ADDIS ABABA UNIVERSITY, COLLEGE OF HEALTH SCIENCE DEPARTMENT OF ANESTHESIOLOGY, CRITICAL CARE AND PAIN MEDICINE

PREVALENCE OF POSTOPERATIVE HYPOTHERMIA AND ITS FACTORS IN POST ANESTHESIA CARE UNIT AMONG ADULT PATIENTS WHO UNDERWENT ELECTIVE SURGERY AT TIKUR ANBESA SPECIALIZED HOSPITAL, 2023/4

A RESEARCH THESIS IS TO BE SUBMITTED TO ADDIS ABABA UNIVERSITY, DEPARTMENT OF ANESTHESIOLOGY, CRITICAL CARE AND PAIN MEDICINE FOR THE PARTIAL FULFILLMENT OF THE REQUIREMENTS OF A SPECIALTY CERTIFICATE IN ANESTHESIOLOGY, CRITICAL CARE AND PAIN MEDICINE.

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Abbreviations and Acronyms

ACCPM……. Anesthesiology, Critical Care, and Pain medicine

ASA ……American Society of Anesthesiologists

BMI ……Body Mass Index

CICU…… Cardiac intensive care unit

ENT…… Ear Nose Throat

ETB…… Ethiopian Birr

GA…… General Anesthesia

GIT…… Gastrointestinal Tracts

HCP-……Health care providers

OR..…… .. Operation Room

PACU……. Post-Anesthesia Care Unit

SA …… Spinal Anesthesia

SICU……. Surgical intensive care unit

SPSS…… Statistical Package for Social Sciences

TASH ……Tikur Anbessa Specialized Hospital

Abstract

Background: Post-operative hypothermia is defined as a body temperature of <36°C and may be classified as mild, moderate, and severe. It is a frequent occurrence that affects more than 70% of patients undergoing surgery and anesthesia. In the postoperative period, patients might be hypothermic due to different reasons. It continues to be a significant challenge despite previous efforts, which may affect patient outcomes and healthcare costs.

Objective: This study aimed to assess the prevalence of postoperative hypothermia and its associated factors among adult patients in PACU who underwent elective surgery.

Methods: Institutional-based cross-sectional study design was conducted among adult patients who underwent elective surgery. Systemic random sampling was used to select patients. Patient chart review and temperature measurement were utilized for data collection. Analysis was done by using SPSS 27. Logistic regression was used to identify associated factors and a p-value < 0.05 at 95% confidence intervals was considered as statistical significance.

Result: The finding of the study revealed that 39%(n=145) of patients had at least one record of hypothermia. Among them, 22.3% of cases at arrival and 9.1% at the 15-minute had a moderate level, and there were no cases of hypothermia of any severity recorded. Age above 60 years, medical comorbidity, preoperative hypothermia, spinal anesthesia, spinal with epidural anesthesia, unwarmed crystalloid fluid administration, blood transfusion, and duration of surgery were significantly associated with postoperative hypothermia. Sex, ASA, BMI, duration of anesthesia, type of surgery and amount of crystalloid administered have no association with postoperative hypothermia

Conclusion and recommendations: The prevalence of postoperative hypothermia was significant. Proactive warming strategies, including warming intravenous fluids to body temperature and implementing continuous warming measures for longer surgeries, are crucial. Close monitoring and adjustment of warming interventions based on surgical complexity and patient needs are essential to prevent postoperative hypothermia effectively.

Keywords

Hypothermia, TASH, Postoperative patients, Postoperative complication, PACU, Surgical patie

1 Introduction

1.1 Background

The human thermoregulatory system usually maintains core body temperature near 37 degrees C(1). This homeostasis is accomplished by thermoregulatory defense mechanisms such as vasoconstriction, shivering or sweating, and vasodilatation(2,3). Hypothermia is defined as a body temperature of <36°C (96.8F)(4–11) and may be classified as mild (35.0°C-35.9°C), moderate (34.0°C-34.9°C) and severe (≤ 33.9°C). It is a frequent occurrence that affects more than 70% of patients undergoing surgery and anesthesia(12).

A body temperature change of 1-3°C leads to multiple physiological derangements, such as a change in protein metabolism that compromises healing and platelet dysfunction(8) which leads to bleeding and postoperative transfusions, arrhythmia, prolonged hospital stays, surgical site infection, and pressure ulcers(13) so that strict temperature control is important for normal organ, enzymatic, and cellular function, temperature control is tightly regulated by the body to within 0.2 ℃(14).

It also lowers patient satisfaction with the services and causes subjective discomfort due to cold and shivering(13), increased oxygen consumption, and vasoconstriction, all of which also lead to greater energy expenditure(14).

The cause for hypothermia is likely iatrogenic due to the ambient operating room (OR) temperature, surgical exposure, infusion and irrigation of cold fluids, anesthesia, and other factors. Both general and neuraxial anesthesia greatly impair normal thermoregulatory control, thus resulting in hypothermia(15)

Precise temperature regulation involves both the peripheral and central nervous systems through behavioral and autonomic triggers. However, this mechanism is changed by general anesthesia (GA), regional anesthetic agents, and factors experienced in the perioperative environment(12). Afferent signals for cold and hot sensations are transmitted via the A-delta and C nerve fibers, respectively(2,5). Sensory nerve fibers are thought to sense environmental temperature changes through skin projections(14)

The occurrence of postoperative hypothermia is associated with older age, female, emergency surgery, higher American Society of Anesthesiology physical status, major surgical procedure,

amount of intravenous or blood replaced, longer duration of anesthesia or surgery, operating room temperature, preoperative body temperature and anesthetic technique(12,13)

Temperature monitoring provides an early detection of postoperative hypothermia. The pulmonary artery, nasopharyngeal, distal esophageal, and tympanic temperature measurements are the best temperature monitoring sites(16), but temperature from the bladder, axilla, skin, and rectal are slowest to change and underestimate the magnitude of alteration in body temperature(8,17). Although the ear thermometer is easy and fast, its accuracy has always been controversial. It has been noticed that an ear thermometer reading varies from 1 to 2 degrees C below and above the temperature than rectal and oral thermometers. Conversely, tympanic temperature measurements seem to be the best alternative to rectal and infrared skin measurements with appropriate use. The reading can be affected by place of insertion, size of ears (intended for people older than one year of age), fluid, and exudate(12,16).

1.2 **Statement of the problem**

Hypothermia affects more than 70% of patients undergoing anesthesia or surgery at some point during the perioperative period, and it can exacerbate various perioperative problems (18). It also compromises the body's negative temperature regulation, making patients more susceptible to developing hypothermia and associated complications (14).

Despite the high prevalence of postoperative hypothermia among patients undergoing surgery at TASH(31.3%)(18), there is a lack of adequate preventive measures in place. Previous studies have highlighted the negative impact of perioperative hypothermia on patient outcomes, including increased morbidity, prolonged hospital stays, and heightened risk of complications.

While interventions have been recommended to decrease the incidence of hypothermia based on previous research, there is a gap in knowledge regarding the current status of postoperative hypothermia. Therefore, this research aims to assess the prevalence of postoperative hypothermia and its associated factors at TASH.

1.3 **Significance of the study**

Postoperative hypothermia remains a significant challenge despite previous efforts, impacting patient outcomes and healthcare costs. To reduce the likelihood of postoperative hypothermia, preventive procedures such as warming infusion fluids and applying blankets are practiced.

The need to assess the effectiveness of interventions in the face of increasing patient load and surgical complexity makes the current research initiative on postoperative hypothermia at TASH crucial. By examining the prevalence and risk factors for postoperative hypothermia in the current setting, the study aims to provide crucial data for hospital policymakers to develop preventive strategies, minimize risk factors, customize interventions, and improve protocols, thereby enhancing the delivery of perioperative care and efficient use of resources

2 Literature review

We look into several studies done all over the world on postoperative hypothermia in patients who underwent elective surgery to know its prevalence and associated factors. In a retrospective case-control study conducted at Fudan University Shanghai Cancer Center (FUSCC), China, 202 ASA I or II patients undergoing malignant tumor surgery from November 2020 to March 2021 were included. The study aimed to investigate the incidence of postoperative hypothermia and shivering, as well as identify risk factors associated with these complications in this patient population. The study found that the incidence of postoperative hypothermia and shivering was 25.7% immediately upon arrival at the PACU, 18.3% after staying in the PACU for 30 minutes, and 13.9% at discharge from the PACU (15).

A retrospective analysis of the Risk Factors for the Onset of Postoperative Hypothermia in the PACU of 1,788 patients at the Fourth Affiliated Hospital, College of Medicine, Zhejiang University, China from September 2018 to March 2019 who underwent surgery and were admitted to the PACU immediately after surgery found 113 (6.32%) exhibited hypothermia in the PACU and significant risk factors for the onset of hypothermia were general anesthesia, lower preoperative body temperature and higher ASA grade. However, epidural anesthesia was found to have a protective effect(10).

A non-probability sample technique study conducted in Siriraj Hospital, Mahidol University; - Bangkok, Thailand in 2021 G.C in 280 patients by Kongsayreepong et al. to determine the incidence of postoperative hypothermia and its associated factors in adult patients undergoing surgery found that the incidence was 45.4%. The highest incidence of postoperative hypothermia was found in patients 51-60 years old (56.5%). According to Binary Logistic Regression analysis, significant predictive factors of postoperative hypothermia were age, preoperative body temperature, use of warm blankets, abdominal irrigation, and type of surgery(19). Another Observational, prospective study conducted at the University of Porto, Portugal by Abelha et al. on 357 patients to assess the incidence of postoperative hypothermia patients found the incidence is 32%. Patients with hypothermia were more frequently over 65 years old, had a lower BMI, and more often had comorbid illnesses (20).

A retrospective chart review was conducted in a university-based tertiary care hospital in Thailand in 2023 to determine the incidence and associated factors of perioperative hypothermia in 742

patients' adult patients who underwent surgery at a university hospital. The incidence of postoperative hypothermia was 11.9% (95% CI 9.7-14.3), and preoperative hypothermia was 0.4% (95% CI 0.08-1.2). Of the 117 patients with intraoperative core temperature monitoring, the incidence of intraoperative hypothermia was 73.5% (95% CI 58.8–90.8), and hypothermia occurred most commonly after anesthesia induction. Associated factors of postoperative hypothermia were ASA physical status III-IV (OR = 1.78, 95%CI 1.08–2.93, p = 0.023) and preoperative hypothermia. To minimize the incidence of perioperative hypothermia and enhance patient outcomes, appropriate temperature management should be emphasized in patients at high risk(21).

A hospital-based cross-sectional study was conducted in 2014 at the University of Gondar Hospital, Gondar, Ethiopia in 384 patients to determine the incidence of post-operative Hypothermia in Surgical Patients, was 30.72%. Patients with high ASA physical status and who operated under general anesthesia were significant factors in the development of postoperative hypothermia(13).

An institutional-based cross-sectional study was conducted on 265 adult patients who underwent surgery at TASH in 2017. The study found that the overall incidence of preoperative, intraoperative, and postoperative hypothermia was 16.2%, 53.2%, and 31.3%, respectively. Age over 65 years, coexisting medical conditions, preoperative hypothermia, operating room temperature below 23 degrees Celsius, and Administering more than 2 liters of unwarmed crystalloid fluids were identified as significant risk factors (18).

In a hospital-based cross-sectional study conducted in 2019 at Debre Berhan Comprehensive Specialized Hospital, Debre Berhan University, Ethiopia to assess postoperative hypothermia and associate factors in 410 patients who underwent surgery was 130 (31.71%) and age greater than 50 years old, high ASA physical status, an operation done under general anesthesia, major operations and coexisting disease were strongly associated with postoperative hypothermia(12).

Conceptual framework

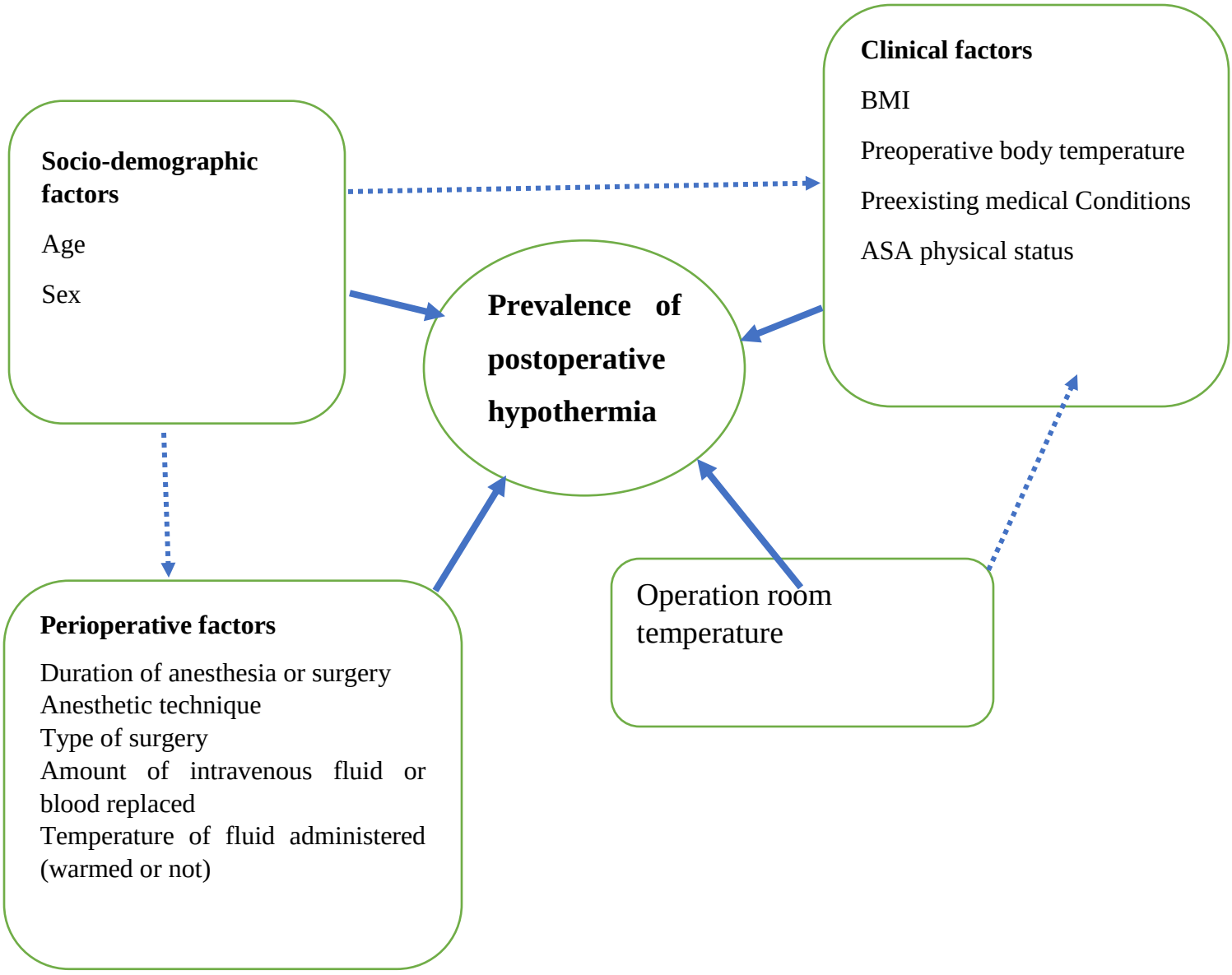

Figure 1:Conceptual framework designed after reviewing the literature on the prevalence of postoperative hypothermia and its associated risk factors in PACU among adult patients who underwent elective surgery at TASH, from November to January 2023/4.

3 Objectives

3.1 General Objective

To assess the prevalence of postoperative hypothermia and its associated risk factors in PACU among adult patients who underwent elective surgery at TASH, Addis Ababa, Ethiopia, 2023/4.

3.2 Specific objectives

1. To determine the prevalence of postoperative hypothermia in PACU among adult patients who underwent elective surgery at TASH, Addis Ababa, Ethiopia, 2023/4.
2. To identify associated risk factors of postoperative hypothermia in PACU among adult patients who underwent elective surgery at TASH, Addis Ababa, Ethiopia, 2023/4.
3. To determine a change in the prevalence pattern as compared to previous findings

4 Methods and materials

4.1 Study design and period

An institution-based analytic cross-sectional study was conducted among adult patients in PACU who underwent elective surgery at TASH, Addis Ababa, Ethiopia from November to January 2023/4.

4.2 Study area

The study was conducted at TASH in PACU which is located in the Central part of Addis Ababa City Administration, the capital of Ethiopia. TASH is a tertiary hospital that provides services for referral cases from other specialized referral hospitals throughout the country. The Department of Anesthesiology, Critical Care, and Pain Medicine has 14 consultant anesthesiologists and 86 residents.

The Post Anesthesia Care Unit (PACU) has 6 beds with 4 functional monitors for elective surgeries, accommodating both adult and pediatric cases. There is also a separate orthopedics PACU which has 3 beds with 2 functional monitors. The room lacks temperature measurement devices, and active warming strategies, and also faces a shortage of blankets to warm post-surgical patients. Two nurses are available to monitor post-surgical patients. Patients are usually monitored for more than one hour and then transferred to their respective elective wards by a porter after a thorough assessment and fulfilling discharge criteria.

4.3 Population

4.3.1 Source population

All adult patients admitted to PACU who underwent elective surgery at TASH, Addis Ababa, Ethiopia, 2023/4.

4.3.2 Study population

All adult patients admitted to PACU who underwent elective surgery at TASH, Addis Ababa, Ethiopia fulfilled the inclusion criteria from November to January 2023/4.

4.4 Sample size and sampling technique

*4.4.*1 Sampling Size Determination

The sample size was determined by using a single population proportion formula with the following assumption.

In a previous study conducted in 2017 at TASH in Addis Ababa, Ethiopia, the incidence of postoperative hypothermia was 31.3%(18), Confidence interval 95%, margin of error of 5%

$$Sample\ size\ n = \frac{\left[\left(z_{\alpha/2}\right)^2 \times p(1-p)\right]}{d^2}$$

Where: -

Z= Standard normal distribution value at 95% CI= (1.96)2

P= proportion of postoperative hypothermia; 31.3% (0.313)

d= margin of error (0.05)

n= sample size

Therefore, n= $[(1.96)^2)\times(0.313)\times(1\text{-}0.313)]/(0.05)^2$= 330

Another 15% was added for non-respondents making a total of n=380

4.4.2 Sampling technique

A systematic random sampling technique was used to select study participants on the daily operation schedule list. Depending upon the average values of the previous surgery per 2 months on the log book, 900 patients were operated on an elective schedule. The sampling interval; K was determined using the formula: K=N/n; 900/380 = 2 Where, n = total sample size, N = population per 2 months (i.e. 900). Therefore, the sampling interval was two, and the first study participant (random start) was selected using the lottery method from the daily operation schedule list. Then, every second case from the operation schedule was included in the study during the study period.

4.5 Eligibility criteria

4.5.1 Inclusion criteria

Selected adult Patients who underwent elective surgery from November to January 2023/4 were included in the study.

4.5.2 Exclusion criteria

Patients with preexisting fever, severe preoperative hypothermia, anesthesia duration <30 minutes, re-operation during the study period, and patients admitted to SICU or CICU were excluded.

4.6 Study variable

4.6.1 Dependent variables

Prevalence of postoperative hypothermia.

4.6.2 Independent variable

Socio-demographic factors: Age, Sex

Clinical factors: BMI**,** ASA physical status preoperative body temperature, pre-existing medical Conditions.

Perioperative factors: Duration of anesthesia or surgery, anesthetic technique, type of surgery, amount of intravenous fluid or blood replaced, temperature of fluid administered (warmed or not)

Environmental factors: Operation room temperature**,** Air circulation in the PACU**,** Ambient temperature.

4.7 Operational definition

Normothermia: A core temperature range of 36°C to 38°C (96.8°F to 100.4°F)

Hypothermia is defined as a body temperature of <36°C (96.8F)(4–11)

Mild hypothermia: A core temperature between 35-35.9°C (6, 7)

Moderate hypothermia: A core temperature between 34-34.9°

Severe hypothermia: when core body temperature is ≤ 33.9°C

Postoperative hypothermia: patients meeting inclusion criteria undergoing elective surgery at TASH, admitted to the PACU, with a measured body temperature below 36°C within one hour, as documented in at least one record.

Preoperative period: 1 hour before induction of anesthesia. This period also covers the transport of patients from the ward to the operating theatre.

ASA physical status: used to assess and communicate patient's pre-anesthesia medical co-morbidities.

Anesthetic technique: refers to the type of anesthesia that the patient will be going to receive based on patient indications and preferences.

Amount of intravenous fluid or blood replaced: the total amount of fluid or blood that the patient going to receive at the operation theater.

Adult: age 18 years and above

4.8 Data collection, tools, and procedure

Data was collected by using a modified and adopted questionnaire tool which was prepared in English, and written informed consent was taken from each patient. The tool contains socio-demographic characteristics, clinical factors, and intraoperative factors.
The temperature of each patient's tympanic membrane was taken both before surgery in the waiting area, before changing their clothes, and in the PACU by a trained nurse. Measurements were made using a reusable infrared thermometer (model TS46) with an accuracy of ±0.03 ºC within the range of 20 ºC-42.2 ºC. This thermometer is suitable because the tympanic membrane, sharing an arterial blood supply with the hypothalamus via the carotid artery, directly reflects core temperatures(22). All patients were examined for ear infections by a trained nurse, and significant ear wax was removed. The probe was introduced into the external auditory meatus, either the left or right ear, by pulling the pinna backward and pointing the thermometer towards the eye. The instrument was calibrated according to the manufacturer's instructions before each reading. Postoperative temperatures were measured upon entry to the PACU and subsequently at 15 minutes, 30 minutes, and 1 hour.

4.9 Data quality control

To ensure data quality, the principal investigator trained the nurses on the study objectives, detailed descriptions of the tools, and data collection procedures using Google Forms before the start of data collection. The principal investigator, serving as the supervisor, checked the completeness and consistency of the collected data throughout the data collection period.

4.10 Data processing and analysis

All responses to the questionnaires were coded, entered, and analyzed using SPSS Version 27. Binary logistic regression was employed for each independent variable, with those having a P value < 0.25 entered into a multivariable logistic regression. A P value < 0.05 at 95% confidence intervals was considered as statistical significance

4.11 **Ethical consideration**

The research was conducted after obtaining ethical clearance and approval from the Department of Anesthesiology, Critical Care, and Pain Medicine. An official support letter was written to TASH and permission for data collection was sought from the hospital authorities. The purpose of the study was explained & written informed consent was obtained from each participant. Confidentiality was maintained at all levels of the study by using an anonymous questionnaire.

5. Result

5.1 Socio-demographic characteristics

From a total of 380 patients, 370 patients were enrolled in the study, and 10 patients were excluded based on exclusion criteria. Among them, 89 (24.1%) were in the age group of 21-30 years, with a mean age of 41.39 years, with a standard deviation (SD) of 15.21. Of the total participants, 190 (51.4%) were female, and 207 (55.9%) belonged to ASA class I. Preoperatively, 73 (19.7%) patients had hypothermia, while an equal number also presented with associated medical comorbidities (see Table 1)

Table 1: Sociodemographic and clinical factors characteristics of postoperative patients underwent elective surgery at TASH in 2023/4

Variable	Frequency	Percent
Age in years		
≤20	42	11.4
21-30	89	24.1
31-40	82	22.2
41-50	69	18.6
51-60	64	17.3
>60	24	6.5
Sex of the study participants		
Female	190	51.4
Male	180	48.6
Physical status of the patient (ASA)		
ASA1	207	55.9
ASA2	149	40.3
ASA3	11	3.0
ASA4	3	.8
BMI in kg/m^2		
<18.5	18	4.9
18.5-24.5	334	90.3

>24.5	18	4.9
Medical comorbidities		
Yes	73	19.7
No	297	80.3
Baseline body temperature		
Hypothermia	73	19.7
Normothermia	297	80.3

5.2 Comorbid medical diseases

Among patients with comorbidities, hypertension accounts for 43.8% (32) followed by RVI (13.8%), and diabetes mellitus 13.8% (see Figure 1).

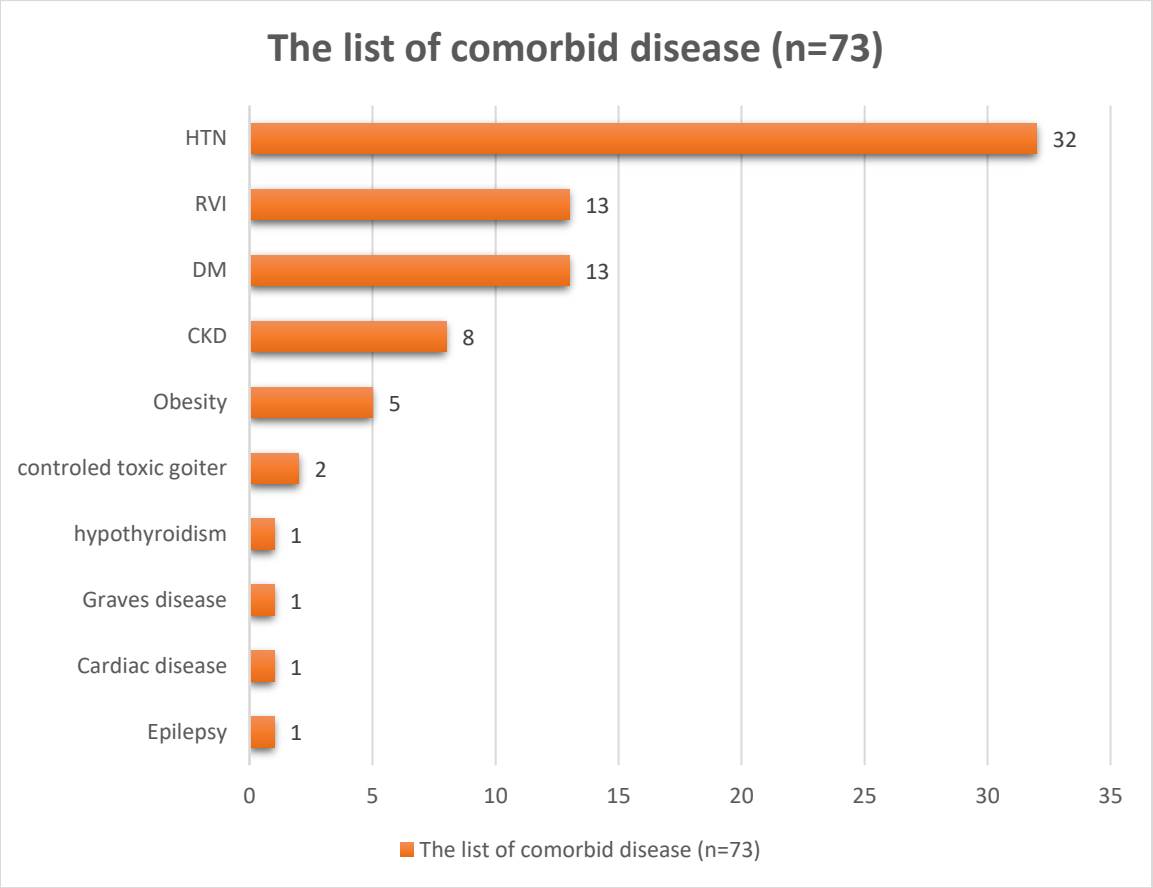

Figure 2: Co-existing medical diseases of the study participants at TASH, 2023/4

5.3 Anesthesia and Surgical related factors

More than 23% (87) of patients were in Urology-surgery, followed by GI and Orthopedics. Of patients who underwent surgery, 54% (200) received general anesthesia. 81% (299) of the administered fluid was warmed, and 11.1% (41) of patients experienced blood loss greater than 1000ml. 69% and 84% of the patients had a duration of surgery and anesthesia, respectively, of more than one hour.

Table 2: Surgical and anesthesia-related characteristics of the study participants

Variable	Frequency	Percent
Types of surgery		
Cardiothoracic	19	5.1
ENT	40	10.8
GI	76	20.5
GYN-OBS	55	14.9
Orthopedics	62	16.8
Urology-surgery	87	23.5
Vascular surgery	25	6.8
Neurosurgery	6	1.6
Type of anesthesia used		
GA	200	54.1
SA	159	43.0
Spinal with epidural	9	2.4
Regional block	2	.5
Amount of fluid intake in ml		
<2000	288	77.8
>2000	82	22.2
Administered fluid warmed		
Yes	299	80.8
No	71	19.2
Intraoperative blood loss in ml		

<500	212	57.3
500-1000	117	31.6
>1000	41	11.1
Transfused blood		
Yes	34	9.2
No	336	90.8
Amount of blood transfused (n=34)		
<500ml	24	70.6
>500ml	10	29.4
Total duration of surgery in hours		
≤1hour	116	31.4
>1hour	254	68.6
Total duration of anesthesia in hours		
≤1hour	60	16.2
>1hour	310	83.8

5.4 Prevalence of postoperative hypothermia

5.*4.1 The overall prevalence of postoperative hypothermia in* PACU

The finding of the study revealed that 39% of patients had at least one record of hypothermia in the four recordings during the postoperative period as shown in the figure below.

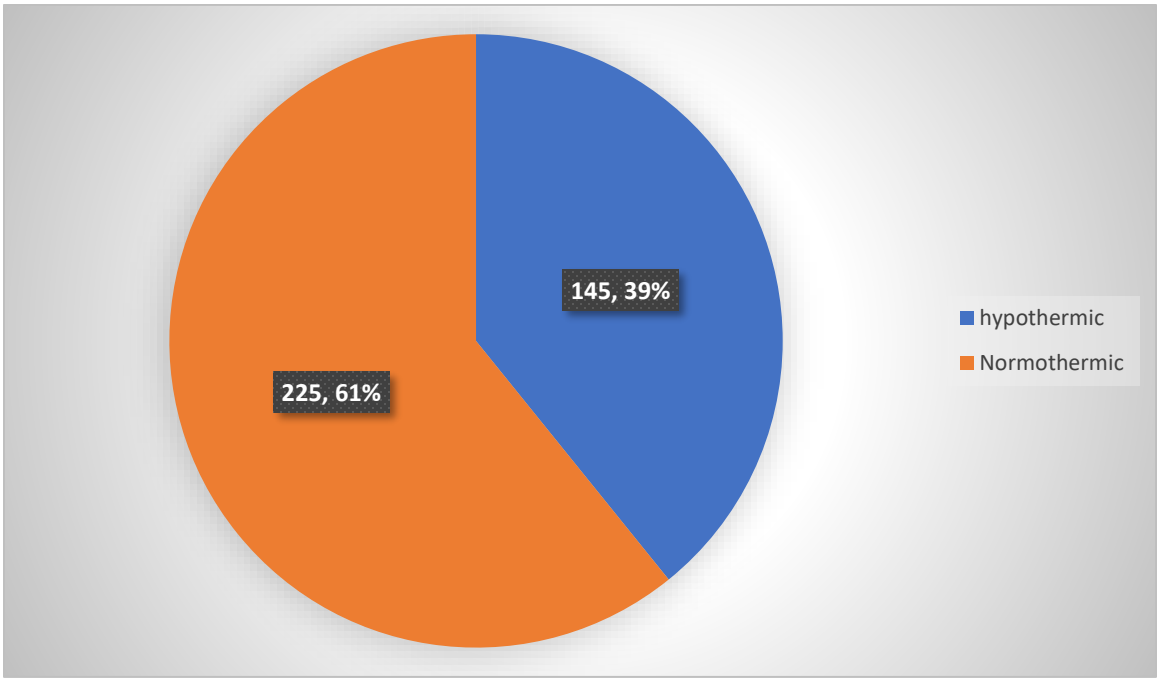

Figure 3: The prevalence of postoperative hypothermia in PACU who underwent elective surgery among adult patients at TASH, 2023/4

5.4.2 The number of hypothermia recorded

Table 3: The number of hypothermia recorded at TASH, 2023/4

Number of hypothermia recording (n=145)	**Frequency**	**Percent**
Only one record	60	41.4
Two records	32	22.1
Three records	27	18.6
Four records	26	17.9

For those experiencing postoperative hypothermia (n=145), the prevalence at each time in the PACU was 95.9%, 60.7%, 36.6%, and 20% at arrival, 15-minute, 30-minute, and 1-hour intervals during the postoperative period, respectively (see table 4).

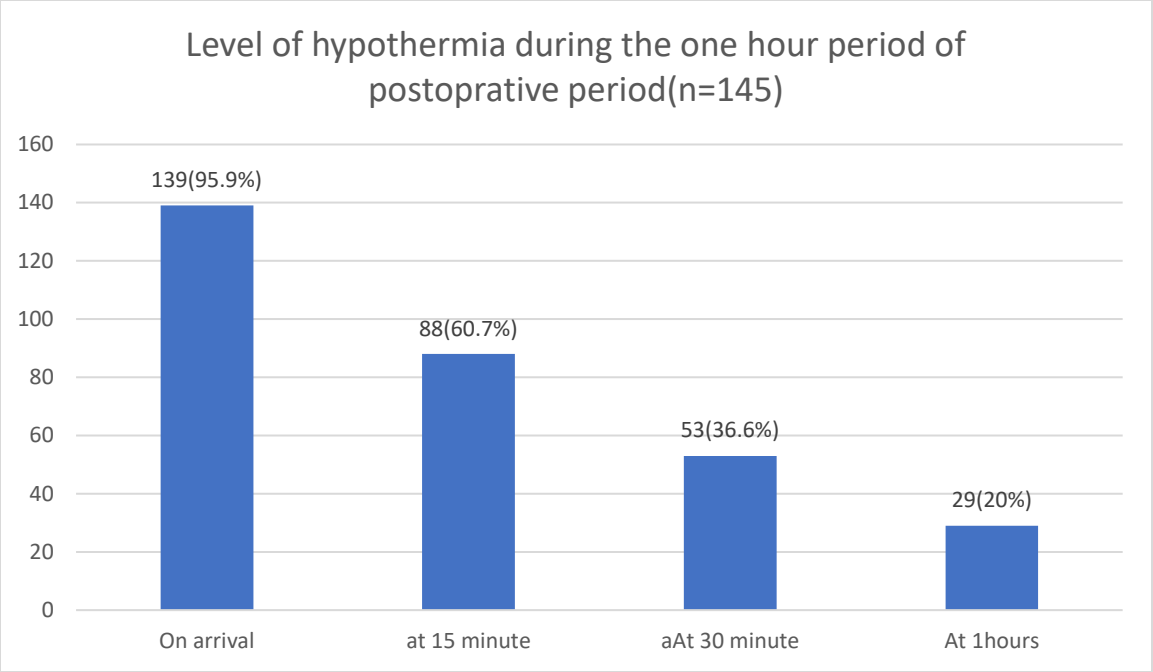

Figure 4:Level of hypothermia during the one-hour postoperative period at TASH, 2023/4

Regarding the severity of postoperative hypothermia, 22.3% of cases at arrival had a moderate level, 9.1% at the 15-minute mark had a moderate level, and there were no cases of hypothermia of any severity recorded in all measurements.

5.5 The determinant factors of postoperative hypothermia

The association between an independent variable and the prevalence of postoperative hypothermia was measured using an adjusted odds ratio and 95% CI. Accordingly, age above 60 years, presence of medical comorbidities, general anesthesia, having preoperatively hypothermia, administration of unwarmed crystalloid fluids, blood transfusion infusion, and longer surgical durations were identified as statistically significant risk factors by multivariate logistic regression.

The multivariate logistic regression revealed that the odds of postoperative hypothermia among patients aged over 60 years were 2.9 times higher odds compared to those aged under 20 years (AOR=2.9, 95% CI=1.04, 11.49) and patients with comorbid disease had 2.6 times greater odds in experiencing postoperative hypothermia (AOR=2.6, 95%CI=1.29, 5.24).

Patients who were having hypothermia preoperatively had 4.1 times higher odds of postoperative hypothermia compared to normothermic patients (AOR=4.1, 95%CI=2.15, 7.99). Participants who underwent spinal anesthesia and spinal with an epidural were 59% and 91% less likely to develop

postoperative hypothermia compared to general anesthesia, respectively (AOR=0.41, 95%CI=0.23, 0.75 & AOR=0.09, 95%CI=0.01, 0.88). Patients who were not administered warmed fluid had 3.5 times higher odds of developing postoperative hypothermia (AOR=3.5, 95%CI=1.82, 6.85). Additionally, patients who transfused blood had 12.9 times higher odds of developing postoperative hypothermia (AOR=12.9, 95%CI=3.88, 42.99), compared to those who were not transfused blood. Patients whose surgery duration exceeded 1 hour had 4.1 times higher odds of developing postoperative hypothermia compared to those whose surgery duration was less than 1 hour (AOR=4.1, 95% CI=1.67, 10.28).

Table 4: The logistic regression association between independent variables and postoperative hypothermia among elective surgical adult patients at TASH, 2023/4

Variable	Hypothermia		p-value	COR with 95%CI	P-value	AOR with 95%CI
	yes	No				
Age						
≤20	18	24	1		1	
21-30	42	47	0.642	1.2(0.57, 2.49)	0.456	1.3(0.49, 6.05)
31-40	23	59	0.099	0.52(0.24, 1.13)	0.321	0.14(0.03, 8.37)
41-50	21	48	0.185	0.58(0.26, 1.29)	0.487	0.48(0.22, 9.49)
51-60	24	40	0.581	0.80(0.36, 1.77)	0.697	0.19(0.04, 7.29)
>60	17	7	0.032	3.2(1.11, 9.46)	0.006	**2.9(1.04, 11.49)**
ASA class						
ASA1	69	138	1		1	
ASA2	71	78	0.007	1.8(1.18, 2.81)	0.341	1.3(0.73, 2.24)
ASA3	4	7	0.836	1.1(0.32, 4.04)	0.575	0.62(0.12, 3.27)
ASA4	1	2	0.999	1(0.09, 11.22)	0.923	0.84(0.02, 30.9es4)
BMI in kg/m^2						
<18.5	11	7	0.100	3.1(0.80, 12.28)	0.367	2.3(0.37, 14.67)
18.5-24.5	128	206	0.672	1.2(0.46, 3.39)	0.497	1.6(0.41, 6.21)
>24.5	6	12	1		1	
Presence of medical comorbidities						

Yes	42	31	0.000	2.6(1.51, 4.30)	0.008	**2.6(1.29, 5.24)**
No	103	194	1		1	
Preoperative baseline temperature						
Hypothermia	48	25	0.000	3.9(2.31, 6.79)	0.000	**4.1(2.15, 7.99)**
Normothermia	97	200	1		1	
Types of anesthesia						
GA	101	99	1		1	
SA	41	118	0.000	0.34(0.22, 0.53)	0.003	**0.41(0.23, 0.75)**
Spinal with epidural	1	8	0.050	0.12(0.02, 0.99)	0.038	**0.09(0.01, 0.88)**
Regional block	2	0				
Administered fluids warmed						
Yes	104	195	1		1	
No	41	30	0.000	2.6(1.51, 4.34)	0.000	**3.5(1.82, 6.85)**
Blood transfused						
Yes	30	4	0.000	14.4(4.96, 41.91)	0.000	**12.9(3.88, 42.99)**
No	115	221	1		1	
Duration of surgery						
≤1hour	23	93	1		1	
>1hour	122	132	0.000	3.7(2.23, 6.28)	0.002	**4.1(1.67, 10.28)**
Duration of anesthesia						
≤1hour	16	44	1		1	
>1hour	129	181	0.032	1.9(1.06, 3.63)	0.132	2.3(0.78, 6.82)

6. Discussion

The findings of this study revealed that 39% (n=145) of the study participants developed postoperative hypothermia. Among those, 95.9% (n=139) of patients had hypothermia upon arrival at the PACU. This result was higher than previous studies done at TASH in 2017 (31.3%), Debre Berhan Comprehensive Specialized Hospital in 2019 (31.71%), and the University of Gondar Hospital in 2014, Ethiopia (30.7%)(12,13,18). It is also higher than the study done at the University of Porto in Portugal (32%), Guilan University in Iran (23.7%), a tertiary care hospital in Thailand (11.9%), and the Fourth Affiliated Hospital in China (6.32%)(15,21,23,24). However, the finding is lower than that of the study done at Siriraj Hospital, Thailand (45.4%)(25).

These differences could be due to not utilizing preventive methods due to the unavailability of resources, increase in service and complexity of the procedures, and also variations in the demographic characteristics of the study populations. Additionally, some studies may use different cutoff temperatures to define hypothermia, while others may assess core body temperature using different methods (e.g., tympanic, rectal, or esophageal probes). Variations in perioperative management protocols, including preoperative warming techniques, intraoperative temperature monitoring, and postoperative warming interventions, can also influence the prevalence of postoperative hypothermia

Patients aged above 60 years had a significant association with postoperative hypothermia. This finding was in line with the study done at TASH(18), Debre Berhan Specialized Hospital(12), Ethiopia, and Siriraj Hospital, Thailand(25). This may be due to older patients being more sensitive to the effects of anesthesia, including vasodilation and impaired thermoregulation. These effects can contribute to heat loss and hypothermia during the perioperative period.

Patients having preexisting comorbid disease had a high risk of developing postoperative hypothermia. The finding was in line with the study done at the University of Porto in Portugal(24), TASH(18), and Debre Berhan Comprehensive Specialized Hospital(12), Ethiopia. This might be due to the reason that comorbidities may impair the body's ability to control its temperature and those patients may usually take medications that may disrupt and delay thermoregulation responses. on the contrary, a study done in Gondar(13), Ethiopia showed that age and coexisting medical illness have no association.

Those patients who had hypothermia preoperatively were at high risk of experiencing hypothermia. This could be the patient's inability to maintain a normal body temperature during

and after surgery due to poor thermal regulation(15,18,21). Patients who took spinal anesthesia and spinal with an epidural were 59% and 91% less likely to have postoperative hypothermia compared to those who took general anesthesia respectively This finding is in line with the study done in Affiliated Hospital in China, University of Gondar Hospital, and Debre Berhan Comprehensive Specialized Hospital, Ethiopia(12,13,15). This could be due to that general anesthesia may disrupt the body's thermoregulatory mechanisms, leading to alterations in heat production, distribution, and conservation. General anesthesia inhibits the body's natural response to cold stress, including shivering. Shivering is a vital mechanism for generating heat and maintaining core temperature in response to hypothermia. The suppression of shivering during anesthesia reduces the body's ability to compensate for heat loss, predisposing patients to develop postoperative hypothermia.

The study found that patients administered unwarmed fluid had a higher likelihood of postoperative hypothermia consistent with research conducted at TASH, Ethiopia(18). This could be attributed to the infusion of unwarmed fluids, particularly in large volumes, which can decrease core body temperature through convection. Cold fluids lower blood temperature, leading to heat loss and contributing to hypothermia. Additionally, cold fluid administration can prompt peripheral vasoconstriction as the body tries to conserve heat and maintain core temperature. Those patients required a blood transfusion intraoperatively and had also a significant risk of developing hypothermia, likely due to the transfusing of unwarmed blood.

This study revealed that patients with a surgical duration exceeding 1 hour had 4.1 times greater odds of developing postoperative hypothermia, aligning with findings from research conducted at Kocaeli University in Turkey(26) and Iran(24). This could be patients with extended surgery times increasing the risk of postoperative hypothermia by increasing exposure to a cold environment, disrupting thermoregulatory mechanisms, and causing metabolic disturbances.

However, this contrasts with previous studies done in Ethiopia, where no relationship was found between the duration of surgery and postoperative hypothermia.

7. Strengths and limitations of the study

This study in its assessment of risk factors associated with postoperative hypothermia by using Google Forms for efficient, accurate data collection and a tympanic ear thermometer for reliable temperature measurements enhances the study's credibility and the validity of its findings.

On the contrary, the limitations of this study were not following patient outcomes and the unavailability of data on ambient room temperature during the study period, which potentially influenced the accuracy of temperature assessment.

8. Conclusion

The prevalence of postoperative hypothermia among postoperative patients is high among adult patients in PACU. Age above 60 years, presence of medical comorbidities, having preoperatively hypothermia, administration of unwarmed crystalloid fluids, blood transfusion, and longer surgical durations were identified as statistically significant risk factors for the prevalence of post-operative hypothermia on the other hand spinal anesthesia and spinal with epidural anesthesia were identified as protective factors.

These findings underscore the importance of tailored interventions to mitigate hypothermia risk in surgical settings, particularly among elderly patients with comorbidities.

9. Recommendation

Postoperative hypothermia is highly prevalent. To mitigate this, Proactive strategies, such as warming intravenous fluids to body temperature and continuous warming during longer surgeries, are essential. Close monitoring and adjustment of warming interventions based on surgical complexity and patient needs are vital for effective prevention.

It is recommended that policymakers incorporate active warming measures and reliable temperature monitoring for both patients and operating rooms in infrastructure improvements. Ensuring the availability of adequate blankets and clothing to keep patients warm is also important. Furthermore, initiating quality improvement projects focused on preventing hypothermia and enhancing overall patient care will contribute to better outcomes.

10. References

1. Lenhardt R. Anesthesia and body temperature. Front Biosci. 2010;(2):1145–54.
2. thermoregulatory treshold.pdf.
3. Todd MM, Sessler D. Perioperative Heat Balance. 2000;(2):578–96.
4. Hypothermia : prevention and management in adults having surgery. 2022;(April 2008).
5. Riley C, Andrzejowski J. Inadvertent perioperative hypothermia. BJA Educ [Internet]. 2018;18(8):227–33.
6. M.ozaki thermoregulatory thresholds during epidural and spinal anesthesia, 1994
7. Kiekkas P, Poulopoulou M, Papahatzi A, Souleles P. Effects of hypothermia and shivering on standard PACU monitoring of patients. AANA J. 2005;73(1):47–53.
8. Sessler DI. Perioperative thermoregulation and heat balance. Lancet [Internet]. 2016;6736(15):1–10. Available from: http://dx.doi.org/10.1016/S0140-6736(15)00981-2
9. Kim D. Postoperative hypothermia. Acute Crit Care. 2019;34(1):79–80.
10. Li C, Zhao B, Li L, Na G, Lin C. Analysis of the Risk Factors for the Onset of Postoperative Hypothermia in the Postanesthesia Care Unit. J Perianesthesia Nurs [Internet]. 2021 Jun 1 [cited 2023 May 5];36(3):238–42. Available from: http://www.jopan.org/article/S1089947220302823/fulltext
12. Allene MD. Postoperative hypothermia and associate factors at Debre Berhan comprehensive specialized hospital 2019: A cross sectional study. Int J Surg Open [Internet]. 2020;24:112–6. Available from: https://doi.org/10.1016/j.ijso.2020.05.008
13. Belayneh T. Post-operative Hypothermia in Surgical Patients at University of Gondar Hospital, Ethiopia. J Anesth Clin Res. 2014;05(10).
14. McSwain JR. Perioperative hypothermia: Causes, consequences and treatment. World J Anesthesiol. 2015;4(3):58.
15. Xu R, Hu X, Sun Z, Zhu X, Tang Y. Incidence of postoperative hypothermia and shivering and risk factors in patients undergoing malignant tumor surgery: a retrospective study. BMC Anesthesiol [Internet]. 2023;23(1):1–11. Available from: https://doi.org/10.1186/s12871-023-01991-8
16. Rauch S, Miller C, Bräuer A, Wallner B, Bock M, Paal P. Perioperative Hypothermia — A Narrative Review. 2021;
17. Zaza KJ, Hopf HW. 15 - Thermoregulation: Normal Physiology, Anesthetic Effects, and

Perioperative Considerations [Internet]. Second Edi. Pharmacology and Physiology for Anesthesia. Elsevier Inc.; 300–310 p. Available from: https://doi.org/10.1016/B978-0-323-48110-6.00015-6

18. Fekede MS, Sahile WA. Magnitude and associated factors of Perioperative hypothermia in patients who underwent Elective surgery at Tikur Anbessa Specialized Hospital, Addis Ababa, Ethiopia. Int J Med Sci Clin Invent. 2019;6(2):4332–6.
19. Ratanatherawichian Y, Asdornwised U, Thongkam N, Kanlayanakoop K. Incidence and Predictive Factor of Postoperative Hypothermia of Patients in Post-Anesthesia Care Unit
20. Luís C, Moreno C, Silva A, Páscoa R, Abelha F. Inadvertent Postoperative Hypothermia at Post-Anesthesia Care Unit : Incidence , Predictors and Outcome *. 2012;2012(November):205–13.
21. 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. 2023;23(1):137.
22. Khorshid L, Eşer I, Zaybak A, Yapucu U. Comparing mercury-in-glass, tympanic and disposable thermometers in measuring body temperature in healthy young people. J Clin Nurs. 2005 Apr;14(4):496–500.
23. 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 1 [cited 2023 May 5];109(6):741–7. Available from: https://onlinelibrary.wiley.com/doi/full/10.1002/aorn.12696
24. Ashoobi MT, Shakiba M, Keshavarzmotamed A, Ashraf A. Prevalence of Postoperative Hypothermia in the Post-Anesthesia Care Unit. Anesthesiol Pain Med. 2023;13(5).
25. Incidence of Postoperative Hypothermia and Associated Factors in Adult Patients Undergoing Surgery in Siriraj Hospital
26. Aksu C, Kuş A, Gürkan Y, Solak M, Toker K. Kocaeli üniversitesi ameliyathanesi postoperatif hipotermi insidansi{dotless} araşti{dotless}rmasi{dotless}. Turk Anesteziyoloji ve Reanimasyon Dern Derg. 2014;42(2):66–70

11 Annexes

11.1 Annex I: Questionnaire

Addis Ababa University College health sciences, school of graduate studies, department of anesthesiology, critical care and pain medicine

The questionnaire was prepared to assess the prevalence of postoperative hypothermia and its associated factors

Consent form

Hi, good morning/afternoon.

My name is ----------, I am here on behalf of Dr. Amare Gebrie., a student at Addis Ababa University School of Medicine, Department of Anesthesiology, Critical Care and Pain Medicine. He is conducting a research thesis on "Prevalence of postoperative hypothermia and its associated factors among adult patients who underwent elective surgery at TASH, Addis Ababa ETHIOPIA from November to January, 2023/4 G.". He has got formal permission from Addis Ababa University School of Medicine and TASH officials to conduct the study.

You are selected to participate in this study. There will be no direct benefit to participating in this study, but in the future information gathered by this study will help policymakers, programmers, and researchers to give appropriate attention to issues of interest and design specific treatment options.

The information will be kept confidential by using only code numbers and locking the data. Only the members of the study team will have access to the non-coded data and the data will not be used for purposes other than the study. Your willingness and active participation are very important for the success of this study.

If you need any further information or explanation regarding to the study, you can have this address to contact.

Would you be willing to participate? [put "x'' mark] Yes_____ No_____

Name: Dr. Amare Gebrie Tel- +251-912148218 E-mail: amaregebrie2103 @gmail.com

Part I: Questions on socio-demographic characteristics of the patients

MRN_____

1. Age in years _____ year

2. Sex of participants

1. Male 2. Female

3. ASA physical status

A. ASA I B. ASA II C. ASA III D. ASA IV

4. Weight in Kg _____Kg

5. Height in meter _____m

6. BMI in kg/m2

A. <18.5 kg/m2 (underweight)
B. 18.5 kg/m2- 24.9 kg/m2(normal)
C. > 24.5 kg/m2 (overweight)

7. Is there any co-existing medical disease?

A. Yes 2. No

B. If yes; specify the disease

Part II: Questions about the anesthetic and surgical characteristics of the patient.

1. Type of surgery

A. Orthopedics B. Neurosurgery C. ENT D. Gastrointestinal E. Gyn-Obs F. Cardiothoracic G. Uro-surgery I. Vascular surgery

2. Types of anesthesia used

A. GA B. SA C. SA with Epidural D. Regional blocks E. Others (specify it)

Part III. Questions about temperature measurement

Baseline patient body temperature _____(0C)

Postoperative temperature arrival to PACU _____

After 15 minutes _____

After 30 minutes _____

After 1 hour _____

Part IV: Questions about intraoperative characteristics of patients

Total amount fluids administered _____ml

Is administered fluid warmed?

1. Yes 2. No

Amount of intraoperative blood loss in ml

Is blood transfused? 1. Yes 2. No

If yes, Amount of blood transfused in ml

1. ≤ 500 ml 2.>500 ml

Duration of surgery in minutes _____

Duration of anesthesia in minutes_____

Complication of hypothermia if any_____

DECLARATION OF THE PRINCIPAL INVESTIGATOR

The undersigned agrees to accept responsibility for the scientific ethical and technical conduct of the research project and for the provision of required progress reports as per terms and conditions of the Department and College, in effect at the time of grant is forwarded as the result of this application.

Name of the student: _____

Date. _____

Signature _____

APPROVAL OF THE FIRST ADVISOR

Name of the first advisor: _____

Date. _____

Signature _____

APPROVAL OF THE SECOND ADVISOR

Name of the second advisor: _____

Date. _____

Signature _____