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Prevalence of hypothermia and its related factors in trauma patients

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Abstract

Introduction: Hypothermia is often present in trauma patients at the time of arrival to the hospital. Moderate hypothermia can be associated with an increased patient mortality rate. Early diagnosis and treatment can be effective in better patient outcomes.

Materials and Methods: In this analytic cross-sectional study, 325 trauma patients admitted to the emergency room (ER) of Poursina hospital were evaluated. The initial temperature was recorded as the tympanic temperature of the first 15 minutes of patients' arrival to the ER department by the infrared thermometer TM 80 manufactured by Healer Company. Other variables included: age, sex, IV fluid injected volume, method of patient transport, systolic blood pressure, and heart rate. After collecting data, analysis was done using SPSS software version 25.

Results: According to the findings of our study, 56 trauma patients out of 325 patients were hypothermic (17.2%). The average systolic blood pressure was lower in hypothermic patients and the average IV fluids volume injected into hypothermic trauma patients was higher than in other patients.

Conclusion: Trauma patients are prone to hypothermia, although this complication does not have a high prevalence due to its harmful effects such as decreased systolic blood pressure, increased injected IV fluid volume, and increased hospitalization time, trauma patients should be monitored regularly for body temperature and necessary measures should be considered to eliminate hypothermia in trauma patients.

Keywords: Hypothermia, Trauma, Body temperature

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Introduction

Trauma is the most important cause of loss of effective life in human population because it disables the young force for economic and social activities. Major or severe trauma is the primary cause of death in up to 10% of all deaths worldwide. It is defined as having an injury severity score (ISS) of 15 or greater (1, 2). Inadvertent injuries are the 6th leading cause of death and the 5th leading cause of severe disability internationally (1, 2). Following trauma, hemodynamic and metabolic changes occur in the human body, some of which can be so complicated and lead to high mortality rates despite significant medical interventions. Trauma can be one of the most expensive medical problems due to significant expanses spent on trauma patients for primary care, rehabilitation, and in some cases lifetime caregiving.

Hypothermia is defined as body temperature below 36° C.(1, 3-5) It is categorized as mild (temperature between 34-36° C), moderate (temperature between 30-34° C), and severe (temperature below 30° C) (3). Heat loss occurs by four mechanisms: radiation, conduction, evaporation, and convention (6). The negative effects of hypothermia on trauma patients were first described by Dr. Benjamin Rush, the surgeon-general of military hospitals during American Revolutionary War.(1) Within that period, he eventually prohibited wet clothing for injured soldiers in order to avoid more serious complications (7). The lessons learned from these conflicts led to a change in over 30 clinical practice guidelines in combat conflicts, including the Iraq war (1). Hypothermia has many physiological effects. It decreases cerebral metabolism due to reduced brain blood flow and causes confusion, incoordination, and somnolence leading to coma at around 30° C (8). On the other hand a meta-analysis study done by Odette A. et al. suggested that mild induced hypothermia might have a beneficial effect on the management of traumatic brain injury although its effectiveness remains controversial (4).

Mild hypothermia (T<36°C) leads to increased sympathetic tone, heart rate, blood pressure, and cardiac output in order to maintain sufficient blood flow to vital organs while moderate hypothermia will depress cardiac activity.(9, 10) A study done by Kjetil S. has shown that moderate and severe van leads to atrial fibrillation (11). Another study was done by Reuler JB. Has shown that even though mild hypothermia can increase respiratory rate, leading to mild respiratory acidosis, it is not lethal. On the other hand, at moderate levels of hypothermia, airway reflexes are reduced, predisposing patient to aspiration, atelectasis, and ineffective gas exchange.(10) Hypothermia decreases the enzymatic activity of clotting factors, leading to impaired platelet function and inhibition of fibrinogen synthesis (12, 13). According to a review done by Frank Hildebrand et al., hypothermia seems to decrease the release of pro-inflammatory cytokines leading to an increasing the incidence of posttraumatic infectious complications (14). Considering pathophysiological and prognostic prospective of hypothermia in trauma patients, this issue has attracted interest. In civilian trauma, exposure, hypovolemia and infusion of cold IV fluids are likely the most important factors contributing to temperature loss in an injured individual (15). Prevention of hypothermia is usually easy to perform, yet likely the most commonly forgotten measure in the care of trauma patients (11). Preventative and therapeutic modalities in this matter vary from simple, non-invasive, passive external warming techniques (such as removal of cold, wet clothing; movement to a warm environment) to active external rewarming (e.g. insulation with warm blankets) to active core rewarming (e.g. warmed intravenous fluid infusions, heated humidified oxygen, body cavity lavage, and extracorporeal blood warming) (11). A study done by Thomassen O. et al., on 8 healthy volunteers showed that Hibler's method (a combination of vapor tight layer and an additional dry insulation layer) was the most effective method to prevent heat loss (16). Understanding the negative impacts of hypothermia and early screening of this matter in traumatic patients are of great importance (11, 17). According to the findings of the research history in Iran, it has been found that studies in the field of hypothermia in patients with trauma in Poursina hospital, Rasht, Guilan, Iran in 2019.

Materials and Methods

In this analytic cross-sectional study, 325 patients with trauma admitted to Poursina hospital in 2019 were evaluated. The initial temperature was recorded as the

temperature of the first 15 minutes of patients' arrival to the ER department using the infrared tympanic thermometer TM 80 manufactured by Healer Company. In order to collect data, we used a checklist including patients' demographic, BMI, age, sex, body temperature of the first 15 minutes of patients' arrival to the ER department, IV fluids volume given to patients before body temperature assessment, blood pressure, and heart rate. Hypothermia was defined as body temperature below 36℃. Collected data were analyzed using SPSS software version 25. In order to describe quantitative variables mean and standard deviation, and for qualitative variables numbers and percentages were used. All patients' information must remain confidential.

Results

In this prospective study, trauma patients admitted to the emergency room of Poursina hospital in 2019 were evaluated. The initial temperature was recorded as the temperature of the first 15 minutes of the patients' admission to the emergency room. 56 patients out of 325 (17.2%) were hypothermic. The subjects were in the age range of 20 to 66 years with an average of 37.88±11.32 years. Most of the patients were transported to the hospital by ambulance (52.3%). Due to distribution abnormality of data related to quantitative variables, Mann-Whitney test was used to analyze them. Chi-Square and Logistic Regression tests were used to analyze qualitative variables. Shapiro-Wilk and Kolmogorov-Smirnov tests showed that the distribution of data related to the quantitative variables in this study does not have a normal distribution ($p>0.05$). Further information is listed in table 1.

Table 1. comparison of characteristics between trauma patients with hypothermia and others.

Variable		Hypothemia	Others	P.value
Age (Year)		38.53±11.79	37.25±11.24	0.626[a]
IV fluids volume (Liter)		3.37±0.45	2.38±0.82	0.0001[a]
Blood pressure		79.57±6.79	104.02±11.79	0.0001[a]
Heart rate		83.09±13.14	89.39±12.88	0.822[a]
Sex	Male	42 (16.7%)	209 (83.3%)	0.0662[b]
	Female	14 (18.9%)	60 (81.1%)	
Trauma mechanism	Multiple trauma	20 (17.5%)	94 (82.5%)	0.878[b]
	Blunt	24 (16.2%)	124 (83.3%)	
	Sharp	12 (19.00%)	51 (81.00%)	
Method of transportation	Personal	29 (37.9%)	126 (46.84%)	0.822[b]
	EMS	27 (15.9%)	143 (53.16%)	

Discussion

Most of the trauma patients included in our study were between 20 to 40 years old (82.2%). 251 patients out of 325 were male (77.2%). The most common mechanism of trauma was blunt trauma (45.5%). Most of the patients were transferred to hospital via ambulance (52.3%).

According to the findings of our study, considering calculation error of 5%, the prevalence of hypothermia in trauma patients was between 10 to 18.15%. The severity of hypothermia was assessed as mild in all reported cases. This finding is consistent with the result of Lapostolle et al. in 2012, Ireland et al. in 2011, and Waibel et al. in 2010 and 2009 studies.

On the other hand, this finding is in contrast to results from Balvers et al. in 2009, Shafi et al. in 2005, and Wang et al. in 2005. This conflict could be related to the difference in definition of hypothermia. In our study hypothermia was defined as body temperature below 36° C but in these contradictory studies, hypothermia was defined as body temperature below 35° C.

Lapostolle et al. had done a cross-sectional descriptive study in order to assess the prevalence of hypothermia and the factors affecting it among trauma patients on arrival to the ambulance in 2017. 131 patients out of 461 were hypothermic (29%) (18).

In 2016, Balvers et al. 953 patients have included out of whom 354 ICU patients were hypothermic (37.1%) (19).

In 2005 Wang and colleagues investigated the prevalence of hypothermia and its relationship with mortality rates in patients with major trauma. In this retrospective cohort study, 38520 patients admitted to

medical centers were included of whom 1921 were hypothermic (5%) (20).

In 2005, Shafi et al. examined the role of hypothermia as an independent risk factor in trauma patients' mortality. Out of 38550 cases reviewed 35283 patients (8.5%) developed hypothermia. According to these results, hypothermia increases mortality risk by 1.01 times (17).

In a 2009 study designed to determine the prevalence of hypothermia, Beilman et al. surveyed 359 patients with severe trauma and reported a 43% prevalence of hypothermia (21). The difference in sample size, patient transfer conditions, severity of trauma and different geographical locations, differences in the definition of hypothermia can be reasons for discrepancies in the findings of our research and studies.

In 2012, Lapostolle et al. presented a study aimed at identifying the factors influencing the onset of hypothermia during prehospital care in trauma patients. A total of 448 patients were studied. Hypothermia (body temperature less than 35° C) was observed in 64 of 448 patients upon admission (14%) (22).

A 2011 study by Ireland et al. examined the prevalence of accidental hypothermia in trauma patients and identified its causes. Hypothermia was defined as body temperature below 35° C. 732 medical records of trauma patients who were referred to the Adult Trauma Center were reviewed between January and December 2008. According to the results of this study, mortality rate was 9.15% and the prevalence of hypothermia was 13.25% (23).

A 2010 study by Waibel et al. assessed the prevalence and effects of hypothermia in 1629 pediatric trauma patients during a period of 5 years (2002-2007). 182 patients included in this study were hypothermic (24). In another similar study, Waibel and colleagues assessed the effects and prevalence of hypothermia (body temperature below 36° C) in traumatic adult patients in 2009. For this purpose, 9482 patients were studied from 2002 to 2007, of whom 15.7% were hypothermic (25).

In our study the average systolic blood pressure and IV fluids volume injected to patients with hypothermia were lower and higher respectively. Thus, the mean systolic blood pressure of hypothermic patients was 79.57±6.8 mmHg and 104.03±11.79 mmHg was reported in other patients. This finding is inconsistent with previous studies. (17)

Mean IV fluids volume received in traumatic patients with hypothermia was estimated to be 3.37±0.45 liters and 2.39±0.83 liters in other patients. This finding is also inconsistent with previous studies. (21)

No meaningful relationship was found between hypothermia in trauma patients and age, sex, heart rate, mechanism of trauma, and how patients were transmitted.

In a 2017 study by Lapostolle et al. low GCS, low ambient temperature, and patients getting soaked during the accident were cited as factors influencing hypothermia. Also, systolic blood pressure in patients with hypothermia was significantly lower than in others but there was no correlation between age, gender, and heart rate of hypothermic and other patients, which is consistent with our study (18).

In a 2012 study by Lapostolle et al, the obvious factors associated with lack of hypothermia included: lack of intubation, vehicle temperature, temperature of IV fluids, lack of sufficient patient coverage, and lack of head trauma, according to this study, the main risk factor for the onset of hypothermia was Injury Severity Score (ISS), but environmental conditions and EMS medical care were also important (22).

In a 2016 study by Perlman et al. hypothermia in patients with severe traumatic injury was evaluated. Findings from this study showed that hypothermia is an independent risk factor in predicting mortality in trauma patients. Injury Severity Score (ISS), wet clothing, low temperature in the patient transport unit, long-term anesthesia were also monitored as risk factors for hypothermia in this study (1).

In a 2005 study by Wang et al. Logistic Regression findings showed that the incidence of hypothermia and severe head injury increased the risk of mortality by 3.03 and 2.2 times, respectively (20).

In a 2005 study by Shafi et al., it was reported that the incidence of hypothermia increased the risk of mortality by 1.01 times (17).

Another study by Waibel et al in 2010 showed that hypothermia increased the risk of death by 2.41 times (24).

In a 2009 study designed to determine the prevalence of hypothermia, Beilman and colleagues surveyed 359 patients with severe trauma and concluded that the mortality rate among hypothermic patients with trauma was 16% and 12% among other trauma patients. However, these differences were not considered significant (21).

Prevalence and some of the factors affecting trauma patients that are less discussed in domestic studies were assessed in this study. It is also important to mention that study of the factors affecting the incidence of hypothermia requires much more variables than the variables presented in this study, so in order to determine these factors, more extensive studies are needed. Regular and routine measurement of body temperature of trauma victims is an important issue and should be considered by medical staff. Since there is no similar study to the present study in Iran, it is suggested that similar studies using a larger sample size be performed to confirm or refute the results obtained from the present study. The role of important factors such as the severity of trauma injury, patient transfer conditions in terms of ambient temperature, time elapsed until the patient arrives at the treatment center, patients' GCS, temperature of IV fluids injected to patients, season of the year, and other variables should be considered in future by researchers in this field. The effect of hypothermia on increasing the risk of patients' mortality is another issue that is suggested to be investigated in future studies.

Conclusions

Trauma patients are prone to hypothermia, although this complication does not have a high prevalence due to its harmful effects such as decreased systolic blood pressure, increased injected IV fluid volume, and increased hospitalization time, trauma patients should be monitored regularly for body temperature and necessary measures should be considered to eliminate hypothermia in trauma patients.

Author contribution

AA designed the project and wrote the manuscript and alsp collected the data. **PP**, **KHM**, **BB**, **AShR** and **ZJ** accomponished in some other parts of the manuscript including writing and **MSh** analysis the data. All the authors read and confirmed the final edited version of the manuscript.

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Conflict of interest

The authors declared no conflict of interest.

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