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ACCIDENTAL HYPOTHERMIA AND RELATED RISK FACTORS AMONG TRAUMA PATIENTS IN PREHOSPITAL SETTING

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ABSTRACT

INTRODUCTION: Hypothermia is highly prevalent among trauma patients. If hypothermia is diagnosed and managed early, complications from hypothermia can be reduced. This study aimed to determine the prevalence of accidental hypothermia and related factors in prehospital trauma patients.

MATERIAL AND METHODS: This is a single-center prospective observational study. From 2 to 16 November 2018, 132 trauma patients were selected by convenience sampling. To collect data, the patient's core body temperature (CBT) and the temperature of the ambulance cabin were measured as the patient left the ambulance. A combination of observation and emergency medical technician records was used to identify factors influencing hypothermia onset or exacerbation. SPSS 16 was used to analyze the data using descriptive statistics and multiple logistic regression. A significance level of 5% was considered.

RESULTS: It was calculated that 44.1% of prehospital trauma patients had accidental hypothermia. The predicting variables for accidental hypothermia in trauma patients were found to be level of consciousness (OR = 2.19, $p < 0.049$), pulse rate (OR = 1.04, $p < 0.02$), and ambient cabin temperature (OR = 1.32, $p < 0.015$).

CONCLUSIONS: At the time of hospital admission, a significant number of trauma patients were hypothermic. This study emphasizes the need for identifying unintentional hypothermia in trauma patients early on during the pre-hospital stage.

KEY WORDS: accidental hypothermia; risk factors; trauma; core body temperature (CBT); prehospital care

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INTRODUCTION

Trauma patients are constantly in danger from hypothermia, which worsens the clinical result of the patient. Accidental hypothermia affects up to 66 percent of severely injured patients who are treated in the emergency department (ED). Environmental exposure, hemorrhagic shock, inadequately warmed intravenous (IV) fluids, vasoconstriction, and heightened shivering threshold brought on by medications like anesthetics and muscle relaxants are some of the causes of hypothermia [1, 2]. Accidental hypothermia in trauma patients is defined as a decline in CBT below 36°C

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and is divided into three categories: mild (34–36°C), moderate (32–34°C), and severe (below 32°C) [3–5]. There is more data supporting the link between hypothermia and higher morbidity and death rates in trauma patients. Even mild hypothermia can greatly enhance morbidity in trauma victims [5, 6]. The mortality rate in trauma patients is significantly increased by hypothermia combined with acidosis and coagulopathy [7]. Additionally, prolonged intensive care unit (ICU) stays and increased incidences of cardiovascular, neurological, renal, and coagulation issues are linked to hypothermia in injured patients [5, 8]. The factors that cause hypothermia in trauma patients have been researched, and some have been identified. These include clinical factors like hypoxia, tachycardia, hypotension, spinal cord injury, blood loss, and large open wounds [5, 9], as well as environmental factors like contact with cold surfaces, exposure to cold ambient air, and administration of cold intravenous fluids [10]. The mortality rate in trauma patients is significantly increased by hypothermia combined with acidosis and coagulopathy [7]. Additionally, prolonged intensive care unit (ICU) stays and increased incidences of cardiovascular, neurological, renal, and coagulation issues are linked to hypothermia in injured patients [5, 8]. The factors that cause hypothermia in trauma patients have been researched, and some have been identified. These include clinical factors like hypoxia, tachycardia, hypotension, spinal cord injury, blood loss, and large open wounds [5, 9], as well as environmental factors like contact with cold surfaces, exposure to cold ambient air, and administration of cold intravenous fluids [10]. Numerous sources, including research studies, case studies, and anecdotal information, are used to support hypothermia studies. The causes of hypothermia in the prehospital stage have not been thoroughly studied, despite the fact that many processes and several states of hypothermia are widely known and documented in the pertinent literature [11]. In these situations, it has been demonstrated that early diagnosis and treatment of hypothermia lower the severity of the injury [12, 13]. In this study, we sought to identify the prevalence of accidental hypothermia and related risk factors in prehospital trauma patients.

MATERIAL AND METHODS

A single-center prospective observational study was performed on a sample of trauma patients transferred to the emergency department of Ayatollah Mousavi Hospital in Zanjan, Iran. After the approval of the research ethics committee (IR.ZUMS.REC.1397.198), 152 trauma patients were recruited through convenience sampling from 2 to 16 November 2018. Adult trauma patients older than 18 who had pre-hospital emergency medical services (EMS) transfers were included in the study. Patients who were transported by other means (such as personal cars) or who were referred from other medical facilities were not included in the study. Adult trauma patients older than 18 who had pre-hospital emergency medical services (EMS) transfers were included in the study. Patients who were transported by other means (such as personal cars) or who were referred from other medical facilities were not included in the study. Temperature variables (CBT, ambulance ambient temperature, and infused fluids) were measured using a calibrated tympanic thermometer (beurer FT 58 Ear Thermometer made in Germany). The accuracy of the digital tympanic thermometer was 0.3–0.2°C with 3 readings on each side of the tympanic membrane of each ear. The patient's core body temperature (CBT) and the ambient temperature of their surroundings were monitored and recorded as soon as they arrived at the hospital. However, when the patients were taken out of the ambulance, the temperature of the IV fluids was checked and documented. A sheet created by the researcher and an EMS data sheet was used to collect data. Descriptive statistics and multiple logistic regression analysis (backward model) were used for the statistical analysis, which was carried out using SPSS software version 16. A significance level of 5% was considered.

RESULTS

The study included 152 eligible trauma victims. Seventy-three percent of the patients were men. The average patient age was 38 (17.39) years old. The Glasgow Coma Scale (GCS) for trauma patients had a mean and standard deviation of 14.7. (1.2). Closed trauma was the most frequent mechanism of trauma (73%) and motor vehicle accidents accounted for the majority of trauma causes (74.3%) (Tab. 1). The findings demonstrated that neither the CBT nor the ambient temperature of trauma patients was evaluated at the accident scene nor in the ambulance. The mercury-type thermometer in the ambulance was unable to measure the CBT.

Table 1. Demographic characteristics and factors related to hypothermia in trauma patients

Variables		N	%
Gender	Male	111	73
	Female	41	27
Location of trauma	Head	37	24.3
	Thorax	5	3.3
	Abdomen	2	3.1
	Spine	5	3.3
	Upper limb	15	9.9
	Lower limb	21	13.8
	Multiple traumas	67	44.1
Mechanism of injury	Blunt	111	73
	Penetration	5	3.3
	Mix	36	23.7
Etiology	Motor vehicle crash (MVC)	113	74.3
	Sharp tools and stabbings	2	1.3
	Falling	27	17.8
	Workplace accident	8	5.3
	Other	2	1.3
Climate	Rainy to cold	124	81.6
	Snowy	28	18.4
Working shift	Morning	49	32.2
	Evening	63	41.4
	Night	40	26.3
Receiving intravenous fluids	Yes	23	15.1
	No	129	84.9
Wet clothes	Yes	14	9.2
	No	148	90.8
Proper patient covering	Yes	82	53.9
	No	70	46.1

Table 2. Core body temperature, ambient cabin temperature, and temperature of Intravenous fluids in trauma patients

Temperature variables		N (%)
Core body temperature upon arrival	Hypothermia (Total)	67 (44.1)
	Normal (36–38°C)	85 (55.9)
	Mild (34–36°C)	60 (39.5)
	Moderate (32–34°C)	7 (4.6)
	Severe (< 32°C)	0
Ambient cabin temperature	< 22°C	111 (73)
Intravenous fluids temperature	< 37°C	23 (15.1)

Additionally, there was nothing in the ambulance cabin that might have warmed the fluids for the infusion.

The findings revealed that at the time of ED admission, 67 patients' age, gender, level of consciousness, blood oxygen saturation, pulse, respiratory rate, systolic blood pressure, location of trauma, mechanism of injury, etiology, climate, patient clothes and covering condition, underlying diseases, ambient cabin temperature, location of trauma, and receiving intravenous fluids were among the factors related to accidental hypothermia in trauma patients that were included in the multiple logistic regression by the Backward LR model (44.1%) had a CBT of less than 36° C (Tab. 2). Among the factors related to accidental hypothermia in trauma patients (age, gender, level of consciousness, blood oxygen saturation, pulse rate, respiratory rate, systolic blood pressure, location of trauma, mechanism of injury, etiology, climate, patient clothes and covering condition, underlying diseases, ambient cabin temperature, place of trauma, receiving intravenous fluids) that were included in the multiple logistic regression by the Backward LR model. Only the ambient cabin temperature ($p < 0.015$, OR = 1.32) the pulse rate ($p < 0.020$, OR = 1.045), and the level of consciousness ($p < 0.049$, OR = 2.19) were significant risk factors in the model's final step (Tab. 3).

DISCUSSION

This study examines the occurrence of accidental hypothermia and the risk factors associated with it in trauma patients transported by EMS. The findings demonstrate that a sizable portion of trauma patients (44.1%) had a CBT of less than 36°C at

Table 3. Logistic regression of risk factors associated with accidental hypothermia in trauma patients

Risk factors	B	S. E	Wald	df	p value	Odds ratio
Level of consciousness at the scene	0.783	0.398	3.87	1	0.049	2.19
Pulse rate	0.044	0.019	5.42	1	0.020	1.045
Ambient cabin temperature	0.277	0.114	5.91	1	0.015	1.32

df — degree of freedom

the time of ED arrival. This study shows that hypothermia occurred in trauma patients who were not given the proper thermal care when they were transported to the hospital. At the time of admission to the ED, they were still hypothermic. Controlling patients' CBT at the scene of the accident and providing adequate temperature care while they are being transported to the hospital are particularly crucial. Hypothermia is prevalent in the pre-hospital emergency phase, according to a number of studies (14–51 %) [14–16]. In a study by Kornfalt et al. [17], cases of severe hypothermia in trauma patients at the prehospital stage were not seen, which is similar to the current study. In this regard, trauma patients that were examined by Mommsen et al. [14] displayed moderate and severe hypothermia.

Three variables (LOC, pulse rate, and the temperature of the ambulance cabin) were identified in this study as risk factors for accidental hypothermia in trauma patients. Several studies indicate that a number of factors contribute to the development and progression of hypothermia in trauma patients during pre-hospital emergencies. The temperature of the ambulance cabin during the transfer of trauma patients to the hospital is one of these factors. The CBT of trauma patients decreases as a result of the insufficient ambulance cabin temperature. The temperature of the ambulance cabin is seen as a significant risk factor in this study. According to Lapostolle [18], one of the major risk factors for hypothermia during the transfer of trauma patients to the hospital is the ambient cabin temperature [18]. Our findings were supported by several studies. They demonstrated that ambient temperature can act as an independent predictor of hypothermia among trauma patients in various clinical settings [19–23]. Additionally, certain research [3, 24] has indicated that ambient temperature is an independent determinant in the occurrence of accidental hypothermia in trauma patients in emergency departments and operating rooms.

The patient's LOC was another variable related to hypothermia. In two separate studies, Lapostolle et al. demonstrated that a low GCS was an independent factor related to hypothermia [16, 18]. Other investigations [25, 26] similarly showed that hypothermic patients' GCS was significantly lower than normothermic patients. Similarly to this, Pirnes (2017) claims that hypothermic patients with a lower LOC need to stay in the hospital for an extended period of time after an injury [26].

In the current study, pulse rate was also addressed as a potential risk factor for hypothermia. In this regard, Lapostolle et al. [18] note that heart rate should be taken into account along with body temperature in the assessment of hypothermia in trauma patients. However, researchers did not discover a connection between heart rate and hypothermia in trauma patients in two investigations [16, 18]. These studies considered 35°C as the cut-off point for hypothermia, whereas the current study used 36°C. This variation could be attributable to the various definitions of hypothermia.

Analysis of additional hypothermia-related factors did not reveal a statistically significant connection in the current study. The findings were in line with some studies [16, 18, 26] regarding age and gender as risk factors for hypothermia. In contrast, Hsieh et al. [4] found that gender was a risk factor for hypothermia in trauma patients [4]. In the study by Lapostolle [16, 18], wet clothes were also identified as a risk factor for hypothermia. These variables weren't regarded as risk factors, though.

Even in temperate or tropical climates, environmental exposure-induced hypothermia can happen at any time of year. The greatest risk is found in cold and wet conditions [2]. Prehospital care should prioritize optimizing resources for the detection and treatment of hypothermia. In addition to a lack of staff training on how to handle patients who have accidentally become hypothermic, gaps in practice relating to temperature assessment have been found in the literature. Rewarming techniques are employed in prehospital care to enhance patient outcomes and lessen the discomfort imposed by colds [6, 27]. Therefore, in their work, physicians, nurses, and emergency paramedics must follow evidence-based guidelines. It is possible to successfully integrate best practice interventions for trauma patients' rewarming and temperature measurement at a very low cost. We must follow evidence-based recommendations for assessment and care in order to support medical professionals caring for individuals with unintentional hypothermia outside of hospitals.

Limitations of the study

This study has several limitations, including the fact that it is single-centered and includes all trauma patients, who may have injuries of varying severity

and get different types of anesthesia (general, spinal, and local), which may have an impact on the study's findings. More reliable findings can be obtained by doing multicenter studies with individuals who suffered injuries of a similar degree and underwent the same type of anesthesia.

CONCLUSIONS

In this study, a sizable portion of the patients had hypothermia. This suggests that in the prehospital phase, thermal care was not provided to trauma patients. The trauma literature has mentioned a number of factors that contributed to the onset and progression of hypothermia. The occurrence of hypothermia in the population under study was significantly influenced by LOC at the scene, patient pulse rate, and ambulance cabin temperature. At the scene of an accident, it's crucial to manage the CBT of trauma patients. The study's findings revealed that neither at the scene of the incident nor during the transfer to the ED, the CBT of any trauma patients assessed or recorded. Additionally, the thermometers in the ambulances were mercury-in-glass ones that could not precisely measure the CBT. Trauma victims' hypothermia may be exacerbated by the lack of heating equipment in the ambulance cabin. Accidental hypothermia can be prevented by improving the skills of EMS personnel in CBT assessment and documentation, warming IV fluids, and timely application of warming blankets. Additionally, it is crucial to keep the ambulance's cabin's temperature within a safe range while transporting patients.

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Conflict of interest

All authors declare no conflict of interest.

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