding

Prompt recognition and aggressive management of these acute organ complications are crucial to preventing further deterioration and improving outcomes in heat stroke.

Histopathological Findings in Heat Stroke Cases

The neuropathological changes associated with heat stroke are complex and can involve multiple regions of the central nervous system. Severe hyperthermia can lead to direct thermal injury to brain tissue, resulting in widespread neuronal necrosis and gliosis. Additionally, the global physiological disturbances seen in heat stroke, such as impaired cerebral blood flow, oxidative stress, and metabolic derangements, can contribute to diffuse brain damage.

Histopathological examination of the brain in heat stroke cases often reveals acute ischemic changes, including neuronal shrinkage, cytoplasmic eosinophilia, and nuclear pyknosis. Cerebral edema and herniation may also be observed,reflecting the breakdown of the blood-brain barrier and the inability of the brain to effectively regulate its microenvironment.

In some cases, selective vulnerability of certain brain regions, such as the hippocampus, basal ganglia, and cerebellum, has been reported. These areas may be particularly susceptible to the metabolic and vascular derangements associated with heat stroke, leading to more pronounced neuropathological changes. Ultimately, the specific neuropathological findings in heat stroke cases can vary depending on the duration and severity of the hyperthermic insult, as well as the individual's underlying physiological and genetic factors that may influence the brain's response to extreme heat stress.

Toxicological Considerations in Heat Stroke Investigations

Toxicological assessments play a crucial role in the postmortem diagnosis and investigation of heat stroke cases. Comprehensive toxicological analyses can help identify any contributing factors, such as the presence of illicit drugs, medications, or other chemical substances that may have impaired the body's thermoregulatory mechanisms or exacerbated the physiological disturbances associated with heat stroke.

Role of Environmental Forensics in Heat Stroke Analysis

Environmental forensics plays a crucial role in the analysis of heat stroke cases. By investigating the environmental conditions and factors that contributed to the development of heat stroke, forensic experts can provide valuable insights to determine the cause and manner of death. This includes assessing ambient temperature, humidity, sun exposure, and other relevant environmental variables that may have exacerbated the heat-related illness[7]. Additionally, environmental forensics can help identify any potential contributing factors, such as the presence of urban heat islands, lack of shade or cooling infrastructure, or other environmental stressors that may have increased an individual's vulnerability to heat stroke. Integrating environmental forensic analysis with traditional medical and toxicological investigations is essential for a comprehensive understanding of heat stroke-related fatalities.

Establishing Cause and Manner of Death in Heat Stroke

The diagnosis of heat-related death be based on a history of exposure to high ambient temperature and the reasonable exclusion of other causes of hyperthermia. Postmortem examination, including complete autopsy, toxicological analysis, and environmental investigation, is crucial in establishing the cause and manner of death in heat stroke cases[7]. The presence of a core body temperature above 40°C (104°F), along with evidence of central nervous system dysfunction, such as delirium, seizures, or coma, is a key diagnostic criterion for heat stroke[2].

Careful consideration of the individual's medical history, any predisposing factors, and a thorough review of the circumstances surrounding the death are also essential for determining the cause and manner of death. In some cases, the cause of death may be attributed to heat stroke, while the manner of death could be classified as accidental, natural, or even homicide, depending on the specific circumstances and contributing factors involved.

Conclusion

Heat stroke is a life-threatening medical condition that requires prompt recognition and aggressive management to prevent severe complications and mortality. Multifactorial in nature, heat stroke can be challenging to diagnose and investigate, especially in forensic settings. A comprehensive approach, involving a thorough medical history, detailed physical examination, targeted laboratory testing, and a careful autopsy with supporting toxicological and environmental analyses, is crucial for establishing the cause and manner of death in heat stroke cases.

Financial Support and sponsorship: Nil

Conflicts of interest: There are no conflicts of interest.

Informed Consent: Not applicable as it is medicolegal autopsy-based case where subject confidentiality was maintained.

References

1. Amundson DE. The Spectrum of Heat Related Injury with Compartment Syndrome. Military Medicine. 1989 Sep 1;154(9):450–2.
2. Bouchama A, Knochel JP. Heat Stroke. New England Journal of Medicine. 2002 Jun 20;346(25):1978–88.
3. Cheshire WP. Thermoregulatory disorders and illness related to heat and cold stress. Autonomic Neuroscience [Internet]. 2016 Apr;196(196):91–104. Available from: https://www.sciencedirect.com/science/article/pii/S1566070216300017
4. Greenwald MH, Dorfman DH. Life-threatening illness with elevated temperature. Clinical Pediatric Emergency Medicine. 2000 Mar;1(2):150–6.
5. Horseman MA, Rather-Conally J, Saavedra C, Surani S. A Case of Severe Heatstroke and Review of Pathophysiology, Clinical Presentation, and Treatment. Journal of Intensive Care Medicine. 2012 Jan 9;28(6):334–40.
6. Jardine DS. Heat Illness and Heat Stroke. Pediatrics in Review. 2007 Jul 1;28(7):249–58.
7. Mirnawati, Nurnaningsih, Asriani R, I Amirullah, Ramadhan Tosepu. Risk of Heat Stroke due to Extreme Heat Changes: A Review. IOP Conference Series Earth and Environmental Science. 2021 Apr 1;755(1):012082–2.
8. Ubaldo OGV, Quiwa K, Rollan RE, Tripon E, Sebastian E. The Fire from Within: Multiorgan Failure with Bimodal Rhabdomyolysis from Exertional Heat Stroke. Case Reports in Hepatology. 2020 Feb 7; 2020:1–7.
9. Yaqub B, Al Deeb S. Heat strokes: aetiopathogenesis, neurological character- istics, treatment and outcome. Journal of the Neurological Sciences. 1998 Apr;156(2): 144–51.