

## Clinical Characteristics of Critically-ill Heat Stroke Population

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### Abstract:

**Background:** During Hajj season of 2015, a significant number of heat stroke cases were reported. This was mainly due to hot weather, which may exceed 40C throughout the day. This review included fifteen critically ill heat stroke patients presented to the King Abdulaziz University Hospital. **Objective:** This study aimed to review clinical presentation, complications and outcomes of these patients. **Methods:** A retrospective study was performed; data were collected from hospital records where all patients received care at the hospital ICU department. Demographic data, clinical and laboratory data and imaging parameters were abstracted. Data were entered and analyzed using the STATA Statistical Package. **Results:** A total of fifteen patients were included. The mean age was 51.2 (10.5) years and 46.7% were females. The mean presenting temperature was 36.1 (1.8). The median GCS was 8 (range 3 to 15). The median hospital stay was 7 days (interquartile range, 17 days). In-hospital mortality occurred in two patients (13.3%). Twelve patients (80%) required admission to the ICU for mechanical and / or hemodynamic support. The median APACHE-2 score was 22 (range 14 to 33). The median ICU stay was 9.5 days (interquartile range, 14.5 days). None ST elevation myocardial infarction was diagnosed in three patients (20%). Seven patients (46.7%) had rhabdomyolysis but acute kidney injury was noted only in four (26.7%) who required Continuous renal replacement therapy and/ or hemodialysis. **Conclusion:** Patients with heat stroke are usually acutely ill with multi organ involvement. While the prognosis has improved with modern medical care, septic shock or renal impairment can carry mortality risk.

**Key Words** – Critical care, Heat stroke, Hajj, pilgrimage, Saudi Arabia

## INTRODUCTION

Every year during the month of Dhu Al-Hijja, more than 2 million Muslims gather in Makkah, Saudi Arabia to perform Hajj, where it's considered one of the largest annual mass gathering in the world performed under high daytime temperatures and physical exertion. Therefore, the risk of heat related illnesses is high. Ministry of Hajj collaborates with the Ministry of Health to improve pilgrims' experience and offers high quality of care and services. To avoid the risk of heat exposure during hajj time, pilgrims are advised to avoid crowded areas. Cool water, conditioned tents and sun-blocking canopies are provided [1].

Heat stroke is one of the exertion -related conditions that may become serious or life threatening if not treated adequately. It is characterized by high body temperature above 40 C°, central nervous system dysfunction and hot, dry skin [2], [3], [6]. Two forms of heatstroke exist, Exertion heatstroke (EHS) generally occurs after strenuous physical activity in a hot environment. Classic non-exertional heatstroke (NEHS) occurs during environmental heat waves. The presenting signs and symptoms will involve all body systems since the temperature of all organs becomes elevated [7].

In this study, we described the clinical characteristics and outcomes of fifteen critically ill heat stroke patients presented to King Abdulaziz University Hospital (KAUH) in Jeddah, Saudi Arabia and who were admitted in the Intensive Care Unit (ICU).

## **SUBJECTS AND METHODS**

All patients admitted with exertional heat stroke during the 2015 Hajj season were identified from administrative records and included. All of them required Intensive Care Unit (ICU) admission. The ICU of KAUH functions as a closed system in which ICU consultants are the physicians in charge while all physicians from the different specialties are called on as-needed consultation basis. The Ethics Research Committee of King Abdulaziz University was addressed and the study was approved by it.

### **Study Design and Patient Population**

Retrospective review of the electronic medical records was performed for all patients. We recorded demographic data, the initial admitting clinical and laboratory parameters, secondary diagnoses at the time of admission, and the hospital course including clinical, imaging, and laboratory parameters.

### **Statistical Analysis**

STATA Statistical Package was used for data entry and analysis. Descriptive statistics were calculated as means or medians for continuous variables, and proportions for categorical variables.

## **RESULTS**

The total of patients included in the study was fifteen patients. There mean age is 51.2 (10.5) years and 46.7% were females. All were non-Saudi nationals. The most common comorbid conditions were diabetes (20%) and hypertension (13.3%). The median body mass index (BMI) was 25.4 (range 17.6 to 33). On presentations, the mean presenting temperature was 36.1 (1.8). The mean systolic and diastolic blood pressure were 129.6 (22) and 78.9 (11.7) mmHg, respectively. The median GCS was 8 (range 3 to 15).

The median hospital stay was 7 days (interquartile range, 17 days). In-hospital mortality occurred in two patients (13.3%): a 59-year-old man from septic shock and a 44-year-old man from complications of renal failure.

## **Organ System Dysfunction**

### **Pulmonary Findings**

Two patients had history of cough upon admission but none had bloody sputum or wheezing. Twelve patients (80%) required admission to the ICU for mechanical and / or hemodynamic support. Seven patients (46.7%) arrived to the hospital already intubated and five more were hemodynamically unstable in the initial triage and were directly admitted to the intensive care unit. The median APACHE-2 score was 22 (range 14 to 33). The median ICU stay was 9.5 days (interquartile range, 14.5 days). The mean baseline pH level was 7.31 (0.08). The diagnostic criteria for acute respiratory distress syndrome (ARDS) were met by only one patient. Five patients (33%) had bacterial pneumonia but none had pleural effusion or pneumothorax.

### **Cardiovascular Findings**

The mean reading for admission mean arterial pressure (MAP) was 80.2 mmHg (22.1). The mean baseline troponin level was 4.7 (median 2, range 0.04 to 20.7). None of the patients developed right or left ventricular dysfunction. However, none ST elevation myocardial infarction (NSTEMI) was present in three patients (20%). Five patients (33%) developed arrhythmias that were controlled pharmacologically.

### **Renal Findings**

The mean baseline serum creatinine was 159 mg/ dl (64.3) while serum blood urea nitrogen level was 9.5 (4.5). Seven patients (46.7%) had rhabdomyolysis but acute kidney injury was noted only in four (26.7%). Two patients required both Continuous renal replacement therapy (CRRT) and hemodialysis (HD) while of the remaining two: one had CRRT and the other HD.

### **Gastroenterology Findings**

Upon admission, only one patient gave a history of nausea and vomiting. There was no history of diarrhea or melena on admission in all patients. Only one patient had a prior history of chronic liver disease. Elevated levels of aspartate aminotransferase (AST) or alanine aminotransferase (ALT) were mostly associated with abnormal Baseline liver enzymes in 50% of the patients. The median admission AST was 207 U/L (median 207 U/L, range 34 to 2560) while the mean ALT was 307 U/L (median 95 U/L, range 15 to 1648). These readings increased during hospitalization to reach its peak level on day 3 and then subsided. During hospitalization, none of the patients developed any GI bleeding or pancreatitis

### **Infectious Disease**

One patient only had a positive nasal swap for Methicillin-resistant *Staphylococcus aureus* (MRSA) upon admission. Infections defined as positive cultures of the blood, urine, or endotracheal aspirate were noted in seven patients (46.7%). Five patients had organisms cultured from the blood including Extended spectrum beta-lactamase (ESBL) (3 patients) and were urinary tract included *Escherichia coli* (4 patients), *Staphylococcus hominis* (one patient). Cultures for suspected urinary tract infection were positive in three patients (ESBL, *Klebsiella*, and *Enterococcus faecalis*). Endotracheal sputum cultures showed *Klebsiella* (2 patients), MRSA (1 patient) and *Strep viridans* (1 patient).

### **Neurologic Findings DIC**

There was not documented history of headache in any of the patients. On admission, the median Glasgow Coma Scale (GCS) was 8 (IQR 4). One patient was reported to have has suffered a stroke during his hospitalization (a 42-year-old man).

### **Hematologic Findings**

The mean values of admission, three-day, and two-week hematological parameters are summarized in

**Table 1. mean values of admission**

Parameter	Day			
	1	3	7	14
Hb	12.3	11.4	10.1	8.8
WBC	15	13.6	11.3	14.1
PLT	111.7	110.1	184	269.5
PTT	48.6	58.4	31.7	35.8
PT	17.9	17.9	11.8	11.4
INR	1.6	1.6	1.1	1

During hospitalization, three patients (20%) had a hemoglobin reading less than 7 g/ dl and 2 patients (13.3%) required transfusion of a total of seven units. Four patients (26.7%) had evidence of disseminated intravascular coagulation, defined by intravascular formation of fibrin due to the widespread activation of coagulation, which results in the thrombotic occlusion of small and midsize vessels. Multiple organ failure can be followed if the blood supply to organs or the hemodynamics and metabolic derangements occurred which is attributed to intravascular coagulation. At the same time, the use and subsequent depletion of platelets and coagulation proteins may induce severe bleeding (9).

Three out of the four patients who required platelet and fresh frozen plasma transfusions had evidence of DIC. One patient required cryoprecipitate transfusion and had evidence of DIC. One of the four DIC patients died in hospital.

### **DISCUSSION**

There are number of factors related to increase the risk of development of heat stroke; almost all of which are encountered during the hajj. There is excessive heat exposure at all locations and rituals related to hajj. These have an impact on increasing the risk of developing heat stroke [5]. Also, pilgrims with pre-existing medical conditions can have an increased risk of heat stroke. However, in this study the majority of patients were medically free from chronic medical conditions.

Depressed level of consciousness is present in almost all patients with heat stroke as the brain is sensitive to hyperthermia. Seizures occur in about 60% of heat stroke patients, over two third of patients

were found to have constricted pupils and pinpoint. Prolonged hyperthermia can lead to the development of coma which has a poor prognostic sign and subsequent chronic disabilities [6].

The cardiovascular system has the ability to compensate for heat-related conditions, thus the pilgrim age plays an important role, and elderly usually have a greater risk [7]. Hospital admission during hajj time and hot weather is higher in elderly and patients with associated co-morbid conditions [4]. The excessive circulatory requirements in heat stroke patients are mostly manifested with sinus tachycardia [6].

In a study that involved 160 patients from Arafat and Mina hospitals, most of them presented with lower respiratory tract infection, exacerbation of bronchial asthma and COPD [4]. Victims with heat stroke related conditions the most commonly involved systems are; respiratory system (57%) followed by cardiovascular system (19.4%), and gastrointestinal tract (6.35) [4] Victims who are suspected to have been developed heat stroke should be immediately treated and investigated for multiple organ damage [6].

Respiratory complications in heat stroke patients most commonly present with hyperventilation. Those patients can develop respiratory alkalosis and tetany if not treated early. In heat stroke patients acute respiratory distress syndrome ARDS was linked to the development of disseminated intravascular coagulation (DIC) [6]. In severe heat stroke 25% of patients are at risk to develop acute renal failure. The major cause is decreased renal blood flow that is followed by hydration and peripheral vasodilation [6]. Another study demonstrated that there is no increase in mortality among hospitalized patients with past history of diabetes, hypertension and cardiac disease but underlying chronic lung disease was a significant mortality predictor [8]. A review on the effect of heat on the morbidity and mortality of elderly patients presented that a 1c° rise in temperature is associated with increased cardiovascular, respiratory, diabetes mellitus, genitourinary, infectious disease and heat-related morbidity [10].

The highest increases in risk of mortality for heat induced were observed in cerebrovascular, cardiovascular and respiratory outcome [10]. Crowding conditions during hajj time and Hajj pilgrims with median age of 61 years old were suffering a chronic and debilitating disease associated with increased risk of health issues. The frequency of diabetes, high blood pressure, and hypercholesterolemia was significantly higher [11]. It was found that elderly pilgrimage and the most vulnerable groups were individuals with low socioeconomic status and low education levels. Thus, government should focus on health education campaigns to elevate awareness and sensibility to the negative effect of heat waves during hajj time [12].

This study is restricted to a single tertiary hospital and a limited number of subjects. Therefore, the results of this study can't estimate the whole population of pilgrims participating in the Hajj, but it can outline valuable information about the clinical presentation, complication and outcome of patients who presented with heat stroke at King Abdulaziz university hospital.

## **CONCLUSION**

This study was designed to describe the characteristics of patient presenting with heat stroke during hajj time. The study revealed that many of those patients require immediate hospitalization and intensive care especially the old age with chronic medical illnesses. The mortality has improved with modern medical care although septic shock and renal impairment may carry a mortality risk in these patients.

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