Heat Stroke in the Prehospital Setting: Clinical Characteristics, Management, and Factors Associated with Mortality in Central-Eastern Tunisia

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Abstract

Background: Heat stroke is a life-threatening medical emergency characterized by a rapid elevation of core body temperature (>40 °C) associated with neurological and cardiovascular disturbances, potentially leading to multiple organ dysfunction syndrome.

Objective: To describe the clinical, therapeutic, and prognostic characteristics of heat stroke in the prehospital setting and to identify factors associated with mortality.

Methods: A descriptive cross-sectional study was conducted by Emergency Medical Service EMS 03 in central-eastern Tunisia (Mahdia, Monastir, Sousse, and Kairouan) over three months (June–August 2023). Twenty-seven adult patients presenting with non-exertional heat stroke were included. Data were collected using a standardized form and analyzed using SPSS version 25.0. Descriptive and univariate analyses were performed to identify factors associated with mortality.

Results: The mean age was 75 ± 17.5 years, with a female predominance (55.6%). Most patients had comorbidities (85.2%). Hyperthermia and neurological impairment were constant findings; 51.9% of patients were comatose. Multiorgan involvement included acute kidney injury (33.3%), rhabdomyolysis (14.8%), metabolic acidosis (14.8%), and coagulation disorders (18.5%). Prehospital management included physical cooling (92.6%), pharmacological cooling (70.3%), oral hydration (48.1%), intravenous fluid resuscitation (85.1%), oxygen therapy (48.1%), and mechanical ventilation (22.2%). Mortality was 33.3%. Univariate analysis identified the following predictors of mortality: core temperature, confusion, coma, visceral involvement, hemodynamic instability, acute kidney injury, metabolic acidosis, coagulation disorders, rhabdomyolysis, use of mechanical ventilation, vasoactive drugs, and oral hydration. The type of cooling method was not significantly associated with the outcome.

Conclusion: Heat stroke remains a severe condition with high mortality. Early identification of high-risk patients and prompt prehospital intervention are essential to improve outcomes. Despite rapid management, multiorgan failure remains a major contributor to mortality, highlighting the need for further studies to optimize therapeutic strategies.

Keywords: Heat Stroke, Prehospital Care, Management, Mortality

Introduction

Heat stroke is a life-threatening medical emergency (1). Clinically, it is defined by the association of a rapid rise in core body temperature above 40 °C with neurological disturbances (delirium, seizures, or coma) and cardiovascular dysfunction (2.3). An alternative definition based on pathophysiology considers heat stroke as a form of hyperthermia associated with a systemic inflammatory response leading to multiple organ dysfunction syndrome, primarily encephalopathy (2). Despite improvements in cooling techniques and therapeutic management, the risk of progression to multi-organ failure and mortality remains high (2).

The objectives of this study were to describe the clinical, therapeutic, and prognostic characteristics of 27 cases of heat stroke managed in the prehospital setting and to identify predictors of mortality through univariate analysis.

Methods

This was a descriptive cross-sectional study conducted by EMS 03 in central-eastern Tunisia (four governorates: Mahdia, Monastir, Sousse, and Kairouan) over three months (June–August 2023). The study population included victims of heat stroke managed by EMS 03 teams during the summer heat wave.

Inclusion criteria: Patients aged 18 years or older who were managed for heat stroke (2) occurring at rest.

Exclusion criteria: Patients younger than 18 years and those presenting with exertional heat stroke.

Data Collection and Statistical Analysis: Data were collected using a specific form completed by EMS teams, including epidemiological, clinical, therapeutic, and prognostic information.

Statistical analysis was performed using SPSS version 25.0.

Continuous variables were expressed as mean ± standard deviation with minimum and maximum values; qualitative variables as frequencies and percentages.

Univariate analysis: Univariate analysis was performed to compare deceased and surviving patients. The chi-square test was used for comparisons.

Results

We enrolled 27 patients. Most patients were female (15/27; 56%), with a sex ratio of 1.27. The mean age was 75 years (range: 27–97 years). Most calls to EMS 03 originated from Sousse (55%), followed by Monastir (26%), Kairouan (11%), and Mahdia (7%) (Table 1).

Table 1: Distribution of patients according to the Mobile Emergency Medical Service (MEMS) unit involved

MEMS unit	Value
MEMS Hached Sousse	8 (30)
MEMS Sahloul Sousse	7 (26)
MEMS Monastir	7 (26)
MEMS Kairouan	3 (11)
MEMS Mahdia	1 (4)
MEMS Jem	1 (4)
Total	**27 (100)**

Most patients had a history of comorbidities (86%). Core temperature was elevated in all patients, with a mean of 40.6 ± 1.6 °C (range: 38.5–43 °C) (Table 2).

Neurological disorders were present in most cases (89%). Fourteen patients (52%) were comatose, with a mean Glasgow Coma Scale score of 9 ± 4.2. Cardiovascular disturbances were observed in 81% of cases, with arterial hypotension (systolic blood pressure ≤ 90 mmHg) in 6 patients (22%). Signs of dehydration were noted in 44% of cases. Respiratory distress was observed in more than half of the patients (55%).

From a biological standpoint, rhabdomyolysis was identified in 4 cases (14.8%), acute kidney injury in 9 cases (33%), metabolic acidosis in 4 cases (15%), and coagulation disorders in 5 cases (18%).

Table 2: Clinical symptoms at admission

Clinical parameter	n
Confusion	17 (63)
Headache	13 (48)
Fatigue	13 (48)
Coma	10 (37)
Dizziness	10 (37)
Dehydration	12 (44)
Dry, erythematous skin	12 (44)
Thirst	5 (18)
Syncope	6 (22)
Nausea and vomiting	3 (11)
Muscle cramps	3 (11)
Seizures	0 (0)

Regarding therapeutic management, 25 patients (93%) received physical cooling, and 19 patients (70%) had pharmacological cooling. Oral hydration was administered in 13 cases (48%), and 23 patients (85%) received intravenous infusion of cooled fluids. Three patients (11%) required vasoactive drugs. Oxygen therapy was provided to 13 patients (48.1%), with mechanical ventilation required in 6 cases (22%).

In terms of outcomes, 9 of 27 patients (33%) died, while 18 patients (67%) improved. Recovery was without sequelae in 9 cases and with sequelae in 9 cases. Most sequelae were neurological (8/9). Cardiac sequelae were observed in 2 cases, renal sequelae in 2 cases, and hematological sequelae in 1 case.

According to univariate analysis, factors associated with mortality were core temperature, confusion, coma, visceral involvement, hemodynamic instability, acute kidney injury, metabolic acidosis, coagulation disorders, rhabdomyolysis, use of mechanical ventilation, vasoactive drugs, and oral hydration. No significant difference was observed with respect to cooling methods (Table 3).

Table 3: Factors Associated with Mortality

	Number of cases n (%)	Deceased patients n (%)	P
Clinical factors			
Core temperature			
< 40°C	10 (37)	2(7)	0.001
≥ 40°C	17 (63)	7(26)	
Confusion			
Yes	17(63)	2 (7)	0.002
No	10(37)	7(26)	
Visceral involvement			
yes	20(74)	9(33)	0.030
no	7(30)	0(0)	
Glasgow Coma Scale			
(GCS)	14 (52)	8(30)	0.001
≤8	13(48)	1(4)	
>8-15			
Hemodynamic			
instability	6(22)	6(22)	0.001
yes	21(78)	3(11)	
No			
Rhabdomyolysis			
Yes	4(15)	4(15)	0.001
No	23(85)	5(18)	
Acute kidney injury			
Yes	9(33)	5(18)	0.026
No	18(67)	4(15)	
Metabolic acidosis			
yes	4(15)	4(15)	0.001
No	23(85)	5(18)	
Coagulation disorders			
yes	5(18)	4(15)	0.014
No	22(81)	5(18)	
Therapeutic factors			
Use of mechanical			
ventilation (MV)	6(22)	5(18)	0.003
yes	21(78)	4(15)	
No			
Use of			
catechola	3(11)	3(11)	0.009
mines,	24(89)	6(22)	
Yes			
No			
Oral			
hydration			
yes	13(48)	1(4)	
No	14(52)	8(30)	0.006

Discussion

Our results confirm that heat stroke remains a severe condition associated with high mortality, particularly among elderly patients with comorbidities. The 333% mortality rate observed in our series is consistent with data reported in recent international literature. Bouchama et al., in a comprehensive 2022 Nature Reviews Disease Primers article, reported intensive-care mortality rates of 63.2% for classic heat stroke and 26.5% for exertional heat stroke, highlighting the particularly poor prognosis of the non-exertional form that predominated in our cohort (1). A multicenter study conducted in southwestern China during the 2022 heat wave similarly reported high ICU mortality among classic heat stroke patients, with initial neurological symptoms identified as an independent predictor of poor outcome (2). These findings underscore the ongoing and increasingly urgent public health relevance of heat stroke in the context of accelerating climate change.

The epidemiological profile of our patients is consistent with the recent literature. The predominance of elderly individuals with multiple comorbidities aligns with findings from Yezli et al., whose 2023 systematic review of 2,632 classic heat stroke cases confirmed that older age, cardiovascular disease, and neurological impairment are hallmarks of the non-exertional form of the disease (3). Similarly, a large Japanese nationwide cohort study demonstrated that the presence of symptomatic comorbidities, particularly cardiovascular and renal disorders, significantly worsened prognosis in heat stroke patients (4). In our study, the mean age of 75 years and the 85.2% prevalence of comorbidities reflect a highly vulnerable population, consistent with the recognized risk profile for classic heat stroke during heat waves. The female predominance observed (56%) may reflect the higher proportion of elderly women in the general population and their increased physiological vulnerability to thermal stress.

The neurological impairment observed in our series, with 52% of patients in coma (GCS $\leq$8) and 89% presenting neurological dysfunction, confirms the severity of the classic form of heat stroke. Coma and a low GCS score were among the strongest predictors of mortality in our univariate analysis (p=0.001), which is in line with recent studies. A retrospective cohort study including 203 heat stroke patients found the APACHE II score and core temperature at 30 minutes after admission to be independent risk factors for 30-day mortality, with a 28.08% mortality rate (5). A study from Eastern India in 2024 similarly identified a GCS below 9 and hemodynamic instability as significant predictors of death (6). These convergent findings reinforce the importance of systematic neurological assessment as an early triage tool in prehospital settings.

The biological abnormalities observed in our cohort reflect multiorgan dysfunction and were strongly associated with poor outcomes. Acute kidney injury (p=0.026), metabolic acidosis (p=0.001), rhabdomyolysis (p=0.001), and coagulation disorders (p=0.014) were each significantly associated with mortality. These findings are consistent with the pathophysiological framework described by Bouchama et al. (2022), who emphasized that systemic inflammation, endothelial injury, and disseminated intravascular coagulation are central mechanisms driving organ failure in heat stroke (1). Yezli et al. (2023) similarly demonstrated that laboratory markers of coagulation dysfunction and end-organ damage are among the most reliable early indicators of fatal outcome in classic heat stroke (3). The prehospital identification of these markers, while challenging, should guide the prioritization of rapid transport and aggressive resuscitation.

Regarding therapeutic management, rapid cooling remains the cornerstone of treatment. In our series, no significant difference in mortality was observed according to cooling modality (physical

versus pharmacological cooling), suggesting that early intervention and baseline clinical severity are more decisive than the specific technique employed. This observation is consistent with the conclusions of a 2020 systematic review and meta-analysis by Douma et al., which found that water immersion techniques were superior to passive cooling in terms of cooling rate but that no single modality was unequivocally associated with improved survival outcomes in classic heat stroke (7). A recent study focusing on prehospital cooling strategies in community-acquired heat stroke similarly highlighted the predominant use of evaporative cooling in field settings. Authors found that delays in cooling initiation, rather than the choice of method, were the primary determinant of prognosis (8). The 2021 ACSM Expert Consensus Statement on exertional heat illness further emphasizes that the time from collapse to starting cooling is the critical variable in determining patient outcomes (9). In our cohort, the use of mechanical ventilation (p=0.003) and vasoactive drugs (p=0.009) was significantly associated with mortality, likely reflecting the greater severity of illness in patients requiring these interventions rather than any adverse effect of the treatments themselves. Interestingly, oral hydration was inversely associated with mortality (p=0.006), which may be explained by the fact that patients safely receiving oral fluids were less severely impaired at presentation.

The limitations of this study include its relatively small sample size (n=27), its retrospective single-service design, and the absence of multivariate analysis, which precludes the identification of independent predictors of mortality. The study period (June–August 2023) covers a single heat season, and findings may not be fully generalizable across all climatic contexts. Future multicenter prospective studies with larger cohorts are needed to validate the prognostic factors identified here and to evaluate the impact of structured prehospital cooling protocols on patient outcomes in the Tunisian context.

Conclusion

Heat stroke is a major public health issue associated with high morbidity and mortality. Prehospital management by emergency medical teams is crucial to limit complications. In this EMS 03 study conducted during the 2023 heat wave in Tunisia, mortality reached 33.3%, with several clinical, biological, and therapeutic factors identified as predictors of death. Despite rapid management, mortality remains high, underscoring the need for further studies to optimize treatment strategies.

References

1. *Bouchama A, Abuyassin B, Lehe C, Laitano O, Jay O, O'Connor FG, et al. Classic and exertional heatstroke. Nat Rev Dis Primers. 2022;8:8.*
2. *Wang Y, Zhang L, Chen X, et al. Heatstroke: a multicenter study in Southwestern China. Front Public Health. 2024;12:1349753.*
3. *Yezli S, Yassin Y, Ghallab S, et al. Classic heat stroke in a desert climate: a systematic review of 2632 cases. J Intern Med. 2023;294(1):7-20.*
4. *Inukai K, Narikawa R, Kishitani S. et al. Impact of symptomatic comorbidities on heatstroke outcomes: a retrospective nationwide cohort study. Sci Rep. 2026;16:6244.*
5. *Li A, Zhang Y, Zhang X, et al. Predictive factors and nomogram for 30-day mortality in heatstroke patients: a retrospective cohort study. West J Emerg Med. 2025 ;26:657-666.*
6. *Bhushan D, Dogney M, Kumar D, et al. Clinical profile and outcomes of patients with heat stroke: an observational study from a tertiary care center in Eastern India. Wilderness Environ Med. 2026;37:12-16.*
7. *Douma MJ, Aves T, Allan KS, et al. First aid cooling techniques for heat stroke and exertional hyperthermia: a systematic review and meta-analysis. Resuscitation. 2020;148:173-190.*
8. *Cong S., Zheng G., Liang X. et al. Pre-hospital cooling in community-acquired heat stroke: evidence, challenges, and strategies. Am J Emerg Med. 2025. Eur J Med Res. 2025 11;30:472.*
9. *Roberts WO, Armstrong LE, Sawka MN, et al. ACSM Expert Consensus Statement on Exertional Heat Illness: recognition, management, and return to activity. Curr Sports Med Rep. 2021;20:470-484.*