Hypothermia and Its Association with Mortality Among Major Trauma Patients in a Tropical Climate: A Retrospective Study from Southern Taiwan

Pei-Ling Lee*, Chao-Wen Chen†, Chuan-Yu Hu*,
Mei-Yu Pan*, Shu-Fen Ko*, Shu-Chen Mu*
*Division of Trauma and Surgical Critical Care, Department of Surgery,
Kaohsiung Medical University Hospital, Kaohsiung Medical University,
Kaohsiung, Taiwan
e-mail: peiling@trauma.tw, {chuanchuan19 | jadesweet06080527}@gmail.com,
850174@kmuh.org.tw, 920547@ms.kmuh.org.tw
†Department of Emergency Medicine, Faculty of Medicine,
College of Medicine, Kaohsiung Medical University,
Kaohsiung, Taiwan
e-mail: kmutrauma@gmail.com

***Abstract*—Hypothermia is an important factor for poor prognosis after trauma, and it may still occur even in tropical climates. To explore the incidence of hypothermia in patients with severe trauma in southern Taiwan and its association with mortality risk, trauma registration data of a critical emergency hospital in Kaohsiung from 2023 to 2024 were analyzed, and patients with Injury Severity Score (ISS) >15, a recorded emergency department temperature between 32.0°C and 37.9°C, and hospitalization were included. Patients were subsequently categorized into two groups: hypothermia (32.0–34.9°C) and normothermia (35.0–37.9°C). A total of 1324 patients were included, of which 31 (2.34%) had hypothermia, and the mortality rate was 51.6%. Hypothermia was significantly associated with Glasgow Coma Scale (GCS), Intensive Care Unit Length Of Stay (ICU LOS) and death (p<0.005). Hypothermia still occurs in patients with severe trauma in tropical regions, and their mortality risk is significantly increased. Hypothermia should be listed as an important indicator for the initial treatment of trauma, and early intervention can help improve prognosis.**

Keywords-lethal diamond; major trauma; traumatic hypothermia; trauma registry.

I. Introduction

Hypothermia, together with acidosis, coagulopathy, and hypocalcemia, forms the "Lethal Diamond," a cluster of physiological derangements that accelerate trauma mortality. Hypothermia impairs cardiac contractility, induces arrhythmias, disrupts coagulation, and weakens immune response, and has been consistently linked to poor outcomes in trauma patients [1]. It is defined as a core body temperature below 35°C. Literature reports show that up to two-thirds of severely injured adults present with hypothermia upon arrival at the emergency department [2]. However, data from the American College of Surgeons-Trauma Quality Improvement Program (ACS-TQIP) registry indicate a lower incidence (1%) in the United States, though mortality risk increases significantly [3]. Climate appears to influence incidence, with 12.6% in temperate zones [4], 5.7% in subtropical regions such as Australia [1], and even measurable rates in the Middle East [5]. Kaohsiung City, located in southern Taiwan, has a tropical monsoon climate with annual temperatures ranging 15–32°C [6]. This study explores the incidence of hypothermia in trauma patients in a tropical setting and its association with mortality. The remainder of the paper is organized as follows: In Section II, we describe the steps of methods. Section III presents the study results. Section IV discusses the findings. Section V discusses the limitations. Finally, Section VI discusses the conclusion and future work.

II. Methods

We conducted a retrospective observational cohort study using trauma registry data from a Level I trauma center in Kaohsiung, Taiwan, covering the period from January 2023 to December 2024. Inclusion criteria were: Injury Severity Score (ISS) >15, Emergency Department (ED) temperature 32.0-37.9°C, and hospital admission. Trauma patients with a temperature recorded on arrival in the ED between 32.0°C and 37.9°C were included and categorized into two groups: normal temperature (35.0–37.9°C) and hypothermia (32.0–34.9°C). Descriptive statistics were used to summarize patient characteristics. Categorical variables were compared between groups using chi-square tests or Fisher's exact tests, as appropriate. Continuous variables were analyzed using independent t-tests. A p-value <0.05 was considered statistically significant. All analyses were performed using IBM Statistical Package for the Social Sciences (IBM SPSS) Statistics version 25. No advanced predictive algorithms were applied; analyses were limited to standard statistical tests for categorical and continuous variables.

III. Results

Of the 1,324 patients included (ED temperature 32.0–37.9°C), 31 (2.34%) were classified as hypothermic (32.0–34.9°C), while the remainder were normothermic (35.0–37.9°C). The mean age of the hypothermia group was 56.32 ± 22.16 years old, and 51.1% were male. Most of them were transferred patients (90.3%), and 93.5% were triaged as level 1. Trauma team activation occurred in 67.7%, and 35.5% had a Systolic

Blood Pressure (SBP) <90 mmHg. Notably, 93.5% were coma (Glasgow Coma Scale, GCS<9). Over half (54.8%) underwent surgery. The most common injury mechanisms were traffic accident (74.2%) and falls (19.4%). Hypothermia peaked in April (19.4%) and September (16.1%), with autumn being the most frequent season (35.5%).

TABLE I. BASELINE CHARACTERISTICS IN SEVERELY INJURED PATIENTS ON HOSPITAL ARRIVAL

Variable	Mortality N(%)	Survival N(%)	p-value
Sex			0.605
Male	10(55.6)	8(44.48)	
Female	6(46.2)	7(53.8)	
Arrival Method			0.583
EMS	2(66.7)	1(33.3)	
Transfer	14(50.0)	14(50.0)	
Triage			0.131
Level1	16(55.2)	13(44.8)	
Level2	0(0)	2(100)	
SBP(mmHg)			0.31
<90	7(63.6)	4(36.4)	
>=90	9(45.0)	11(55.0)	
GCS			0.131
<9	16(55.2)	13(44.8)	
>=9	0(0)	2(100)	
Season			0.364
Spring	4(44.4)	5(55.6)	
Summer	1(33.3)	2(66.7)	
Autumn	8(72.7)	3(27.3)	
Winter	3(37.5)	5(62.5)	

TABLE II. SEVERITY OF EACH BODY REGION, ICU LOS AND THE OUTCOME OF HYPOTHERMIA

Variable	Mortality mean(SD)	Survival mean(SD)	p-value
Max AIS			
Head/Neck	3.38(1.63)	3.0(2.20)	0.592
Face	0.63(0.89)	0.60(0.91)	0.939
Thorax	2.31(1.74)	2.13(1.81)	0.781
Abdomen	2.25(1.81)	1.07(1.67)	0.068
Extremity	1.69(1.45)	1.067(1.22)	0.209
External	0.94(0.44)	0.93(0.26)	0.975
ISS	33.38(8.41)	28.47(9.49)	0.138
ICU LOS	2.69(2.46)	15.80(8.45)	<0.005*

The mean ISS was 31.0 ± 9.15. The overall mortality rate in the hypothermia group was 51.6%. GCS, Intensive Care Unit Length Of Stay (ICU LOS), and mortality were significantly associated with hypothermia ($p < 0.005$), while no significant associations were found for sex, arrival method, injury mechanism, season, or blood pressure.

IV. DISCUSSION

In southern Taiwan's tropical climate, hypothermia still occurred in major trauma patients and was strongly linked to mortality (51.6%). Although incidence (2.34%) was lower than in temperate (12.6%) and subtropical (5.7%) regions, outcomes were consistent with global benchmarks such as American College of Surgeons-Trauma Quality Improvement Program (ACS-TQIP). This highlights that climate affects incidence but not prognostic significance. Hypothermia remains a universal threat in trauma care, requiring early detection and management. International guidelines, including Tactical Combat Casualty Care (TCCC), recommend passive and active warming, warmed fluids, and minimizing heat loss. Future work should assess the implementation of preventive warming, especially during interhospital transfers, to improve survival outcomes.

V. LIMITATIONS

This study was conducted in a single trauma center, limiting generalizability. Temperature was measured via tympanic thermometry, not core temperature. Most patients were interhospital transfers, and prehospital warming measures could not be verified. The study also lacked data on transfusion status and laboratory values.

VI. CONCLUSION AND FUTURE WORK

Hypothermia can occur even in tropical regions and is significantly associated with mortality in severely injured trauma patients. Although this study focused on trauma patients in a tropical climate, future research should investigate mechanisms to prevent poor outcomes associated with hypothermia. Strategies may include both passive warming (thermal blankets, heated environment) and active warming (warmed intravenous fluids, warming devices), as well as minimizing heat loss during interhospital transfers. Moreover, the methodology used in this study can be replicated in other settings, including temperate and subtropical climates, and may also be extended to other critical conditions such as burns, where hypothermia has prognostic implications.

REFERENCES

[1] L. M. Aitken, J. K. Hendrikz, J. M. Dulhunty, and M. J. Rudd, "Hypothermia and associated outcomes in seriously injured trauma patients in a predominantly sub-tropical climate," Resuscitation, vol. 80, no. 2, pp. 217–223, 2009. https://doi.org/10.1016/j.resuscitation.2008.10.021

[2] G. K. Luna, R. V. Maier, E. G. Pavlin, D. Anardi, M. K. Copass, and M. R. Oreskovich, " Incidence and effect of hypothermia in seriously injured patients," J Trauma, vol. 27, no. 9, pp. 1014-8, 1987. doi: 10.1097/00005373-198709000-00010. PMID: 3656463.

[3] A. M. Jose et al., "Hypothermia on admission predicts poor outcomes in adult trauma patients,". Injury, vol. 56, no. 5, 2024. doi: 10.1016/j.injury.2024.112076. Epub 2024 Dec 3. PMID: 39658434.

[4] M. Azarkane, T. W. H. Rijnhout, I. A. L. van Merwijk, T. N. Tromp, and E. C. T. H. Tan, "Impact of accidental hypothermia in trauma patients: A retrospective cohort study," Injury, vol. 55, no. 1, 2024. doi: 10.1016/j.injury.2023.110973. Epub 2023 Aug 4. PMID: 37563046.

[5] B. L. Bennett et al., "Management of Hypothermia in Tactical Combat Casualty Care: TCCC Guideline Proposed Change 20-01 (June 2020) ," J Spec Oper Med, vol. 20, no. 3, pp.21-35, 2020. doi: 10.55460/QQ9R-RR8A. PMID: 32969001.

[6] Central Meteorological Administration, Ministry of Transportation and Communications (2025/6/30). *113th Annual Climate Data Report - Ground Data.* https://www.cwa.gov.tw/V8/C/D/publication.html?key=5