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PERIOPERATIVE HYPOTHERMIA IN ADULTS IN A TERTIARY UNIVERSITY HOSPITAL: A CROSS-SECTIONAL ANALYSIS

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ABSTRACT
Background: Perioperative hypothermia, defined as a core body temperature below 36°C, is a frequent complication in surgical patients, associated with adverse outcomes such as infections, cardiovascular events, and increased morbidity and mortality. This study evaluated the incidence of perioperative hypothermia, identified associated risk factors, and assessed prophylactic measures in a tertiary university hospital. **Methods:** We conducted an observational, cross-sectional study of patients undergoing elective surgeries between February and May 2024. Tympanic temperature was measured at six perioperative time points, and clinical, demographic, and anesthetic data were collected. Statistical analysis included descriptive statistics and hypothesis testing, with significance set at p<0.05. **Results:** A total of 91 patients were included, with a 92.3% incidence of hypothermia. Male sex was significantly associated with hypothermia (58.3% vs. 14.3%, p=0.043), while other factors, including ASA classification, obesity, and anesthetic type, showed no significant correlation. Temperature decreased most during the first hour post-induction, with median preoperative and end-of-surgery values of 36.3°C and 35.1°C, respectively. Prophylactic warming techniques were underutilized, with only 28.6% of patients receiving active warming. **Conclusions:** The study revealed a high incidence of perioperative hypothermia, emphasizing the need for improved temperature management protocols and healthcare team education.

Keywords: Perioperative, hypothermia, anesthesia, risk factors, body temperature, surgical complications.

INTRODUCTION

Maintaining core body temperature between 36°C and 37.5°C is essential for physiological homeostasis. Perioperative hypothermia, defined as a core temperature below 36°C, frequently occurs during the perioperative period due to anesthetic effects, exposure to cold operating room environments, and fluid administration. The reported incidence ranges from 20% to 70%, varying based on patient populations and surgical settings[1,2,3].

Hypothermia increases the risk of complications, including infections, cardiovascular instability, coagulopathy, prolonged recovery, and higher morbidity and mortality rates4,5,1,6,7. Despite the availability of preventive guidelines, hypothermia management remains inconsistent across institutions[1,8,9,10,11].

This study aimed to evaluate the incidence of perioperative hypothermia, identify associated risk factors, and assess the effectiveness of prophylactic warming measures in a tertiary university hospital.

METHODS

Study design and Population

This observational, cross-sectional study included patients undergoing elective surgeries at a tertiary university hospital between February and May 2024. Ethical approval was obtained from the institutional review board (CAAE 74811323.7.0000.5292), and all participants provided written informed consent.

Inclusion criteria were adults aged ≥18 years undergoing surgeries lasting ≥60 minutes. Exclusion criteria included emergency surgeries and procedures precluding temperature measurement.

Data Collection

Patient demographic and clinical characteristics, including age, sex, body mass index (BMI), comorbidities, and ASA classification, were recorded. Anesthetic and intraoperative variables, such as type and duration of anesthesia, use of crystalloids, and application of warming techniques, were documented.

Tympanic temperature was measured using an infrared thermometer at six time points: admission to the operating room (T1), 15 minutes post-induction (T2), 60 minutes post-induction (T3), 120 minutes post-induction (T4), end of surgery (T5), and 60 minutes after completion of surgery for individuals kept in the post-anesthesia care unit (PACU) (T6). For the purposes of this study, hypothermia was considered to occur when the tympanic membrane temperature was <36°C. Furthermore, at each of these moments, the ambient temperature was checked using a digital hygrometer.

Statistical Analysis

Data were analyzed using R (version 4.1) and Jamovi (version 2.3). Continuous variables were summarized as means, medians, and interquartile ranges, while categorical data were expressed as frequencies and percentages. The Shapiro-Wilk test assessed normality. Hypothesis testing included Student's t-test and Fisher's exact test. Correlations between temperatures and environmental factors were evaluated using Spearman's rank coefficient. Significance was set at $p<0.05$.

RESULTS

Patient Characteristics

At the end of data collection, 91 patients were included in the study. Among them, 92.3% experienced hypothermia. Most were male (58.3%) and the mean age in the group was 49.4 years. Table 1 summarizes the demographic and clinical data.

Table 1 – Descriptive and clinical characteristics of patients divided by group.

Variables	Group				P-value
	Hypothermia (N = 84)		Normothermia (N = 7)		
Sex					
Female	35	41.7 %	6	85.7 %	0.043[a]
Male	49	58.3 %	1	14.3 %	
Age					
Mean (standard deviation)	49.4	(16.81)	51.14	(14.26)	0.791[b]
Up to 65 years old	67	79.8 %	6	85.7 %	1.000[b]
Over 65 years old	17	20.2 %	1	14.3 %	
Systemic arterial hypertension	35	41.7 %	4	57.1 %	0.456[a]
Obesity	18	21.4 %	3	42.9 %	0.346[a]
Sedation	27	32.1 %	1	14.3 %	0.431[a]
Total intravenous anesthesia	16	19.0 %	2	28.6 %	0.621[a]
Balanced general anesthesia	39	46.4 %	4	57.1 %	0.703[a]
Spinal anesthesia	29	34.5 %	2	28.6 %	1.000[a]
Epidural anesthesia	9	10.7 %	0	0.0 %	1.000[a]
ASA classification					
I	22	26.2%	1	14.3%	0.201[a]
II	34	40.5%	2	28.6%	
III	27	32.1%	3	42.8%	
IV	1	1.2%	1	14.3%	
Anesthesia time					
Up to 2 hours	33	39.3 %	4	57.1 %	0.436[b]
Over 2 hours	51	60.7 %	3	42.9 %	
Warming technique					
None	61	72.6 %	4	57.1 %	0.384[a]
Thermal blankets	23	27.4 %	3	42.9 %	
Crystalloid volume					
Up to 1 liter	37	44.0 %	3	42.9 %	1.000[b]
Over 1 liter	47	56.0 %	4	57.1 %	
Heated crystalloid					
No	66	80.5 %	5	71.4 %	0.626[b]
Yes	16	19.5 %	2	28.6 %	

[a] *Fisher's Exact Test;* [b] *Student's t-test.*

Risk Factors

Male sex was the only significant risk factor for hypothermia. Other variables, including age, ASA classification, BMI, and anesthesia type, showed no significant associations.

Prophylactic Measures

Thermal blankets were used in 27.4% of patients in the hypothermic group and 42.9% in the normothermic group. Heated crystalloid was administered to only 19.5% of patients in the hypothermic group and 28.6% in the normothermic group.

Temperature Trends

As shown in Table 2, the mean/median temperatures decreased significantly between T1 and T5 (36.3°C to 35.1°C). The steepest decline occurred within the first hour post-induction. Environmental temperatures ranged from 21.7°C to 24.8°C. As summarized in Table 3, there was a significant correlation between patient and room temperature at T2 (ρ=0.231, p=0.028) and T5 (ρ=0.276, p=0.008).

Table 2 – Distribution of patient and operating room temperatures

Variable	Temperature[a]	P-value[b]
Patient T1	36.3 (35.9-36.6)	< .001
Ambient T1	24.5 (±0.883)	0.067
Patient T2	35.3 (34.5-36.1)	0.022
Ambient T2	22.9 (±1.698)	0.277
Patient T3	34.8 (33.8-35.6)	0.018
Ambient T3	21.8 (±1.876)	0.954
Patient T4[c]	34.9 (33.5-35.5)	0.034
Ambient T4	21.7 (±1.760)	0.579
Patient T5	35.1 (33.8-35.8)	< .001
Ambient T5	21.8 (±1.667)	0.797
Patient T6[d]	35.9 (34.6-36.2)	< .001
Ambient T6	24.8 (24.2-25.2)	< .001

[a] Data were presented in mean±SD or median format (Q1-Q3) depending on whether or not there was a normal distribution; [b] Shapiro-Wilk test; [c] Only patients with anesthesia time longer than 120 minutes had their temperature measured at T4; [d] Only patients who remained in the PACU had their temperature monitored at time T6.

Table 3 – Correlation between patient and operating room temperatures

Correlated variables	Rho	Spearman P-value
T1 patient and T1 ambient	0.087	0.414
T2 patient and T2 ambient	0.231	0.028
T3 patient and T3 ambient	0.183	0.082
T4 patient and T4 ambient	0.195	0.146
T5 patient and T5 ambient	0.276	0.008
T6 patient and T6 ambient	-0.101	0.356

DISCUSSION

The findings of this study demonstrate an alarmingly high incidence of perioperative hypothermia (92.3%), significantly exceeding the rates reported in similar investigations[12,13]. This difference may reflect the limited use of prophylactic measures in the study hospital, compounded by insufficient adherence to established guidelines[9,14].

Previous studies, such as those conducted in Brazil12 and Turkey13, reported hypothermia incidences of 69.8% and 78.6%, respectively. These variations may arise from differences in institutional practices, environmental controls, and the frequency of temperature monitoring. For instance, continuous or serial temperature assessments, as performed in this study, can capture transient hypothermic events that might otherwise go undetected[15,16].

The significant correlation between ambient and patient temperatures, particularly at T2 and T5, aligns with evidence highlighting the importance of maintaining operating room temperatures within recommended ranges (20–23°C)1,13. Nevertheless, even within this range, substantial heat loss through convection and conduction was observed, suggesting that ambient control alone is insufficient without active warming strategies.

Male sex was identified as a significant risk factor for hypothermia ($p=0.043$ $p = 0.043$), contrasting with some reports that found no sex-based differences[13,17]. This discrepancy could stem from population-specific factors or sample size limitations. Notably, men may be more prone to peripheral heat loss due to differences in body surface area-to-mass ratios, a phenomenon requiring further investigation.

Contrary to expectations, age and ASA classification were not significant predictors of hypothermia. While older adults are typically more susceptible to thermoregulatory dysfunction[18], the small proportion of elderly patients in this study may have precluded robust statistical comparisons. Similarly, while higher ASA classifications suggest greater comorbidity burden, their lack of association with hypothermia aligns with recent findings that emphasize multifactorial determinants, such as procedural and environmental factors[19].

The underutilization of warming techniques likely contributed to the high hypothermia incidence observed. Despite evidence supporting the efficacy of forced-air warming systems and pre-warmed fluids in reducing hypothermia risk, their adoption in the study hospital was limited[1,20]. For instance, only 27.4% of hypothermic patients received thermal blanket warming, and 19.5% received pre-warmed crystalloids.

This low adherence reflects broader systemic challenges, including resource limitations, lack of standardized protocols, and inadequate staff training10. International guidelines[14], recommend implementing multimodal warming strategies tailored to individual patient risks. However, their practical application requires institutional commitment and resource investment.

The pronounced drop in temperature within the first hour post-induction highlights the critical window for intervention. Active warming should ideally commence preoperatively and continue throughout the perioperative period. Moreover, the strong correlation between ambient and patient temperatures suggests that optimizing operating room conditions, alongside active warming, may yield synergistic benefits.

Educating surgical teams about the adverse outcomes associated with hypothermia—such as increased infection risk, coagulopathy, and prolonged recovery—is essential. Addressing these gaps could mitigate complications, improve patient outcomes, and reduce healthcare costs[7,21].

LIMITATIONS

This study has several limitations. The single-center design and relatively small sample size restrict the generalizability of findings. Additionally, while tympanic temperature measurement is a practical non-invasive method, it may underestimate core temperatures compared to invasive techniques such as pulmonary artery or esophageal monitoring[22,23].

CONCLUSION

This study highlights the high incidence of perioperative hypothermia and underscores the importance of implementing robust temperature management protocols. Increased adherence to prophylactic warming measures and healthcare provider education are critical to mitigating hypothermia-related risks.

REFERENCES

1. Silva ED, Mendes FF, Braz LG, Duval Neto GF, Falcão LF, Galhardo Junior C, et al. Instruções brasileiras sobre intervenções para prevenção e treinamento a respeito de hipotermia perioperatória inadvertida em adultos – produzida pela Sociedade de Anestesiologia do estado de São Paulo [Internet]. Journal of Infection Control. 2018 [cited 2024 May]. Available from: https://repositorio.usp.br/item/002938664.
2. Ralph N, Gow J, Conway A, Duff J, Edward KL, Alexander K, et al. Costs of inadvertent perioperative hypothermia in Australia: A cost-of-illness study. Collegian [Internet]. 2019 Dec [cited 2024 May];27(4). Available from: https://www.sciencedirect.com/science/article/abs/pii/S1322769619301891.
3. Özsaban A, Acaroğlu R. The Effect of Active Warming on Postoperative Hypothermia on Body Temperature and Thermal Comfort: A Randomized Controlled Trial. J Perianesth Nurs [Internet]. 2020 Apr [cited 2024 May];35(4):423–9. Available from: https://pubmed.ncbi.nlm.nih.gov/32360129/.
4. Moola S, Lockwood C. Effectiveness of strategies for the management and/or prevention of hypothermia within the adult perioperative environment. International Journal of Evidence-Based Healthcare. 2011 Dec;9(4):337–45.
5. Simegn GD, Bayable SD, Fetene MB. Prevention and management of perioperative hypothermia in adult elective surgical patients: A systematic review. Annals of Medicine and Surgery [Internet]. 2021 Dec [cited 2024 May];72(72). Available from: https://pmc.ncbi.nlm.nih.gov/articles/PMC8605381/.
6. Mahoney CB, Odom J. Maintaining intraoperative normothermia: a meta-analysis of outcomes with costs. AANA J. 1999 Apr;67(2):155-63.
7. Reynolds L, Beckmann J, Kurz A. Perioperative complications of hypothermia. Best Pract Res Clin Anaesthesiol [Internet]. 2008 Dec [cited 2024 May];22(4):645–57. Available from: https://www.sciencedirect.com/science/article/pii/S152168960800061X.
8. Link T. Guidelines in Practice: Hypothermia Prevention. AORN J [Internet]. 2020 May 28 [cited 2024 May];111(6):653–66. Available from: https://aornjournal.onlinelibrary.wiley.com/doi/10.1002/aorn.13038.
9. Sessler DI. Perioperative Temperature Monitoring. Anesthesiology [Internet]. 2021 Jan 1 [cited 2024 May];134(1):111-118. Available from: https://journals.lww.com/anesthesiology/fulltext/2021/01000/perioperative_temperature_monitoring.21.aspx.
10. Deng X, Yan J, Wang S, Li Y, Shi Y. Clinical Survey of Current Perioperative Body Temperature Management: What Major Factors Influence Effective Hypothermia Prevention Practice? Journal of Multidisciplinary Healthcare [Internet]. 2022 Aug 8 [cited 2024 May];15:1689–96. Available from: https://pmc.ncbi.nlm.nih.gov/articles/PMC9374200/.
11. Wang J, Deng X. Inadvertent hypothermia: A prevalent perioperative issue that remains to be improved. Anesthesiology and Perioperative Science. 2023 Sep 12;1(3).

12. Peixoto C de A, Ferreira MBG, dos Santos Felix MM, Pereira CB de M, Cândido JV, Rocha VFR, et al. Factors contributing to intraoperative hypothermia in patients undergoing elective surgery. Perioperative Care and Operating Room Management. 2020.
13. Sari S, Aksoy SM, But A. The incidence of inadvertent perioperative hypothermia in patients undergoing general anesthesia and an examination of risk factors. International Journal of Clinical Practice. 2021 Feb 28;75(6).
14. NICE. Inadvertent perioperative hypothermia: the management of inadvertent perioperative hypothermia in adults. NICE, 2008.
15. Sessler DI. Perioperative thermoregulation and heat balance. Lancet [Internet]. 2016 Jun 25 [cited 2024 May];387(10038):2655-2664. Available from: https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(15)00981-2/ abstract.
16. Alfonsi P, Bekka S, Aegerter P; SFAR Research Network investigators. Prevalence of hypothermia on admission to recovery room remains high despite a large use of forced-air warming devices: Findings of a non-randomized observational multicenter and pragmatic study on perioperative hypothermia prevalence in France. PLoS One [Internet]. 2019 Dec 23 [cited 2024 Jun];14(12):e0226038. Available from: https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0226038.
17. Akers JL, Dupnick AC, Hillman EL, Bauer AG, Kinker LM, Hagedorn Wonder A. Inadvertent Perioperative Hypothermia Risks and Postoperative Complications: A Retrospective Study. AORN J [Internet]. 2019 Jun [cited 2024 Jun];109(6):741-747. Available from: https://aornjournal.onlinelibrary.wiley.com/doi/10.1002/aorn.12696.
18. Wongyingsinn M, Pookprayoon V. Incidence and associated factors of perioperative hypothermia in adult patients at a university-based, tertiary care hospital in Thailand. BMC Anesthesiol [Internet]. 2023 Apr 25 [cited 2024 Jun]; 23(1):137. Available from: https://bmcanesthesiol.biomedcentral.com/articles/10.1186/s12871-023-0208 4-2.
19. Chen HY, Su LJ, Wu HZ, Zou H, Yang R, Zhu YX. Risk factors for inadvertent intraoperative hypothermia in patients undergoing laparoscopic surgery: A prospective cohort study. PLoS One [Internet]. 2021 Sep 23 [cited 2024 Jun];16(9):e0257816. Available from: https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0257816.
20. Xiong Z, Zhu J, Li Q, Li Y. The effectiveness of warming approaches in preventing perioperative hypothermia: Systematic review and meta-analysis. Int J Nurs Pract [Internet]. 2022 Sep 4 [cited 2024 Jun];29(6). Available from: https://onlinelibrary.wiley.com/doi/10.1111/ijn.13100.
21. Billeter AT, Hohmann SF, Druen D, Cannon R, Polk HC. Unintentional perioperative hypothermia is associated with severe complications and high mortality in elective operations. Surgery [Internet]. 2014 Nov [cited 2024 Jun];156(5):1245–52.

Available from: https://www.surgjournal.com/article/S0039-6060(14)00194-9/abstract.

22. Poveda V de B, Nascimento A de S. Intraoperative body temperature control: esophageal thermometer versus infrared tympanic thermometer. Rev Esc Enferm USP [Internet]. 2016 Dec [cited 2024 Jun];50(6):946–52. Available from: https://www.scielo.br/j/reeusp/a/R3sbWgCZyDs5rWGF7LDvJzr/?lang=en.

23. Cutuli SL, Osawa EA, Eyeington CT, Proimos H, Canet E, Young H, et al. Accuracy of non-invasive body temperature measurement methods in critically ill patients: a prospective, bicentric, observational study. Critical Care and Resuscitation [Internet]. 2021 Sep 6 [cited 2024 Jun];23(3):346–53. Available from: https://pmc.ncbi.nlm.nih.gov/articles/PMC10692569/.