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Effects of accidental hypothermia on posttraumatic complications and outcome in multiple trauma patients

P. Mommsen [a,d,*], H. Andruszkow [a,d], C. Frömke [b], C. Zeckey [a], U. Wagner [a], M. van Griensven [c], M. Frink [a], C. Krettek [a], F. Hildebrand [a]

[a] Trauma Department, Hannover Medical School, 30625 Hannover, Germany
[b] Institute for Biometry, Hannover Medical School, 30625 Hannover, Germany
[c] Ludwig Boltzmann Institute for Experimental and Clinical Traumatology, Vienna, Austria

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ABSTRACT

Introduction: Accidental hypothermia seems to predispose multiple trauma patients to the development of posttraumatic complications, such as Systemic Inflammatory Response Syndrome (SIRS), sepsis, Multiple Organ Dysfunction Syndrome (MODS), and increased mortality. However, the role of accidental hypothermia as an independent prognostic factor is controversially discussed. The aim of the present study was to evaluate the incidence of accidental hypothermia in multiple trauma patients and its effects on the development of posttraumatic complications and mortality.

Patients and methods: Inclusion criteria for patients in this retrospective study (2005–2009) were an Injury Severity Score (ISS) $\geq$16, age $\geq$16 years, admission to our Level I trauma centre within 6 h after the accident. Accidental hypothermia was defined as body temperature less than 35 °C measured within 2 h after admission, but always before first surgical procedure in the operation theatre. The association between accidental hypothermia and the development of posttraumatic complications as well as mortality was investigated. Statistical analysis was performed with χ^2-test, Student's *t*-test, ANOVA and logistic regression. Statistical significance was considered at $p < 0.05$.

Results: 310 multiple trauma patients were enrolled in the present study. Patients' mean age was 41.9 (SD 17.5) years, the mean injury severity score was 29.7 (SD 10.2). The overall incidence of accidental hypothermia was 36.8%. The overall incidence of posttraumatic complications was 77.4% (SIRS), 42.9% (sepsis) and 7.4% (MODS), respectively. No association was shown between accidental hypothermia and the development of posttraumatic complications. Overall, 8.7% died during the posttraumatic course. Despite an increased mortality rate in hypothermic patients, hypothermia failed to be an independent risk factor for mortality in multivariate analysis.

Conclusions: Accidental hypothermia is very common in multiply injured patients. However, it could be assumed that the increase of mortality in hypothermic patients is primarily caused by the injury severity and does not reflect an independent adverse effect of hypothermia. Furthermore, hypothermia was not shown to be an independent risk factor for posttraumatic complications.

Introduction

Hypothermia is defined as a core temperature less than 35 °C.[1–9] Multiple trauma patients are predisposed to accidental hypothermia due to exposure to the environment, application of cold intravenous fluids and anaesthetic medication. Additionally, haemorrhagic shock with anaerobic metabolism and hypoperfusion of the thermoregulatory centres in the hypothalamus leads to a reduced thermogenesis.[10–13] At the time of admission, accidental hypothermia occurs in up to 66% in severely injured patients[3,14,15] having potentially serious physiological effects on coagulation and haemodynamic system. Especially, vascular, extremity, pelvic and abdominal injuries seem to be associated with the development of accidental hypothermia.[14,16] Furthermore, the extent of hypothermia correlates with overall injury severity of multiple trauma patients.[17]

Several studies have reported an association between accidental hypothermia and the risk for posttraumatic complications[11] and worse outcome.[10,18–20] In severely injured patients with a core temperature <32 °C, a mortality rate of 100% has been described.[19]

* Corresponding author at: Trauma Department, Hannover Medical School, Carl-Neuberg-Strasse 1, 30625 Hannover, Germany. Tel.: +49 511 532 8132, fax: +49 511 532 5877.
E-mail address: mommsen.philipp@mh-hannover.de (P. Mommsen).
[d] These authors contributed equally.

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Due to these negative effects of accidental hypothermia current trauma care guidelines recommend early and effective rewarming of hypothermic trauma patients. However, Steinemann et al. described an association between accidental hypothermia and increased mortality, but not after stratification by physiological and anatomic indicators of injury severity.[7] In a recent study, Beilman et al. reported accidental hypothermia to be a significant risk factor for Multiple Organ Dysfunction Syndrome (MODS), but not for mortality.[11]

Therefore, the role of accidental hypothermia as an independent predictor for the development of posttraumatic complications and mortality in multiple trauma patients is still controversially discussed. The question remains whether accidental hypothermia has a primary impact on trauma outcome or simply represents the result of injury severity and exposure. Therefore, the present study aimed to evaluate the incidence of accidental hypothermia in multiple trauma patients as well as the effects of accidental hypothermia on the development of posttraumatic complications, such as MODS, Systemic Inflammatory Response Syndrome (SIRS) and sepsis, and mortality.

Patients and methods

Ethical approval and informed consent

The present study has been approved by the local Ethical Committee. The need to obtain informed consent was waived by the local ethical committee.

Inclusion and exclusion criteria

Multiple trauma patients [Injury Severity Score (ISS) $\geq$16] aged $\geq$16 years treated at our Level 1 trauma centre between January 2005 and March 2009 were included in the present study. Further inclusion criteria were primary admission to our hospital within 6 h after injury and documentation of temperature within 2 h after admission, but before the first surgical procedure in the operation theatre. Exclusion criteria were steroidal and non-steroidal anti-inflammatory medication, hormone therapy, vascular obstruction (cardiac coronary disease, renal dysfunction, diabetes), malignancy or chronic diseases of the liver, kidneys or lung due to their marked impact on posttraumatic complications and outcome (Table 1).

Definitions

MODS was defined according to Marshall et al.[21] According to the literature, manifest MODS was considered at a Marshall Score >8 points on at least 1 day during the observation period.[21,22] Diagnosis of SIRS was related to the criteria of the Consensus Conference of the American College of Chest Physicians and Society of Critical Care Medicine [ACCP/SCCM] on at least 2 consecutive days.[23] Hypothermia was defined as a documented temperature less than 35 °C within the first 2 h after admission to our trauma centre, but at least before operative interventions in order to exclude a perioperative loss of body temperature. This temperature limit is well accepted in the medical literature.[2,3,5–9,24] Body temperature was determined by bladder or oesophageal probe (in case of urethral or pelvic injuries), both representing reliable methods for the measurement of core temperature.[10,25–29] Temperature data was recorded electronically.

Table 1
Inclusion and exclusion criteria.

Inclusion criteria	Exclusion criteria
Age $\geq$16	Steroidal and non-steroidal
ISS $\geq$16	anti-inflammatory medication
Primary admission within 6 h after trauma	Hormone replacement
	Malignancies
Documentation of temperature within 2 h after admission	Chronic diseases of liver, kidneys or lung
	Vascular obstruction

Clinical parameters and outcome evaluation

Clinical data including demographics, mechanism of injury, distribution of concomitant injuries according to the Abbreviated Injury Scale (AIS), as well as duration of intensive care and mechanical ventilation, and mortality were recorded. Laboratory, haemodynamic and respiratory parameters were documented. The results of clinical examination and blood chemistry were recorded up to 14 days after admission.

Statistical analysis

In the present explorative study the influence of hypothermia on the development of posttraumatic complications and mortality was modelled with χ^2-test and multivariable logistic regression. For the adjustment of potential confounders, clinically relevant and statistically significant variables (p-value $\leq$0.2) were entered into the multivariable model. Confounders in all analyses included age, transfusion of PRBC (packed red blood cells), plasma (FFP) and platelets (PLT) as well as ISS, traumatic brain injury (AIS_{head}) and further concomitant injuries (AIS_{face}, AIS_{chest}, $AIS_{abdomen}$, $AIS_{extremity}$, $AIS_{external}$). Differences in the duration of ventilation, length of ICU and hospital stay between hypothermic and non-hypothermic patients were analysed using ANOVA following pairwise t-test. Again, the analytic model included the aforementioned confounding factors from univariate analyses. Results are presented as two-sided 95% confidence intervals for the difference in means or the odds ratio. The level of statistical significance was considered at $p < 0.05$. Due to the explorative character of the present study, a multiplicity correction was omitted. Statistical analysis was performed using SPSS computer software (SPSS 11.5, Chicago, IL, USA) and SAS (Version 9.2, Cary, NC, USA).

Results

Demographics and hypothermia

310 patients with multiple injuries [mean age 41.9 years, standard deviation (SD) 17.5] were included in the present study. 220 patients (71.0%) were male and 90 (29.0%) were female. The mean ISS was 29.7 (SD 10.2). Overall demographic data are summarised in Table 2. The overall incidence of accidental hypothermia was 36.8% (Table 3). 70 patients (22.6%) showed a body temperature between 35 °C and 34 °C (mild hypothermia). 42 patients (13.6%) suffered from a moderate hypothermia (body temperature between 34 °C and 32 °C) and 2 patients (0.6%) developed a body temperature less than 32 °C (severe hypothermia). Hypothermic patients were shown to have a higher ISS (p-value 0.048, t-test) and AIS_{head} (p-value 0.033, t-test) compared to non-hypothermic patients. In addition, hypothermic patients received more PRBC (p-value 0.005, t-test), FFP (p-value <0.001, t-test) and PLT (p-value <0.001, t-test). No differences could be observed concerning age and gender distribution between hypothermic and non-hypothermic patients. Demographic data in patients with or without hypothermia are presented in Table 2.

Clinical data

The overall mean duration of mechanical ventilation was 11.3 (SD 15.4) days, the overall mean length of intensive care unit and