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Original Research Article

Prevalence of Perioperative Hypothermia and Its Associated Complications

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Abstract:

Background: Perioperative hypothermia (core ˙temperature <36°C) is a frequent but often underrecognized complication of anesthesia and surgery, associated with significant adverse outcomes.

Aim: To assess the incidence of perioperative hypothermia and its associated intraoperative and postoperative complications among surgical patients.

Methodology: This hospital-based prospective observational study included 90 adult patients undergoing elective or emergency surgery under general or regional anesthesia. Core body temperature was monitored perioperatively, and hypothermia was defined as a temperature <36°C. Complications and recovery outcomes were recorded. Data were analyzed using SPSS version 27.0.

Results: Perioperative hypothermia was observed in 42.2% of patients, predominantly mild in severity. Hypothermia was significantly associated with higher incidences of shivering, cardiac arrhythmias, increased oxygen requirement, and delayed recovery ($p < 0.05$). Hypothermic patients also had significantly prolonged PACU stay and longer postoperative hospital stay compared to normothermic patients.

Conclusion: Perioperative hypothermia is common and significantly impacts postoperative recovery and outcomes. Routine temperature monitoring and proactive warming strategies are essential to minimize complications and improve perioperative care.

Keywords: Perioperative Hypothermia, Anesthesia, Complications, PACU Stay, Normothermia.

Introduction

Perioperative hypothermia, which is frequently described as the maintenance of core body temperature under 36°C at any point in the surgical process, is a common though often unnoticed complication in surgical patients [1]. In spite of the progress made in anesthetic methods, monitoring, and perioperative care, the issue of hypothermia is still present among a large number of patients who have both minor and major surgeries. The maintenance of˙ normothermia is deemed to be a vital physiological necessity since body ˙temperature is very important for biochemical reactions, oxygen delivery, coagulation pathways, immune system, and heart and blood vessels [2]. The importance of systematic evaluation and treatment for perioperative hypothermia is shown by the fact that even slight drops in core temperature can disturb the body's balance and lead to a chain of negative clinical outcomes.

The perioperative phase is especially prone to disruptions in thermoregulation as a result of the interplay of several factors [3]. The use of anesthetics, be it general or regional, disrupts the normal process of thermoregulation by dehydration of the body, covering the heat movement from the inner organs to the skin surface and vice versa, and leading to the core areas losing heat and the peripheries becoming hot [4]. The large surface area of the body exposed, the person receiving cold intravascular fluid infusion, the operating room being a low-temperature area for a prolonged period are all factors that contribute to the entire process of heat loss through radiation, convection, conduction, and evaporation as operating time is more than the waste of heat in these forms [4] . Moreover, surgical stress and trauma can result in increased metabolic heat production, while muscle relaxants and sedatives may decrease voluntary movement and, consequently, heat generation. All these factors come together resulting in a high rate of perioperative hypothermia being reported in various surgical specialties [5].

There are some patient-related factors that make some patients more susceptible to hypothermia during surgery. The extremes of age, especially neonates and the elderly, are among these factors with impaired thermoregulation and body composition as the main reasons for such high risks [6]. However,

low body mass index, endocrine disorders, cardiovascular diseases or pre-existing anemia patients might be the ones with the highest heat loss and minimum heat production. Emergency surgeries, trauma cases, and procedures associated with significant blood loss also predispose patients to hypothermia while long operations and those requiring large open cavities pose the same risk [7]. The presence of these risk factors point out the need for each patient to be assessed separately regarding the temperature during the operation and the application of thermal management strategies in a proactive manner.

The impact of hypothermia in the perioperative period on the patient has clinical significance which is not limited to discomfort and shivering only [8]. It has been a common finding that hypothermia is related to a higher rate of perioperative and postoperative complications. Coagulation impairment has been one of the most extensively studied effects and blood loss during surgery has been increased as well as the need for blood transfusions. Hypothermia negatively influences the function of platelets and reduces the speed of enzymatic activity within the coagulation cascade thus bleeding times [9]. In addition, hypothermia causing vasoconstriction can reduce the blood flow and oxygen supply to the tissues which would then increase the risk of infections at the surgical site and slow down the healing of the wound. These complications not only lead to an increase in patient's morbidity but also result in longer hospital stay and higher healthcare costs.

One of the primary issues resulting from perioperative hypothermia is the cardiovascular complications that come with it [10]. The stimulation of the sympathetic nervous system due to cold may induce tachycardia, hypertension, and increased demand for oxygen by the heart, hence it might aggravate the ischemic processes in prone people. In extreme situations, hypothermia can disrupt cardiac rhythm and cause hemodynamic instability, particularly among those with heart diseases. Shivering after surgery, which is a typical sign of hypothermia, leads to an additional rise in oxygen consumption and carbon dioxide production thereby exerting more pressure on the system of circulation and respiration. This is particularly hard for patients with limited myocardial and pulmonary reserve such as those suffering from chronic obstructive pulmonary disease or heart failure.

Perioperative hypothermia has far-reaching effects not only on pharmacokinetics but also on the processes of anesthetic recovery. A drop in body temperature can change the rate at which anesthetics are metabolized and cleared from the body, leading to a situation where the drugs' effects are experienced for a longer duration and it takes more time to come out of anesthesia [11]. This can cause a longer stay in the recovery room, more postoperative monitoring, and a longer wait for the return of the protective airway reflexes. Moreover, hypothermia a has been associated with modulated immune responses, among which, diminished leukocyte function, which might be one reason for the higher rates of postoperative infections. Another area of concern is the cognitive decline occurring in older patients that has been linked to disturbances in the body's thermal regulation during surgery, thus underscoring the widespread systemic influence of hypothermia.

Perioperative hypothermia, a condition with various causes and extensive effects, necessitates the perioperative phase to be temperature-wise monitored very accurately. Temperature monitoring consistently or at intervals with reliable methods allows for hypothermia to be detected early and consequently treatment to be administered. Moreover, the monitoring sites of the core temperature such as the esophagus, nasopharynx, tympanic membrane, and bladder give central temperature representations that are more accurate than those obtained from the skin. The choice of the monitoring method should depend on the nature of the operation, anesthetic technique, and the patient's condition, but it is crucial that the alternation of consistency and accuracy is prioritized in order to inform clinical decisions.

Over the past few years, the prevention and management of perioperative hypothermia have been receiving more and more attention to the extent that the evidence-based protocols and guidelines have been implicated in this regard. Among the active warming measures are forced-air warming systems, warmed intravenous fluids and pre-warming techniques which have all been proven to be effective in keeping patients warm and thus cutting the rate of complications related to hypothermia. Nevertheless, the use of such measures is still inconsistent in different healthcare settings, especially in those with limited resources. This inconsistency is a clear indication that there is a need for continuous monitoring of the situation regarding perioperative hypothermia, its complications, and the effectiveness of the preventive measures taken.

In this context, the assessment of perioperative hypothermia and its complications is of great importance for the surgical outcome and patient safety improvement. A complete knowledge of the incidence, risk factors, pathophysiological mechanisms and clinical consequences of hypothermia would support the targeted interventions and the optimization of the perioperative care. In fact, through the monitoring of temperatures as a routine procedure and the preventive management of thermal conditions the healthcare institutions would be able to reduce the negative impact of hypothermia, hasten recovery and thus, bring about, better perioperative outcomes.

Methodology

Study Design: The present study was conducted as a hospital-based observational prospective study that aimed at assessing the incidence of perioperative hypothermia and its correlated complications in patients undergoing surgery under anesthesia. The study design was selected to systematically document the variations in perioperative temperature and correlate them with the medical outcomes during intraoperative and immediate postoperative periods.

Study Area: The study was carried out in the Department of Anaesthesia, Netaji Subhas Medical College and Hospital, Bihta, Patna, India from May 2024 to April 2025

Study Participants: The study population consisted of adult patients undergoing surgery under general or regional anesthesia during the study period.

Inclusion Criteria

- Patients aged 18 years and above
- Patients of either gender
- Patients undergoing elective or emergency surgical procedures under anesthesia
- Patients classified as American Society of Anesthesiologists (ASA) physical status I–III
- Patients with documented perioperative temperature monitoring

Exclusion Criteria

- Patients with pre-existing hypothermia or hyperthermia before surgery
- Patients undergoing cardiac surgery or major trauma surgery
- Patients with thyroid disorders, sepsis, or autonomic dysfunction
- Patients requiring preoperative ventilatory support
- Patients in whom perioperative temperature data were incomplete

Sample Size: A total of 90 patients were included in the study. The sample size was determined based on feasibility, availability of cases during the study period, and similar previous hospital-based observational studies assessing perioperative hypothermia.

Procedure: The researchers recruited the patients who were meeting eligibility criteria to participate in the study. The preoperative assessment included the patient's age, sex, weight, height, body mass index (BMI), ASA physical status, and the type of surgery planned as demographic details. Baseline core body temperature was noted before the start of the anesthesia process. Every patient underwent the standard anesthetic treatment according to the hospital's rules. Anesthesia was initiated with the proper intravenous medications and then either inhalational or intravenous anesthetic agents, opioids, and muscle relaxants were used for maintenance, depending on the decision made by the attending anesthesiologist. The standard monitoring methods such as electrocardiography, non-invasive blood pressure, pulse oximetry, and temperature monitoring were used during the operation.

Core body temperature was continuously measured during the surgery by using tympanic, nasopharyngeal, or esophageal probes and recorded once every 30 minutes. Perioperative hypothermia was considered when the core body temperature dropped below 36°C at any instant during the intraoperative period. The use of active warming measures such as warming blankets, warmed intravenous fluids, and forced-air warming devices was determined by clinical judgment. Patients were monitored in the post-anesthesia care unit (PACU) for any complications associated with hypothermia, such as shivering, delayed recovery, cardiac arrhythmias, increased oxygen requirement, and prolonged PACU stay. A structured data collection proforma was used to record all relevant intraoperative and postoperative data.

Statistical Analysis: All collected data were entered into Microsoft Excel and analyzed using Statistical Package for Social Sciences (SPSS) version 27.0. Continuous variables were expressed as mean and standard deviation, while categorical variables were presented as frequencies and percentages. The association between perioperative hypothermia and its complications was analyzed using appropriate statistical tests such as the Chi-square test and Student's t-test. A p-value of less than 0.05 was considered statistically significant.

Result

The demographic and baseline characteristics of the 90 study participants are depicted in Table 1. The mean age of the participants was 44.6 ± 13.2 years, and the largest proportion was aged between 31 and 45 years (32.2%), followed by 46–60 years (27.8%), whereas equal proportions were noted in the 18–30 years and >60 years age groups (20.0% each). Slightly more males than females were included in the study, as males accounted for 53.3% and females for 46.7%. The average body mass index was 23.8 ± 3.4 kg/m², meaning that the majority of the participants were in the normal to overweight category. The assessment of preoperative physical condition indicated that most of the patients were classified as ASA II (42.2%), followed by ASA I (37.8%), and a small proportion of patients being classified as ASA III (20.0%), which indicates that the majority of participants had mild to moderate systemic disease at the beginning of the study

Table 1: Demographic and Baseline Characteristics of Study Participants (n = 90)	
Variable	**Frequency / Mean ± SD**
Age (years)	44.6 ± 13.2
Age Group (years)	
18–30	18 (20.0%)
31–45	29 (32.2%)
46–60	25 (27.8%)
>60	18 (20.0%)
Gender	
Male	48 (53.3%)
Female	42 (46.7%)
Body Mass Index (kg/m²)	23.8 ± 3.4
ASA Physical Status	
ASA I	34 (37.8%)
ASA II	38 (42.2%)
ASA III	18 (20.0%)

Table 2 presents the surgical and anesthetic profile of the 90 study participants in a summarized way. General surgery procedures were the most common type of surgery (51.1%), next came orthopedic surgeries (20.0%) and gynecological surgeries (17.8%), while other types of surgeries made up the remaining 11.1% of cases. Elective surgeries accounted for the majority (68.9%) of surgeries conducted and emergency surgeries for nearly one-third (31.1%). Concerning anesthesia, general anesthesia was the main type used in 71.1% of the patients, while regional anesthesia was given to 28.9%. With respect to operative duration, the majority of surgeries (46.7%) were completed in the range of 60 to 120 minutes, while each of the two other categories (shorter <60 minutes and longer >120 minutes) had the same number of cases, i.e., 26.7%.

Table 2: Surgical and Anesthetic Profile of the Study Participants (n = 90)	
Variable	**Frequency (%)**
Type of Surgery	
General surgery	46 (51.1%)
Orthopedic surgery	18 (20.0%)
Gynecological surgery	16 (17.8%)
Others	10 (11.1%)
Nature of Surgery	
Elective	62 (68.9%)
Emergency	28 (31.1%)
Type of Anesthesia	
General anesthesia	64 (71.1%)
Regional anesthesia	26 (28.9%)
Duration of Surgery (minutes)	
<60	24 (26.7%)
60–120	42 (46.7%)
>120	24 (26.7%)

The data presented in Table 3 shows how hypothermia was both severe and common during the surgical process among the participants in the study. Perioperative hypothermia occurred in 38 cases (42.2%) of 90 patients altogether, while 52 patients (57.8%) were able to keep their body temperature normal during the surgical process. Most of the hypothermia victims suffered mild hypothermia (34–<36°C), 26 patients (68.4%) in total, moderate hypothermia (32–<34°C) in 10 patients (26.3%), while severe hypothermia (<32°C) was very rare with only 2 patients (5.3%) affected. In terms of the hypothermia episodes, a single episode was reported in 23 patients (60.5%), while multiple episodes were noted in 15 patients (39.5%). It shows that hypothermia, though frequently occurring, was mild in most cases and was usually associated with just one perioperative episode.

Table 3: Incidence and Severity of Perioperative Hypothermia (n = 90)	
Parameter	**Frequency (%)**
Perioperative Hypothermia	
Present	38 (42.2%)
Absent	52 (57.8%)
Severity of Hypothermia (n = 38)	
Mild (34–<36°C)	26 (68.4%)
Moderate (32–<34°C)	10 (26.3%)
Severe (<32°C)	2 (5.3%)
Number of Hypothermia Episodes	
Single episode	23 (60.5%)
Multiple episodes	15 (39.5%)

Table 4 patients suffering from the perioperative hypothermia had a remarkably higher incidence of intraoperative and postoperative complications than the patients who were normothermic. The hypothermia group suffered from shivering to a great extent and it was reported in 47.4% of cases versus 11.5% in the non-hypothermia group, with a very high significance difference ($p < 0.001$). Cardiac arrhythmias were also proved to be more prevalent among hypothermic patients, i.e., 18.4%, in comparison to non-hypothermia 5.8% ($p = 0.04$). Increased oxygen requirement was found to be highly associated with hypothermia, having a markedly 39.5% of patients in this group compared to 15.4% in the normothermic group ($p = 0.01$). Recovery delay was seen in almost one-third of hypothermic patients (28.9%) which was significantly greater than the one-third of patients without hypothermia (9.6%) ($p = 0.02$). The hypothermia group needed blood transfusion more often (15.8% patients) than the group where patients were under normal body temperature (5.8%). Still, this difference was not statistically significant ($p = 0.11$). This implies that complications, except for transfusion requirement, were greatly associated with hypothermia.

Table 4: Intraoperative and Postoperative Complications Associated with Hypothermia			
Complication	**Hypothermia Present (n=38)**	**Hypothermia Absent (n=52)**	**p-value**
Shivering	18 (47.4%)	6 (11.5%)	<0.001*
Cardiac arrhythmias	7 (18.4%)	3 (5.8%)	0.04*
Increased oxygen requirement	15 (39.5%)	8 (15.4%)	0.01*
Delayed recovery	11 (28.9%)	5 (9.6%)	0.02*
Blood transfusion required	6 (15.8%)	3 (5.8%)	0.11

According to Table 5, patients who underwent perioperative hypothermia were kept for a significantly longer time in recovery and the hospital than patients without hypothermia. The difference between the two groups in PACU stay was statistically significant ($p < 0.001$). The mean duration of Post-Anesthesia Care Unit (PACU) stay was markedly higher in the hypothermia-present group (78.4 ± 22.6 minutes) than in the hypothermia-absent group (54.1 ± 18.9 minutes). Similarly, postoperative hospital stay was significantly prolonged among hypothermic patients, averaging 6.2 ± 2.1 days, as against 4.3 ± 1.8 days in normothermic patients ($p = 0.002$). These findings clearly point to the fact that perioperative hypothermia causes delayed postoperative recovery and prolongs the hospital stay.

Table 5: Post-Anesthesia Care Unit (PACU) and Hospital Stay Outcomes			
Outcome Parameter	**Hypothermia Present (Mean ± SD)**	**Hypothermia Absent (Mean ± SD)**	**p-value**
PACU stay (minutes)	78.4 ± 22.6	54.1 ± 18.9	<0.001*
Postoperative hospital stays (days)	6.2 ± 2.1	4.3 ± 1.8	0.002*

Discussion

The study carried out at present reveals a significant occurrence of perioperative hypothermia (42.2%), and it also shows a clear connection between hypothermia and various negative outcomes during the perioperative period. The percentage was in the same line with previously mentioned literature which denoted the rates between 30% and 60% for the patient's undergoing surgery with the help of general anesthesia. Yi et al. of 44.3% for patients under general anesthesia, which is almost similar to this study and indeed provides further evidence that the phenomenon of unintended hypothermia still persists irrespective of the improvements in anesthesia and surgical procedures (Yi et al., 2015) [12]. Riley and Andrzejowski, likewise, pointed out that the

under-awareness and lack of treatments regarding perioperative hypothermia are still issues even in the most modern operating rooms (Riley & Andrzejowski, 2018) [13].

Hypothermia was mainly seen in patients classified as ASA physical status I and II in the current research, which is an indication that hypothermia is not only a problem for high-risk or critically ill patients. The finding is in line with Sessler's work, who stated that the anesthetic-induced suppression of thermoregulation makes even healthy individuals lose considerable amounts of heat during surgery (Sessler, 2001) [14]. The predominance of the use of general anesthesia and the duration of procedures between 60 to 120 minutes for our patients, further justifies the high rate, because general anesthetics lower vasoconstriction thresholds and allow the movement of core heat to the periphery.

The majority of hypothermia events in this research were mild, while moderate and severe cases were quite rare. Such a distribution is similar to that of Yi et al. (2015), where the cases of mild hypothermia prevailed. But still, the very first degree of hypothermia can be accompanied by clinically relevant outcomes. According to Sessler (2001), even a minor drop of 1–2 °C can lead to impaired coagulability, and altered drug bioavailability, as well as an increase in postoperative complications. The occurrence of several hypothermic episodes in one patient group in the current study is an indication that fluctuation of temperature very often lasts through the whole perioperative period rather than presenting as one short-lived event.

This research showed that shivering was the most common complication in hypothermic patients, which was nearly 50% of all cases who suffered from hypothermia. This corresponds with the data of Good et al., who pointed out shivering incidence of about 40–60% in postoperative patients with hypothermia (Good et al., 2006) [15]. It is important to know that shivering essentially contributes to the rise of oxygen consumption and carbon dioxide production; thus, it could be one of the reasons for the higher postoperative oxygen requirements seen in our cohort of hypothermic patients. Besides, Polderman indicated that shivering caused by hypothermia can increase metabolic demand up to as much as 400%, which essentially makes patients with limited cardiopulmonary reserve even more vulnerable (Polderman, 2009) [16].

In this study, cardiac arrhythmias occurred considerably more often in hypothermic patients. This finding is consistent with previous physiological studies that revealed hypothermia to have a negative effect on the heart's electrical conduction and thus be a factor for arrhythmia occurrence (Polderman, 2009). Despite the fact that the total number of arrhythmias was not high, their statistically significant connection highlights the cardioprotective inadequacy during the perioperative period caused by hypothermia. Large observational studies have reported similar associations which point to the necessity of keeping patients at normal body temperature during surgery even when no pre-existing heart conditions are present.

One of the major consequences of hypothermia in this study was the delayed recovery and prolonged PACU stay. Hypothermic patients demanded a much longer PACU observation, which is in agreement with the findings of Zhang et al. (2022) [17], who proved that hypothermia was a major factor in prolonging PACU stay in elderly surgical patients. The occurrence of delayed recovery could be due to the fact that at lower core temperatures there is decreased hepatic metabolism and renal clearance of anesthetic agents, as mentioned by Sessler (2001). These effects can have a major impact on the postoperative workflow, staffing, and resource use.

The trend of increased blood transfusion requirements in hypothermic patients was also noticed in the current study, although it did not achieve statistical significance. Baucom et al. documented that perioperative hypothermia was connected with greater blood loss and increased rates of transfusion in people undergoing colorectal surgery (Baucom et al., 2015) [18]. The small number of subjects and the varied surgical procedures may account for the non-significant results in our study. However, the trend that was observed is still of clinical importance because the effects of hypothermia on platelet function and coagulation pathways are well-documented.

Hypothermia, which is a medical condition characterized by an abnormally low body temperature, was found to significantly prolong the length of hospital stay after surgery. Hypothermic patients, in general, were kept in the hospital for almost two days longer than normothermic patients, in fact. This result backs up the meta-analysis conducted by Dean et al., where it was indicated that the practice of maintaining normothermia throughout laparoscopic surgery resulted in shorter hospital stays and improved recovery profiles (Dean et al., 2017) [19]. On the other hand, some studies did not find the same association between hypothermia and length of hospital stay and attributed the differences in results to variations in patient populations, surgical complexity, and perioperative care. Besides, the current evidence supports the argument that perioperative hypothermia should be considered not only in terms of physiological complications but also in terms of broader economic and logistical impacts.

Overall, the findings of this study support perioperative hypothermia as a frequent, preventable condition with pronounced adverse consequences. Our results being consistent with established literature is

very much a backing for the fact that even mild hypothermia negatively impacts patient comfort, recovery, and healthcare resources. The results indicate that it is very essential to monitor the temperature intensely and employ warming methods actively during the whole perioperative period. Embracing the thermoregulation practices that are backed by scientific evidence may not only bring about a reduction in complications but also a faster recovery and better overall quality of perioperative care.

Conclusion

The current research establishes that perioperative hypothermia is a widespread phenomenon, hitting more than 40% of surgical patients, and is strongly linked to adverse perioperative and postoperative outcomes. The majority of the hypothermic episodes were mild in nature; however, they were associated with increased rates of shivering, cardiac arrhythmias, increased oxygen requirement, delayed recovery, prolonged PACU stay, and extended hospital hospitalization. These results spotlight that even a slight drop in core temperature poses a considerable threat to the patient's wellbeing. The study advocates the necessity of continuous and precise monitoring of temperature during the surgical procedure, and of the active warming strategies being applied timely. The combination of perioperative hypothermia prevention and management undertaken pro-actively can lead to a reduction of complications, a shortening of recovery time, an improved and optimized use of resources, and, ultimately, an enhancement of patient safety and surgical outcomes.

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