

OUTCOME OF PATIENTS ADMITTED WITH EXERTIONAL HEAT RELATED ILLNESS IN INTENSIVE CARE UNIT OF TERTIARY CARE HOSPITAL

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ABSTRACT

Introduction

Exertional heat related illness particularly heat stroke is very common life threatening condition that frequently occur in young military trainee due to high ambient temperature and humidity.

Objective

The study was undertaken to identify its outcome in recruits admitted in intensive care units of military tertiary care hospital.

Methods

An observational cross-sectional descriptive study was done among those recruits admitted in Intensive Care Unit of military tertiary care hospital with diagnosis of heat related illness from June 2016 to August 2017 A.D. Data based on hospital case records were collected and analyzed using SPSS version 22. Primary outcome studied was mortality. Secondary outcomes studied were length of stay in ICU, hospital and on ventilator.

Results

Out of 17 recruits, 12 were diagnosed as heat exhaustion and 5 were diagnosed as heat stroke. SOFA score for heat stroke and heat exhaustion patients ranged from 2-16 and 0-2 with respective mortality rate 7-95% and 0-7%. APACHE II score for heat stroke and heat exhaustion patients ranged from 5-33 and 0-5 with respective mortality rate 5.80-73% and 0-5.80%. There was no mortality among 12 heat exhaustion patients. Out of 5 heat stroke patients, 3 died with 60% mortality rate. Heat stroke patients had maximum stay of 4 days in ICU, hospital for 5 days and ventilator for 4 days.

Conclusions

Exertional heat related illness is common in young military trainee with heat exhaustion and heat stroke being common causes for ICU admission. Heat stroke has higher mortality rate due to multiple organ dysfunction.

KEYWORDS

Heat stroke, military recruits, outcome

INTRODUCTION

Heat related illness (HRI) due to high ambient temperature and humidity are very common in tropical region of Nepal during summer.¹ Exertional heat related illness particularly heat stroke is a life threatening condition that frequently occur in young military trainee.^{2,3,4}

Heat related illness occurs when there is failure of thermoregulatory response to maintain core body temperature between 36° - 38° C.⁵ Types of HRI are heat cramps (muscle cramping), heat syncope (fainting), heat exhaustion (hypotension followed by collapse) and heat stroke which is the severe form where core body temperature is >40°C leading to central nervous system dysfunction.⁶ Mortality rate of heat stroke varies from 10 - 70 % with persistent neurological damage in 7-20% of survivors.⁶ Heat stroke can be non- exertional or exertional resulting from excessive heat production during strenuous activity.^{5,6}

Every year many recruits suffer from HRI at Nepali Army training centre. The objective of the study was to identify clinical outcomes of exertional heat related illness in those recruits who were admitted in ICU of military tertiary care hospital.

METHODS

After an ethical approval of Institutional Research Committee (IRC), an observational cross-sectional descriptive study was conducted among those recruits involved in military training at recruit training centre of Nawalparasi who were admitted in Intensive Care Unit (ICU) of military tertiary care hospital with the diagnosis of exertional heat related illness (HRI) from June 2016 to August 2017 A.D.

Inclusion criteria were all male military recruits involved in long distance running during their training in monsoon season from June to August, referred to ICU of military tertiary care hospital with signs & symptoms of exertional HRI like heat cramps, heat syncope, heat exhaustion and heat stroke. All other military recruits with diagnosis of non exertional heat related illness were excluded. After stratified random sampling, data were collected based on hospital case records. Out of 83 soldiers who have HRI in 2 years, 17 were referred and admitted to ICU of military tertiary care hospital. Diagnosis was made based on clinical presentations. Baseline clinical and investigation data were obtained from

individual case records included in the study. Clinical variables (Table 3) such as body temperature, heart rate, respiratory rate, mean arterial pressure and Glasgow Coma Scale (GCS) were noted. Major outcome variables (Table 4) such as complete blood count, coagulation profile, arterial blood gas analysis, liver function tests, renal function tests and hemodynamic stability were obtained. Predictor variables (Table 3 and Table 4) obtained were temperature, respiratory rate, heart rate, mean arterial pressure, use of ionotropes/vasopressors (Noradrenaline/Dopamine), total leukocyte count, hematocrit, platelet count, serum creatinine, serum sodium, serum potassium, bilirubin, arterial pH, PO₂/FiO₂ ratio, arterial bicarbonate, GCS and urinary output. Based on predictor variables, severity of illness for outcome prediction was assessed within 24 hr of diagnosis of heat related illness using Acute Physiology and Chronic Health Evaluation (APACHE) II and Sequential Organ Failure assessment (SOFA) scoring system. All the data were entered and analysis was done using Statistical Package for Social Sciences (SPSS) version 22. Primary outcome studied was mortality or discharged after improvement. Secondary outcomes studied were length of ICU stay, length of hospital stay and number of days on ventilator.

RESULTS

Out of the 17 recruits, 12 (70.58%) was diagnosed as heat exhaustion with 8 (66.66%) in 2016 A.D. and 4 (33.33%) in 2017 A.D. whereas remaining 5 recruits (29.41%) was diagnosed as heat stroke with 3 (60%) in 2016 A.D. and 2 (40%) in 2017 A.D. (Table 1)

Table 1: Frequency distribution of HRI admitted in ICU in 2016-2017 A.D.

Types of HRI admitted	2016 A.D	2017 A.D.	TOTAL
Heat Exhaustion (HE)	8	4	12
Heat Stroke (HS)	3	2	5

Out of the 12 heat exhausted patients, no one had mortality thereby all improved and discharged. Out of 5 heat stroke patients, three died with 60% mortality rate. (Table 2)

Table 2: Mortality rate of HRI admitted in ICU in 2016-2017 A.D.

Types of HRI admitted	2016 A.D	2017 A.D.	TOTAL	Mortality Rate (%)
Heat Exhaustion (HE)	0	0	0	0
Heat Stroke (HS)	1	2	3	60 (3 out of 5)

Table 3: Clinical variables of HRI admitted in ICU in 2016-2017 A.D.

ICU Diagnosis	Temperature (°F)	Mean arterial pressure /MAP (mm of Hg)	Heart Rate (bpm)	Respiratory Rate (per min)	Glasgow Coma Scale (GCS)
Heat stroke	101.00	55.00	120.00	30.00	8.00
Heat Exhaustion	99.00	68.00	84.00	16.00	14.00
Heat stroke	101.00	65.00	100.00	24.00	13.00
Heat stroke	100.00	67.00	94.00	20.00	13.00
Heat Exhaustion	99.60	70.00	84.00	12.00	14.00
Heat Exhaustion	98.60	67.00	88.00	16.00	13.00
Heat Exhaustion	100.60	66.00	76.00	20.00	13.00
Heat Exhaustion	99.60	72.00	84.00	20.00	14.00
Heat stroke	102.00	60.00	130.00	30.00	3.00
Heat stroke	101.00	58.00	126.00	36.00	3.00
Heat Exhaustion	100.00	65.00	72.00	16.00	14.00
Heat Exhaustion	99.60	68.00	76.00	16.00	15.00
Heat Exhaustion	100.60	66.00	72.00	16.00	15.00
Heat Exhaustion	100.00	70.00	80.00	16.00	15.00
Heat Exhaustion	99.40	72.00	84.00	16.00	15.00
Heat Exhaustion	100.20	74.00	86.00	16.00	15.00
Heat Exhaustion	100.40	72.00	90.00	16.00	15.00

Table 4: Outcome variables of HRI admitted in ICU in 2016-2017 A.D.

ICU Diagnosis	PaO ₂ /FiO ₂	HCO ₃ (mEq/L)	pH	Na(mEq/L)	K(mEq/L)	Cr(mg/dl)	Bilirubin (mg/dl)	Hematocrit	TLC(cmm)	Platelet(cmm)
Heat stroke	288.00	18.00	7.22	139.00	3.50	1.90	0.60	32.00	14300	175,000
Heat Exhaustion	350.00	26.00	7.42	142.00	4.00	0.60	1.00	36.00	11200,	1,78,000
Heat stroke	224.00	24.00	7.39	142.00	3.70	1.60	1.20	34.00	13550	164,000
Heat stroke	288.00	26.00	7.42	138.00	3.20	1.40	1.10	36.00	12880	170,000
Heat Exhaustion	326.00	22.00	7.36	138.00	3.60	0.80	0.80	40.00	11,000	1,64,000
Heat Exhaustion	346.00	23.00	7.38	136.00	3.50	0.60	0.80	44.00	10,800	1,66,000
Heat Exhaustion	300.00	20.00	7.33	140.00	3.80	1.00	0.60	39.00	10,400	1,74,000
Heat Exhaustion	348.00	24.00	7.39	138.00	3.60	0.80	0.80	33.00	10,800	1,52,000
Heat stroke	92.00	20.00	7.33	109.00	2.70	2.40	0.30	30.00	14500	<75,000
Heat stroke	106.00	22.00	7.34	126.00	2.40	2.80	0.80	28.00	13800	90,000
Heat Exhaustion	366.00	25.00	7.41	140.00	3.80	1.00	0.60	45.00	11,000	1,76,000
Heat Exhaustion	436.00	26.00	7.42	140.00	3.80	1.00	0.60	36.00	8000	168,000
Heat Exhaustion	427.00	28.00	7.44	138.00	3.60	0.80	0.80	39.00	7800	172,000
Heat Exhaustion	448.00	27.00	7.43	144.00	4.20	0.80	1.00	42.00	7600	1,78,000
Heat Exhaustion	456.00	26.00	7.45	142.00	4.00	0.60	1.00	33.00	6400	1,58,000
Heat Exhaustion	444.00	24.00	7.42	136.00	3.50	0.60	0.80	45.00	6000	1,60,000
Heat Exhaustion	452.00	25.00	7.46	142.00	4.00	0.80	0.60	48.00	7200	1,76,000

Severity of HRI was studied by using SOFA and APACHE II scoring system (Table 5 and Table 6). Out of 12 Heat exhaustion patients (Table 5), six has zero SOFA and APACHE II scores.

Table 5: Mortality prediction of HE by severity of illness using SOFA and APACHE II Scores

S.N	SOFA Score of HE	Predicted Mortality rate (%)	APACHE II Score of HE	Predicted Mortality rate (%)
1	2.00	7.00	5.00	5.80
2	2.00	7.00	5.00	5.80
3	2.00	7.00	5.00	5.80
4	2.00	7.00	5.00	5.80
5	2.00	7.00	5.00	5.80
6	2.00	7.00	5.00	5.80

Table 6: Mortality prediction of HS by severity of illness using SOFA and APACHE II Scores

S.N.	SOFA Score of HS	Predicted Mortality rate (%)	APACHE II Score of HS	Predicted Mortality Rate (%)
1	9.00	33.00	18.00	33.00
2	5.00	20.00	7.00	7.60
3	2.00	7.00	5.00	5.80
4	16.00	95.00	33.00	73.00
5	15.00	95.00	30.00	70.00

The mean SOFA scores (Table 7) for heat stroke patients were 9.40 ± 6.10 with predicted mortality rate of 50%. The mean SOFA score for heat exhaustion patients was 1 ± 1.04 with predicted mortality rate of 3.50%. The mean APACHE II scores (Table 7) for heat stroke patients were 18.60 ± 12.81 with predicted mortality rate of 37.88%. The mean APACHE II score for heat exhaustion patients was 2.50 ± 2.61 with predicted mortality rate of 2.90%. The common organ systems involved were neurological (64.70%), cardio-respiratory (29.41% patients) and renal (29.41%) with 100% involvement of these organ systems in heat stroke.

Types of HRI	Mean SOFA Score \pm SD	Predicted Mortality Rate (%)	Mean APACHE II Score \pm SD	Predicted Mortality rate (%)
Heat Exhaustion	1 ± 1.04	3.50	2.50 ± 2.611	2.90
Heat Stroke	9.40 ± 6.10	50	18.60 ± 12.818	32.53

Among those one died in 2016 (33.33%) where as two (66.66%) died in 2017. The secondary outcome of heat related illness (Table 8) was studied in terms of mean ICU stay, mean Hospital stay and mean Ventilator stay. The mean ICU stay among HRI patients was 2.44 ± 0.85 SD with maximum stay of four days in one (5.60%) heat stroke patient and minimum stay of one day (16.7 %). The mean hospital stay among HRI patients was 3.28 ± 1.07 SD with maximum stay of five days in one heat stroke patient (5.60%) and minimum stay of two days (11.10 %). The mean stay on ventilator among HRI patients all being those of heat stroke was 0.39 ± 0.97 day with maximum stay for four days in one heat stroke patient (5.60%) and minimum stay for one day in three heat stroke patients (16.70%).

Table 8: Secondary outcome of Heat related illness

Types of HRI	Mean ICU stay \pm SD	Mean Hospital stay \pm SD	Mean Ventilator days \pm SD
Heat Exhaustion	2.40 ± 0.82	2.80 ± 0.82	0
Heat Stroke	2.55 ± 1.34	3.45 ± 1.64	1.20 ± 1.64

DISCUSSION

Heat-related illness (HRI) due to high ambient temperature and humidity is a common feature in Terai (Southern) region of Nepal during summer.¹ HRI particularly heat stroke results in Intensive Care Unit (ICU) admissions^{2,3,4} and is associated with significant morbidity and mortality.^{5,6} There has been studies in marine corps recruits in United Kingdom⁷ and military recruits in United States Army⁸ dealing with risk factors of heat related illness but none has described about its outcome.

In our study, we found that out of the 17 recruits, 12 (70.58%) was diagnosed as heat exhaustion whereas remaining 5 recruits (29.41%) was diagnosed as heat stroke. We used SOFA score^{9,10} and APACHE II scoring system¹¹⁻¹³ to assess the severity of HRI admitted in ICU. They are common scoring systems used in critically ill patients to assess disease severity and predict their outcome in terms of mortality. We found that both the SOFA and APACHE II scores showed high mean score for patients with heat stroke

(9.40 ± 6.10 and 18.60 ± 12.81) patients than for heat exhaustion (1±1.04 and 2.50 ± 2.61). The predicted mortality rate as shown by both scores for heat stroke was 50% and 37.88% where as that for heat exhaustion was 3.50% and 2.90%. The actual mortality rate observed in our study was 60% for heat stroke patients (three out of five) and none for heat exhaustion thereby showing that severity of illness were related to mortality. Our result was similar to the retrospective study done by Kalaiselvan MS et al² in India where mortality rate was 34% in nine heat stroke patients among 26 heat related illness patients.

The secondary outcome of our study as observed in terms of mean ICU stay, mean hospital stay and mean stay on ventilator days showed that heat stroke patients had maximum stay as compared to heat exhaustion thereby related to mortality. Neurological (67.40%), cardio-respiratory (29.41%) and coagulation dysfunction (29.41%) were seen as the main causes of mortality which were similar to that done by Kalaiselvan et al where there was 100 % involvement of neurological system.

CONCLUSION

Exertional heat related illness is common in young military trainee with heat exhaustion and heat stroke being common causes for ICU admission. Heat stroke has higher mortality rate due to multiple organ dysfunction.

RECOMMENDATIONS

We recommend larger case control or cohort study involving multiple training centers throughout the country that can tell us the association of various risk factors with outcome.

LIMITATIONS

The limitation of our study was smaller size of study population thereby not representing recruits from other military training centre of Nepali Army. Multihospital based study must be done to find outcome of heat related illness not only in recruits from Nepali Army but also from Armed Police Force and Nepali Police. Similarly, our study does not tells us about the association of outcome with risk factors.

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CONFLICT OF INTEREST

none

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