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Magnitude of Perioperative Hypothermia and Associated Factors of Intraoperative Hypothermia in Patients 18 years and above Who Undergo Elective Operation at Tikur Anbessa Specialized Hospital, Addis Ababa, Ethiopia, 2017.

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Abstract

Background: Body temperature is a vital sign and 37°C is the mean core body temperature of a healthy human. Core body temperature is normally tightly regulated and maintained within narrow range. Perioperative hypothermia is one of the major problems during surgery and anesthesia that can affect operated patients.

Objective: to assess the magnitude of perioperative hypothermia and associated factors of intraoperative hypothermia in patients undergoing elective anesthesia and surgery at Tikur Anbessa Specialized Hospital, Addis Ababa, Ethiopia from March 6 - May 12, 2017.

Methods: institutional based cross sectional study was conducted on 265 patients 18 years and above who undergo operation at Tikur Anbessa Specialized Hospital, Addis Ababa, Ethiopia from March 6 - May 12, 2017.

Patient interview, chart review and temperature measurement was employed for data collection. Collected data was analyzed using SPSS version 20 window. All Independent variables with the dependent variable, hypothermia, were analyzed using binary logistic regression. A p-value of <0.05 was considered as cutoff point to test for statistically significant.

Result: The overall magnitude of preoperative, intra and post operative hypothermia in this study was 16.2%, 53.2% and 31.3%, respectively. Age >65 years (AOR=7.15, 95% CI, 1.16, 43.99), coexisting illness (AOR, 3.32, 95% CI, 1.06; 10.36), preoperative hypothermia (AOR; 57; 95% CI; 7.1, 455.4), operation room temperature <23 ^{o}c (AOR=1.91; 95 % CI, 1.04; 3.5) and >2 liter cold crystalloid fluids administered (AOR; 2.3; 95% CI, 1.07, 4.9) were found to be factors associated with intraoperative hypothermia.

Conclusion and recommendation: The magnitude of intraoperative hypothermia is high in Tikur Anbessa Specialized Hospital. Anesthesia professionals should warm crystalloid fluids before administering and the operation room temperature should be kept at least above 23 ^{o}c.

For Administrators and other stakeholders of Tikur Anbessa Specialized Hospital, we recommend to consider ways to make OR and PACU temperature controlled rooms for better health care.

Acknowledgement

First, I would like to acknowledge my advisor Mr. Wosenyeleh Admasu for his valuable assistance and comments and I would also like to thank my colleagues who helped me during data collection time. Last but not least, I would like to thank Addis Ababa University for financial support.

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Abbreviations and Acronyms

ASA American Society of Anesthesiologists

BMI Body Mass Index

Bsc Bachelor of Science

ENT Ear Nose Throat

ETB Ethiopian Birr

GA General Anesthesia

GIT Gastrointestinal Tracts

Msc Master of Science

OR Operation Room

PACU Post Anesthesia Care Unit

SA Spinal Anesthesia

SPSS Statistical Package for Social Sciences

TASH Tikur Anbessa Specialized Hospital

Chapter One: Introduction

1.1 Background

Body temperature is a vital sign and 37℃ is the mean core temperature of a healthy human. Humans require near constant internal body temperatures to maintain optimal function of multiple organs and systems (1).

The American Society of Anesthesiologists'(ASA) standards for basic anesthetic monitoring state, ''every patient receiving anesthesia shall have temperature monitored and should be recorded at the same frequency as other vital signs throughout the perioperative period when clinically significant changes in body temperature are anticipated (2). Monitoring and maintaining body temperature perioperatively are necessary for patient care regardless of the type of anesthesia selected, because patients have a major risk of developing hypothermia (3).

Body temperature should be measured in patients having general anesthesia exceeding 30 minutes in duration, and in patients having major operations under neuraxial anesthesia. It is also recommended that all surgical patients should have their core temperature recorded at least every half hour during anesthesia (4). Core body temperature, which is the best single indicator of thermal status in humans, is normally tightly regulated and maintained within narrow range (5).

Perioperative hypothermia is unintentional drop in core body temperature <36°C (96.8 ^{o}F) during or immediately following an operation with the reported magnitude ranges from 50%-90%. It could be classified in to three as mild (core body temperature between 35-35.9°C), moderate (34-34.9°C) and severe when core body temperature is ≤ 33.9°C (6, 7).

During Anesthesia and surgery, patients' thermoregulation can be altered due to different reasons. These include loss of normal response to heat loss, increased heat loss to environment when body cavity is opened to cold OR environment, cooling effect of cold and dry anesthetic gases and reduced body heat production due to reduced metabolic rate (8).

Heat loss from a patient to the environment may occur by 4 mechanisms. Of these, radiation and convection are the largest contributors.

The first means of heat loss is by radiation which accounts for 60% of heat loss. Any objects with temperature above absolute zero degree can lose heat to objects surrounding it. The second means is heat loss by convection, which accounts for 20% heat loss, which is facilitated by temperature difference between the patient and objects (9).

Another means of heat loss is by conduction which occurs due to direct contact of the patient with objects. Cold operation room table and cold OR attires facilitate this type of heat loss. Evaporative and respiratory tract heat losses are other means of heat loss which are heat loss that occur via skin and respiratory tract. Evaporative heat loss mainly occurs by use of cold skin preparation solutions, while heat loss via respiratory system is facilitated by use of cold and dry anesthetic gases (9).

It is one of the major problems during surgery and anesthesia that alters the normal physiology of most body systems and therefore will increases perioperative morbidity and mortality ranging from impairing patient comfort and prolonging hospitalization to life threating ones (10).

1.2 Statement of the problem

Hypothermia is a common event during perioperative time that affects more than 50% of patients undergoing anesthesia/surgery and can have different consequences that increase perioperative complications (10).

Hypothermia during anesthesia and surgery may result from a multitude of associated factors that include age, sex, ASA class and amount of intravenous fluids administered, co-morbidity, anesthetic type, higher level of spinal block (11), longer anesthetic and surgical times, and preoperative temperatures (12,13).

Randomized, controlled trials have proven that mild hypothermia increases the incidence of wound infection and prolongs hospitalization, increases the incidence of morbid cardiac events and ventricular tachycardia, and impairs coagulation. Other complications include enhanced anesthetic drugs effects, prolonged recovery room stays, shivering, and impaired immune function (14).

Mild intentional hypothermia is sometimes induced in an attempt to reduce cerebral and myocardial ischemia, but there are ample evidences that showed that hypothermia will have many adverse consequences on surgical patients (15).

Although magnitude of perioperative hypothermia and associated factors for patients who undergo surgery was studied in our country in Gondar university Hospital, published data on magnitude and associated factors for perioperative hypothermia for patients undergoing operation does not exist in TASH.

Therefore, it has an impact on patient considering both direct and indirect cost incurred due to the complications, morbidity and length of hospital stay.

1.3 Significance of the study

It has been shown by different researchers that perioperative hypothermia will result in and contributes significantly to post operative morbidity and mortality. But, it is a neglected problem in patients undergoing anesthesia and surgery inTikur Anbessa Specialized Hospital.

TASH, which is the largest Referral Hospital in the country, diversity of patients are referred from all regions of the country to this hospital and the numbers of patients that visit the hospital increases from time to time, sometimes the number of patients exceeds the capacity of the Hospital.

Even though there are preventive measures to reduce occurrence of perioperative hypothermia such as warming of fluids, prewarming and active warming of the patient during operation (13, 44, 45), but these techniques do not apply and present in the hospital.

In TASH, patients scheduled for operation wait outside the OR and they are transferred to the OR and recovery room almost naked with a simple cover of surgical gowns. Hence, these situations make patients at risk of hypothermia; besides health professionals are negligence of patient's body temperature and there is no facility to warm patients actively. In addition exposure of body cavity to cold operation room environment will further make them to loss heat. These conditions in turn can result additional cost to patients and to the hospital.

Therefore, conducting a study on the magnitude of perioperative hypothermia and its associated factors in TASH will help to recognize the magnitude of the problem and can also help the Hospital to decrease the magnitude of hypothermia in patients undergoing operation.

The study will also be helpful for hospital administrators to plan preventive measures and strategies or reduce associated factors of perioperative hypothermia.

Chapter Two: Literature Review

2.1 Temperature measurement and monitoring

A consistent measuring site and technique should be used throughout the perioperative period for every patient in order to detect changes of temperature from the baseline and obtain comparative results (16). Clinical research literature reports that the sites that most accurately provide core temperature readings are the pulmonary artery, distal esophagus, nasopharynx, and tympanic membrane. Core temperature can also be estimated with reasonable accuracy using oral, bladder and axillary temperatures (16, 17). Each has distinct limitations but can be used clinically in appropriate circumstances. What level of accuracy is clinically necessary has yet to be established. But a good rule of thumb, one that has been used in many studies, is that the combined inaccuracy of a site–thermometer combination should not exceed 0.5°C (18).

Axillary temperature remains the most widely used and most convenient site for monitoring temperature. Axillary site may be as accurate for core temperature estimation as the tympanic membrane, esophageal and rectal temperature sites. The accuracy of the axillary probe depends on carefully positioning of the tip of the probe close to the axillary artery while maintaining the arm tightly adducted and it can provide accurate measure of core temperature as long as a +0.3-0.6°C compensation is included (18).

2.2 Magnitude of perioperative hypothermia

Most previous articles listed the magnitude of perioperative hypothermia ranging from 50% to 90% (6, 7). A study conducted in 2014 by Ojas et al. in Australia in patients undergoing major colorectal surgery found that the magnitude of intraoperative hypothermia was 74% (19). But other study conducted in 2011 in Pakistan by Arshad et al. in determining the frequency of hypothermia during general anesthesia found incidence of intraoperative hypothermia was 25% (20).

A study conducted in Siriraj Hospital, Mahidol University; Bangkok, Thailand in 2003 by Kongsayreepong et al. to determine the incidence of postoperative hypothermia in patients undergoing operation found that the incidence was 57.1% (21). Another studies conducted in 2005 in Portugal by Abelha et al. in 185 patients to assess adverse effects of hypothermia in postoperative patients found the incidence 57.8% (22).

Other studies conducted in Austin Hospital, Melbourne, Australia in 2008 by Karalapillai et al. (23) and Shari et al. in USA in 2010 to evaluate the magnitude of postoperative hypothermia (24) found the magnitude was 48.1% and 4% respectively.

Another study which has been conducted in 2012 in Portugal by Clara Luis et al. found the magnitude of postoperative hypothermia was 32%. Age >65years, co-morbidities and duration of anesthesia were considered independent predictors for perioperative hypothermia (25).

Study conducted in 2013 by Yi J et al. in China found the overall incidence of intraoperative hypothermia was 39.9%. Major surgery, longer duration of anesthesia, and infusion of larger amounts (>1 liter) of unwarmed intravenous fluids were associated factors for hypothermia (26).

A study conducted in the General University Hospital of Patras, Greece, in 2003 in 170 orthopedic surgical patients, the incidence of postoperative hypothermia on standard PACU was 73.5% (27).

Research conducted by Belayneh et al. at University of Gondar Hospital found the magnitude of postoperative hypothermia was 30.72% (28). Other study conducted by Denu et al. in the same Hospital in 2015 found magnitude of hypothermia preoperatively was 23.4% (29).

2.3 Associated factors of perioperative hypothermia

Both general anesthesia and major regional anesthesia profoundly disturb thermoregulation, allowing significant core hypothermia to develop (30).

At induction of general anesthesia, loss of thermoregulatory control leads to loss of tonic thermoregulatory vasoconstriction: arteriovenous shunts dilate, and core-to peripheral redistribution of body heat occurs. Core temperature typically decreases by 0.5-1.5^{o}C within 30 minutes of induction because of redistribution (10).

The induction of general anesthesia causes a three phase decrease in core temperature. The first phase is the quick sharp fall in core body temperature which is seen during the first 40-60 minutes of anesthesia; where there is redistribution of heat from core to periphery through arteriovenous shunts which is caused by vasodilatation caused by anesthetics. The second phase that follows over the next 2-4 hours is a linear decrease in core

body temperature caused by difference between heat production and loss, and the last phase is the plateau phase caused by vasoconstriction and it is thought to represent heat loss that is equal to heat production (31).

Regional anesthesia can also predispose to hypothermia by causing redistribution and increasing threshold to thermo-regulatory responses as shivering, but the degree of redistribution is less or limited to lower limbs (13).

Previous studies have shown that age is independent factor for perioperative hypothermia (12, 30), although the British National Institute for Health and Clinical Excellence (NICE) (13) assume that age is not an important risk factor for the incidence of hypothermia.

Pediatrics are more susceptible to perioperative hypothermia than adults because their thermoregulation mechanisms are less mature as well as due to a high ratio of body surface area to weight that cause more heat loss (32, 33).

Previous studies have also shown that older patients (over 65 years) had an increased risk for hypothermia because these patients may have lost physiological thermoregulation coping mechanisms and elderly patients have less subcutaneous tissue, and the thermoregulatory mechanisms of vasoconstriction and shivering are less effective (34).

Evidence also showed ASA physical status is a factor for perioperative hypothermia and that the risk increases with ASA grade (12, 13). A study conducted by Belayneh et al. showed that higher ASA physical status had a significant risk factor for the development of hypothermia (28). In contrast, a study conducted by Denu et al. found no association between ASA physical status and development of hypothermia (29).

Previous study has showed that BMI was a protective variable for core hypothermia (23). Lower Body mass index has been shown to be associated with higher risk of perioperative hypothermia (35).

Presence of coexisting medical disease is also one of predictors of intraoperative hypothermia (21). A study conducted in Tokyo, Japan by Kitamura et al. in patients undergoing elective abdominal surgery found that diabetic patients experience a greater reduction in core temperature during general anesthesia than non diabetic patients (36). A study conducted by Denu et al. also showed that presence of coexisting medical illness is one of predictors of intraoperative hypothermia (29).

Certain procedures, like open thoracic, abdominal procedures or gynecological procedures, have an inherently large heat loss index. A retrospective descriptive study in Mount Marty college involving group of 200 ASA I and II patient between the ages 20 and 55 years found that patients experiencing the greatest temperature loss were those undergoing either abdominal or gynecological procedures. This study also found that patients with higher preoperative temperatures stayed warmer perioperatively and those undergoing longer procedures lost more body heat (37).

Longer anesthetic and surgical times were claimed to increase incidence of perioperative hypothermia. Duration of anesthesia particularly greater than 2 hours is associated with development of hypothermia (15, 29). According to a study done in Parma, Italy by Putzu et al. (38) surgical patients always develop perioperative hypothermia when the surgical procedure lasts more than 30 minutes but differing with the study done in Thailand by Kongsayreepong et al. (21) duration of anesthesia was not considered an independent predictor for hypothermia .

Patient's that have sustained one or more traumatic injuries and patients with burns are susceptible to perioperative hypothermia and become unintentionally hypothermic before they reach the health facility (39).

Previous studies showed that patients with low temperature before the start of anesthesia were found to be more hypothermic compared with those with normal baseline temperature (21, 29). This finding is also supported with evidence based guidelines which pointed that prewarming of patients at waiting areas at least for 30 minutes using active warmers prevents inadvertent perioperative hypothermia (13).

Previous study conducted by Frank SM et al. at typical OR ambient temperatures (20°–23°C) have shown an approximately 50% average incidence of hypothermia. This study found that at ambient OR temperatures<21°C, hypothermia often occurs, especially during general anesthesia and at 23°C, hypothermia occurs less often (40).

Study conducted in Egypt by El- Gamal N et al. showed that the temperature of the OR has a decisive effect on the patient's body temperature, and they found that sufficiently warm ambient OR temperature (>26 ^{o}c) is an effective means of preventing hypothermia during general anesthesia, and with this ambient temperature the incidence was only 10% (41).

It is recommended that IV fluids and blood products should be warmed when it is anticipated that more than 2 liters per hour and above 500 ml/h IV fluids and blood products will be

administered in adults respectively (35). But, study done by Belayneh et al. (28) and Denu et al (29) did not found a relation between amounts of intravenous fluids infused, blood transfusion and hypothermia.

2.4 The consequences of perioperative hypothermia

The most severe complications associated with inadvertent perioperative hypothermia are cardiac arrhythmia and myocardial infarction, impaired wound healing and wound infections, coagulation disorders with increased bleeding and increased transfusion requirement (42), pressure ulcer development and increased length of hospital stay, shivering, patient discomfort and dissatisfaction (43).

2.5 Preventive measures of perioperative hypothermia

It is recommended that the surgical team employ both passive and active methods of maintaining normothermia to prevent perioperative hypothermia (44).

The most effective means of maintaining normothermia is prevention, by warming the patient before surgery (prewarming). Warming should start in the preoperative period and should last for at least 30 minutes. Prewarming increases the heat content of the peripheral thermal compartment, reducing the gradient for redistribution (13, 45).

Convective heating using a forced-air warming blanket is very effective, since most of the heat lost by the patient is lost through radiation and convection. During the intraoperative period, that is, from induction to the end of anesthesia all patients who are scheduled to receive anesthesia for longer than 30 minutes should be actively warmed (46).

Chapter Three: Objectives

3.1 General Objective

To assess the magnitude of perioperative hypothermia and associated factors of intraoperative hypothermia in patients 18 years and above underwent elective surgery at Tikur Anbessa Specialized Hospital, Addis Ababa, Ethiopia from March 6 - May 12, 2017.

3.2 Specific objectives

- To determine the magnitude of perioperative hypothermia in patients undergoing anesthesia and surgery at Tikur Anbessa Specialized Hospital.
- To identify associated factors of intraoperative hypothermia in patients undergoing anesthesia and surgery at Tikur Anbessa Specialized Hospital.

Chapter Four: Methodology

4.1 Study design and period

Institutional based cross sectional study was conducted at Tikur Anbessa Specialized Hospital, Addis Ababa, Ethiopia from March 6 - May 12, 2017.

4.2 Study area

This study was carried out at Tikur Anbessa specialized Hospital, Addis Ababa, Ethiopia from March 6 - May 12, 2017.

Addis Ababa, the capital city of Ethiopia with a population of 3,475,952 according to the 2007 population census with altitudes ranging from 2200 to 3000 meter above sea level and average temperature of 22.8°C has 40 hospitals (twelve public and 28 private), 29 health centers, 122 health stations, 37 health posts and 382 modern private clinics (47).

TASH, which is opened in 1972, is one of largest teaching and referral hospital in the country. TASH is now the main teaching hospital for clinical and preclinical trainings of most disciplines since 1998. Annually more than 6,000-8000 people are operated for different surgical conditions in the Hospital. Of this, about 3600 patients above 18 years operated on elective schedule using either general and /or spinal anesthesia. The Hospital has 800 beds, 12 operation rooms that include 9 in the main operation room, 1 in obstetric unit, 2 in orthopedic department.

4.3 Source and study population

4.3.1 Source population

All patients 18 years and above who were undergoing elective surgery at Tikur Anbessa Specialized Hospital

4.3.2 Study population

- Surgical patients 18 years and above who were undergoing elective operation who fulfilled inclusion criteria at Tikur Anbessa Specialized Hospital from March 6 - May 12, 2017.

4.4 Eligibility criteria

4.4.1 Inclusion criteria

Selected Patients 18 years and above that underwent scheduled surgery from March 6 - May 12, 2017 were included in the study.

4.4.2 Exclusion criteria

- patients with severe preoperative hypothermia
- procedure performed under local anesthesia
- anesthesia time less than 30 minutes
- patient's that have sustained one or more traumatic injuries
- Patients with burns if any

4.5 Variables

4.5.1 Dependent variable

Perioperative hypothermia- Yes / NO

4.5.2 Independent variables

- Age, sex, body mass index, ASA physical status
- type of anesthesia, duration of anesthesia and surgery
- preoperative temperature, OR temperature, coexisting illness

4.6 Sample size and sampling technique

4.6.1. Sample size

The sample size of the study was calculated using Epi Info version 7, by taking the total population; N = 3600 patients above 18 years operated on elective schedule using either general and /or spinal anesthesia in 2015/16 in the log book in TASH and using previous study magnitude of preoperative hypothermia in Gondar, Ethiopia of 23.4% (29). A single population proportion formula with level of significance being 5%, 95% confidence level and absolute precision or margin of error at 5% (α= 0.05), design effect 1 and 5% non-response rate was used. Therefore, actual total sample size (n final + 5% non-response rate) was **269**.

4.6.2. Sampling technique

Systematic random sampling technique was used to select study participants on daily operation schedule list. Depending upon average values of the previous surgery per 2 months on the log book, 600 patients were operated on elective schedule. The sampling interval; K was determined using the formula: K=N/n; 600/269 = 2

Where, n = total sample size, N = population per 2 month (i.e. 600).

Therefore, the sampling interval was two and the first study participant (random start) was selected using lottery method from the daily operation schedule list. The first study participant selected by lottery method was the first case from the daily list of operation schedule. Then, every second cases from the operation schedule were included in the study during the study period, (i.e., 3, 5, 7…269).

4.7 Data collection procedures

The data collection procedure includes chart review, patient interview and temperature measurement using a structured questionnaire prepared in English.

After providing training for data collectors (4 Bsc anesthetists) and having verbal informed consent, data was collected using a structured questionnaire. Socio- demographic data like the patient's age, sex, and ASA physical status, duration of anesthesia and surgery, associated coexisting illness were recorded from the chart.

The temperature of the participants was measured pre, intra and postoperatively in the day of surgery using digital axillary thermometer (digital thermometer type, code DI777 with an accuracy of +/- 0.1 ^{o}c in the range of 32-42 ^{o}c) by placing the probe of the thermometer in the armpit close to the axillary artery while tightly adducting the arm. The OR temperature was also recorded after the patient enters in to the OR and applying basic monitors using room thermometer then every hour till operation completes .

Preoperatively the temperature of the participants was measured immediately at the OR before changing their close. Intraoperatively body temperature of the patients was measured after 30 minutes of induction of anesthesia, and then every hour until the operation is completed. The postoperative temperature of the patients was measured every hour up to 2 hours considering that patients stay on average in the recovery room for 1-2 hours and a compensation of 0.6 ^{o}c was added.

4.8 Data quality control

To ensure quality of data pretest of the questionnaire was done on 5% of the sample at Zewditu Memorial Hospital, data collectors were anesthesia professionals and training and orientation about the objective and process of data collection was provided for data collectors, informed consent was obtained from clients for reassurance and the collected data was checked out for completeness, accuracy and clarity.

4.9 Data analysis and interpretation

The data was coded and entered in to Epi info version 7 and exported to SPSS version 20. Data was analyzed using SPSS version 20 window to assess the magnitude of perioperative hypothermia and associated factors for intraoperative hypothermia in patients undergoing operation. All Independent variables with the dependent variable, hypothermia, were analyzed using binary logistic regression. Odds ratio, 95% confidence interval, and p-value were computed to identify associated factors and to determine the strength of the association. Variables with p-value less than 0.2 on binary logistic analysis were taken to multivariate analysis and a p-value of <0.05 was considered as cutoff point to test for statistically significant. The distribution normality of each variable was analyzed in the Kolmogorov-Smirnov test.

4.10 Ethical consideration

The research was conducted after obtaining ethical clearance and approval from Addis Ababa University institutional review board and department of anesthesia. Official support letter was written to Tikur Anbessa Specialized Hospitals and permission for data collection was sought from the hospital authorities. The purpose of the study was explained & verbal informed consent was obtained from each participant. Confidentiality was maintained at all levels of the study by using anonymous questionnaire.

4.11 Dissemination of Results

The final research paper will be given for TASH and the result will be presented on workshops and Ethiopian Association of Anesthetists Annual Conference, so that every anesthetist will be aware of the magnitude of perioperative hypothermia and associated factors of intraoperative hypothermia.

4.12 Operational definitions

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

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

Moderate hypothermia: A core temperature between 34-34.9°C (6, 7)

Severe hypothermia: when core body temperature is ≤ 33.9°C (6, 7).

Preoperative period: 1 hour before induction of anaesthesia. This period also covers the transport of patients from the ward to the operating theatre (45).

Shivering: is a spontaneous, involuntary, tremor-like muscle-hyperactivity which lasts at least for 15 seconds (48).

Chapter Five: Result

5.1 Socio-demographic characteristics of study participants

From a sample of 269 patients, 265 were included in this study. Four patients were excluded from the study because they were sent intubated to intensive care unit after operation.

Majority of the participants 246 (92.8%) were within the age of 18 – 65 years. The mean age of participants was 42 years with standard deviation of 15.7. The minimum and maximum ages were 18 and 84.

With regard to gender, the proportion of male participants was high 148 (55.8%). With regard to American society of Anesthesiologists' (ASA) status, 145 (54.7%) of participants were ASA I, 111 (41.9%) were ASA II and 9 (3.4%) were ASA III, respectively.

The median temperature of the operation room was 23 ^{o}c with standard deviation of 1.25. Most participants 167 (63%) undergo anesthesia and surgery in OR temperature between 20-23 ^{o}c and the rest were operated in OR temperature above 23 ^{o}c.

The mean BMI of participants was 22.2 with standard deviation of 3.46 and median of 21.7.

Ninety (34%) of patients had coexisting medical illness. The most important coexisting diseases were hypertension and Diabetes mellitus (11.7%, 4.9%) respectively.

Table 1: Socio-demographic characteristics of patients operated in Tikur Anbessa Specialized Hospital, Addis Ababa, Ethiopia from March 6 - May 12, 2017 (n=265).

Variables		Frequency (%)
Age in years	18-65	246 (92.8%)
	>65	19 (7.2%)
Sex	Male	148 (55.8%)
	Female	117 (44.2%)
ASA physical status	ASA I	145 (54.7%)
	ASA II	111 (41.9%)
	ASA III	9 (3.4%)
BMI (Kg/m^2)	<18.5	25 (9.4%)
	18.5 – 24.9	200 (75.5%)
	25 – 29.9	29 (10.9%)
	>30	11 (4.2%)
Coexisting disease	Yes	90 (34%)
	No	175 (66%)

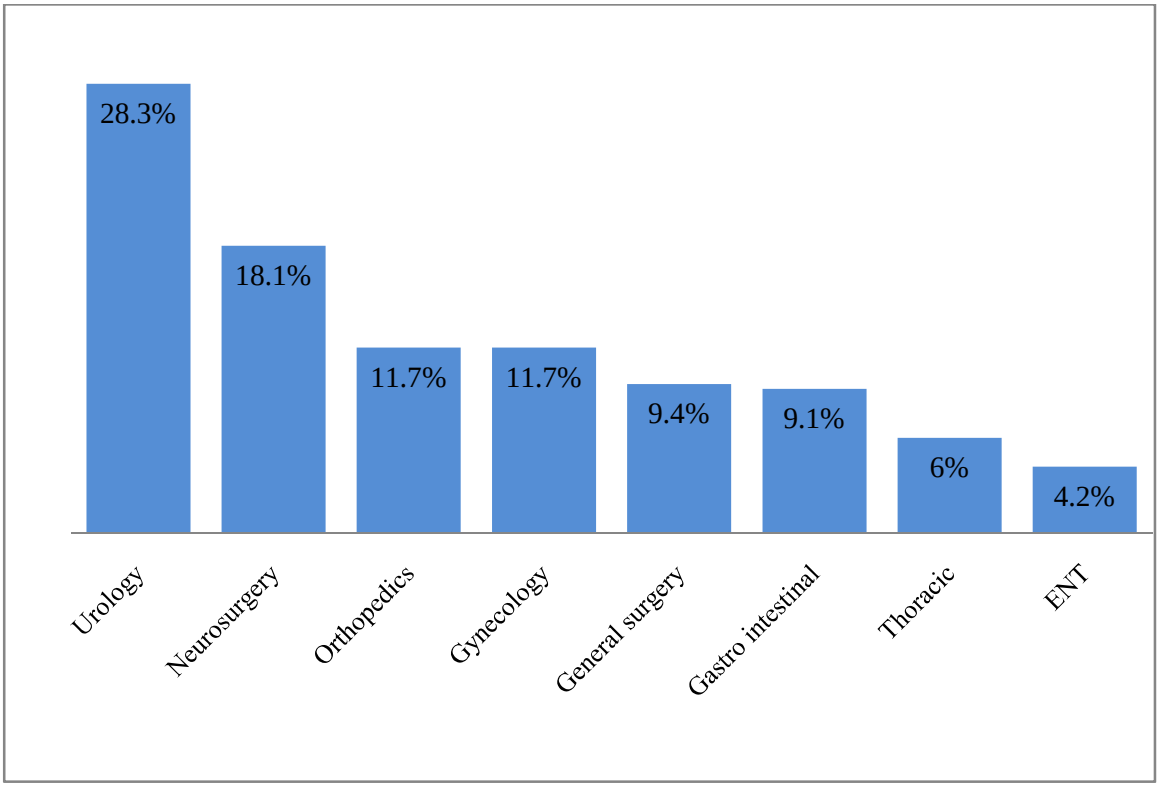
5.2 Anesthetic and surgical characteristics of study participants

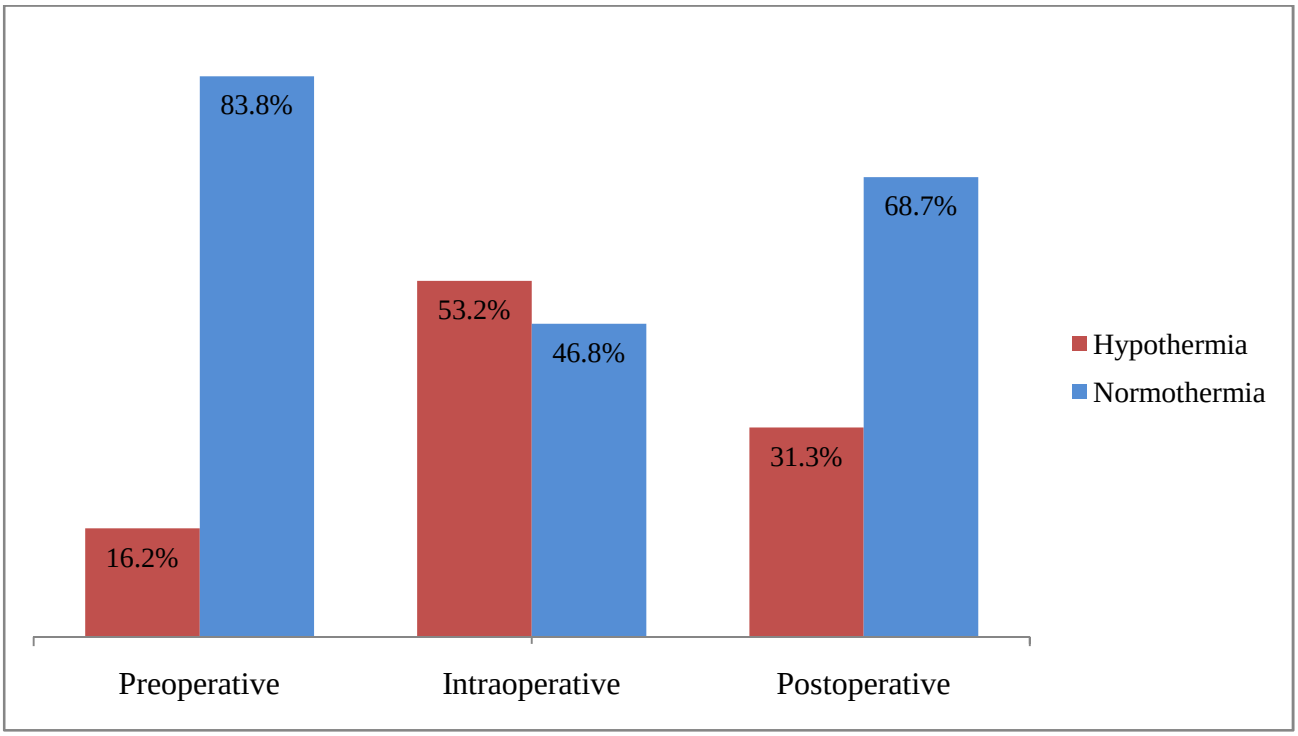
Regarding the type of anesthesia used, 71.7% of patients were undergoing surgery using general anesthesia and the rest were undergoing operation with spinal anesthesia (table 2). The mean anesthetic and surgical durations were 165 and 136.4 minutes with standard deviation of 93 and 88.9 minutes, respectively. Duration of surgery was ranged from 30 – 540 minutes with median of 115 minutes. Anesthetic duration was ranged from 40 – 580 minutes (with median of 140 minutes).

Among the various types of surgical procedures included in this study, urologic procedures were the most commonly performed procedures, which accounted for 75 (28.3%), followed by neurosurgery 48 (18.1%) and Orthopedics 35 (13.2%) procedures (figure 2).

Table 2: Anesthetic and surgical characteristics of patients operated at Tikur Anbessa Specialized Hospital, from March 6 to May 12, 2017 (n=265).

Variable		Number (%)
Type of anesthesia	GA	190 (71.7%)
	SA	75 (28.3%)
Duration of anesthesia (Range 40-580 minute)	≤ 2 hr	101(38.1%)
	>2 hr	164 (61.9%)
Mean ± SD	165 ± 93 minutes	
Duration of surgery (Range 30-540 minute)	≤ 1hr	69 (26%)
	>1hr	196 (74%)
Mean ± SD	136.4 ± 88.9 minutes	
Intraoperative blood loss in milliliter	≤ 500	217 (81.9%)
	> 500	48 (18.1%)
Operation room temperature in ^{o}c	≤ 23	167 (63%)
	>23	98 (37%)
Mean ± SD	23 ± 1.25 ^{o}c	
Amount of crystalloids fluid administered intraoperatively in liter	≤ 2	149 (56.2%)
	>2	116 (43.8%)


28.3%
18.1%
11.7%
11.7%
9.4%
9.1%
6%
4.2%
Urology
Neurosurgery
Orthopedics
Gynecology
General surgery
Gastro intestinal
Thoracic
ENT


83.8%
68.7%
53.2%
46.8%
31.3%
16.2%
Hypothermia
Normothermia
Preoperative
Intraoperative
Postoperative

5.3 Factors Associated with Intraoperative hypothermia

When adjusted for other variables Age, coexisting illness, operation room temperature, crystalloid fluids administered and preoperative hypothermia were found to be factors associated with intra-operative hypothermia (Table 3).

In this study patients above 65 years were 7 times more likely to develop intraoperative hypothermia when compared with adults (AOR=7.15, 95% CI, 1.16, 43.99).

Those patients with associated coexisting medical illness were more than 3 times more likely develop intraoperative hypothermia (AOR, 3.32, 95% CI, 1.06; 10.36).

Patients who were hypothermic in the preoperative time were at 57 times more likely to develop hypothermia intraoperatively than those who were normothermic (AOR; 57; 95% CI; 7.1, 455.4).

This study showed those patients who received more than 2 liter of cold crystalloid fluids were about 2 times more likely to develop hypothermia in the intraoperative time than those who received less than 2 liter of cold crystalloid fluids(AOR; 2.3; 95% CI, 1.07, 4.9, p=0.032).

Patients who underwent anesthesia and surgery in operation room temperature less than 23 ^{o}c were 1.9 times more likely develop intraoperative hypothermia than those operated above 23 ^{o}c (AOR= 1.91; 95 % CI, 1.04; 3.5; p=0.007).

Table 3: Factors associated with intraoperative hypothermia in surgical patient of Tikur Anbessa Specialized Hospital, Addis Ababa, Ethiopia, from March 6- May 12, 2017 (n=265).

Variables		Intraoperative hypothermia		COR (95% CI)	AOR (95% CI)	P-value
		Yes	No			
Age	18-65	124 (50.4%)	122 (49.6%)	1	1	0.034*****
	>65	17 (89.5%)	2 (10.5%)	8.4 (1.89,36.97)	7.15 (1.16,43.9)	
Sex	Male	73 (49.3 %)	75 (50.7 %)	1	1	
	Female	68 (58.1 %)	49 (41.9%)	1.43 (.875; 2.2)	1.36 (.694; 2.664)	0.370
Coexisting disease	Yes	69 (76.7%)	21(23.3%)	4.7 (2.65; 8.34)	3.32 (1.06; 10.36)	0.039*****
	No	72 (41.1%)	103(58.9)	1	1	
ASA status	I	52 (35.9%)	93 (64.1%)	1	1	
	II	83 (74.8%)	28 (25.2%)	5.3(3.07; 9.16)	2.24 (.796; 6.32)	.127
	III	6 (66.7%)	3 (33.3%)	3.57 (.86; 14.9)	1.03 (.15; 7.02)	.978
Preoperative temperature in ^{o}c	≥ 36	99 (44.6%)	123(55.4)	1	1	
	< 36	1 (2.3%)	42 (97.7%)	52.2 (7.06; 385.9)	56.9 (7.1; 455.4)	<0.001*****
Type of anesthesia	GA	111 (58.4%)	79(41.6%)	2.1(1.22; 3.63)	2.13 (.97; 4.69)	0.061
	SA	30 (40%)	45 (60%)	1	1	
Fluid administered in liter	<=2	65 (43.6%)	84(56.4%)	1	1	0.032*****
	>2	76 (65.5%)	40(34.5%)	2.45 (1.5; 4.05)	2.3 (1.07, 4.9)	
OR temperature in ^{o}c	<23	97 (58.1%)	70 (41.9%)	1.7 (1.03; 2.8)	2.55 (1.29; 5.05)	0.007*****
	>23	44 (44.9%)	54 (55.1%)	1	1	
Duration of surgery in hour	≤1	21 (30.4%)	48 (69.6%)	1	1	
	>1	120 (61.2%)	76 (38.8%)	3.61 (2.005; 6.49)	1.617 (.665; 3.935)	0.289
Duration of anesthesia in hour	≤ 2	39 (38.6%)	62 (61.4%)	1	1	
	>2	102 (62.2%)	62 (37.8%)	2.615 (1.57; 4.55)	2.261 (.922; 5.548)	0.075

1= Reference group ***** = significant

COR= Crudes Odds Ratio AOR =Adjusted Odds Ratio

CI = Confidence Interval

Chapter Six: Discussion

Most previous articles listed the magnitude of perioperative hypothermia ranging from 50% to 90% (6, 7). Hypothermia is a common event during perioperative time that affects more than 50% of patients undergoing anesthesia and surgery (10).

The overall magnitude of preoperative, intra and post operative hypothermia in this study was 16.2%, 53.2% and 31.3%, respectively. This study showed that 43 patients developed hypothermia in the preoperative time with temperatures ranged from 34.1 to 37.7°C. This finding is lower compared to a prospective observational study conducted in 312 patients of all age using tympanic thermometer in Gondar university Hospital, Ethiopia by Denu et al. which is 23.4% (29). This difference could be due differences in the site of measurement and type of thermometer used, involving different cases, and small sample size.

This study found 141(53.2%) patients develop intraoperative hypothermia with temperature ranging from 33.3 to 37.1°C and mean temperature of 35.9°C. This magnitude is lower than the magnitude of intraoperative hypothermia in a study conducted by Ojas et al. in Australia where the magnitude was 74% (19), but higher when compared with study conducted by Arshad et al. in Pakistan (20) and a regional cross sectional survey study conducted in 830 patients above 18 years by Yi J et al. in China (26) which was 25% and 39.9% respectively. But, it is within the expected magnitude range of perioperative hypothermia which is 50-90% (6, 7).

This study also showed that 31.3% of patients had body temperature less than 36°C on postoperative period in the recovery room. This finding is lower than quasi-experimental study conducted in 170 orthopedics elective patients above 18 years in Patras, Greece (29) and study conducted in 185 adult patients undergoing scheduled or emergency non cardiac surgery using a cut point of hypothermia of temperature <35 ^{o}c using tympanic thermometer in Portugal by Abelha et al. (22) which was 73.5% and 57.8%, respectively. But, it was high compared with study conducted by Shari et al. in USA (24) which is 4%. The result was almost comparable (32%) with the prospective observational study conducted in Portugal by Clara Luis et al. in 340 adult patients (25) and a Hospital based cross sectional study conducted in 384 patients of all age by Belayneh et al. (30.7%) at University of Gondar Hospital, Ethiopia (28).

These differences on the overall magnitude of perioperative hypothermia could be due differences in definition of hypothermia, site of measurement and type of thermometer used, involving different cases, and small sample size.
From the variables considered in this study on multivariate logistic regression analysis; age, coexisting disease, preoperative hypothermia, operation room temperature and cold crystalloid fluids were found to be factors associated with intraoperative hypothermia.

In this study in paired-samples t-test showed a statistically significant difference in temperature in the preoperative time and after 30 minutes of induction of anesthesia, and the mean decrease in temperature was 0.52 ^{o}c (P <0.001).
This might be due to the effect of induction of general anesthesia causing loss of thermoregulatory control leads to loss of tonic thermoregulatory vasoconstriction: arteriovenous shunts dilate, and core-to peripheral redistribution of body heat occurs. Core temperature typically decreases by 0.5-1.5 ^{o}c within 30 minutes of induction because of redistribution caused by vasodilatation by anesthetics (10).
Previous studies showed that patients with low temperature before the start of anesthesia were found to be more hypothermic compared with those with normal baseline temperature (21, 29). Similarly, this study showed patients who were hypothermic in the preoperative time were at higher risk of developing hypothermia intraoperatively than those who were normothermic.

In this study there was a statistically significant association between patients age and development of intraoperative hypothermia (AOR=7.15, 95% CI, 1.16, 43.99; p= 0.034). This study is consistent with previous studies which have shown that older patients had an increased risk for hypothermia, because these patients may have lost physiological thermoregulation coping mechanisms and elderly patients have less subcutaneous tissue, and the thermoregulatory mechanisms of vasoconstriction and shivering are less effective (12,30,34).

In this study operation room temperature less than 23°C was one of explanatory variable significantly associated with intraoperative hypothermia (p=0.007). Our study is consistent with previous studies conducted by Frank SM et al. at typical OR ambient temperatures (20°–23°C) have shown an approximately 50% average incidence of hypothermia (40) and Study

conducted in Egypt by El- Gamal N et al. found that sufficiently warm ambient OR temperature (>26 ^{o}C) is an effective means of preventing hypothermia (41).

Presence of coexisting medical disease is also one of predictors of intraoperative hypothermia in this study. This study is consistent with previous studies done in Tokyo, Japan (36) and university of Gondar, Ethiopia (29). This can be explained that coexisting medical diseases can delay the onset of thermoregulatory vasoconstriction and reduces its efficacy (10).
Previous studies showed that administration of unwarmed fluids were associated with development of perioperative hypothermia because warming fluids to core temperature requires body heat (11, 26). And it is recommended that IV fluids should be warmed when it is anticipated that more than 2 liters per hour will be administered in adults (35). Similarly, this study showed there was a statistically significant association between more than 2 liter unwarmed crystalloid fluids administered and intraoperative hypothermia. But, it is inconsistent with a study done by Belayneh et al. (28) and Denu et al (29) where they did not found a relation between amounts of intravenous fluids infused and hypothermia.

Evidence showed that the higher the American Society of Anesthesiologist's (ASA) physical status, the greater the risk for hypothermia (12, 13, 28). But, this study showed no significant association between ASA physical status and the development of intraoperative hypothermia.

Inadvertent hypothermia is a recognized side effect of general anesthesia because the body's normal thermoregulatory mechanisms, in particular vasoconstriction and shivering, are inhibited. While the mechanisms may differ, hypothermia also is an unintended side effect of regional anesthesia (13). But, this study showed no association between type of anesthesia and development of hypothermia.
Longer anesthetic and surgical times were claimed to increase incidence of perioperative hypothermia (15, 29). This current study showed that duration of anesthesia and surgeries were not associated with development of intraoperative hypothermia.

6.1 Limitation of the study

- One of the limitations of this study was the use of axillary temperature as a measurement of core temperature.
- In addition, this study includes different cases and procedures for body temperature measurement which may confound the results of this study.

Chapter Seven: Conclusion and Recommendation

7. 1 Conclusion

- The magnitude of intraoperative hypothermia is high in Tikur Anbessa Specialized Hospital.
- Age >65 years, coexisting medical disease, preoperative hypothermia, operation room temperature <23 ^{o}c and >2 liter unwarmed crystalloid fluids administered were found to be factors associated with intra-operative hypothermia.

7.2 Recommendations

- Anesthesia professionals along with surgical team should participate to reduce the occurrence of perioperative hypothermia with early diagnosis
- The operation room temperature should be kept at least above 23 ^{o}c.
- Appropriate waiting areas with warming facility should be prepared
- Anesthetist should administer warm IV crystalloids.
- Finally for administrators and other stakeholders of Tikur Anbessa Specialized Hospital, we recommend to consider ways to make OR and PACU temperature controlled rooms for better health care.

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Annexes

Annex I: Conceptual framework

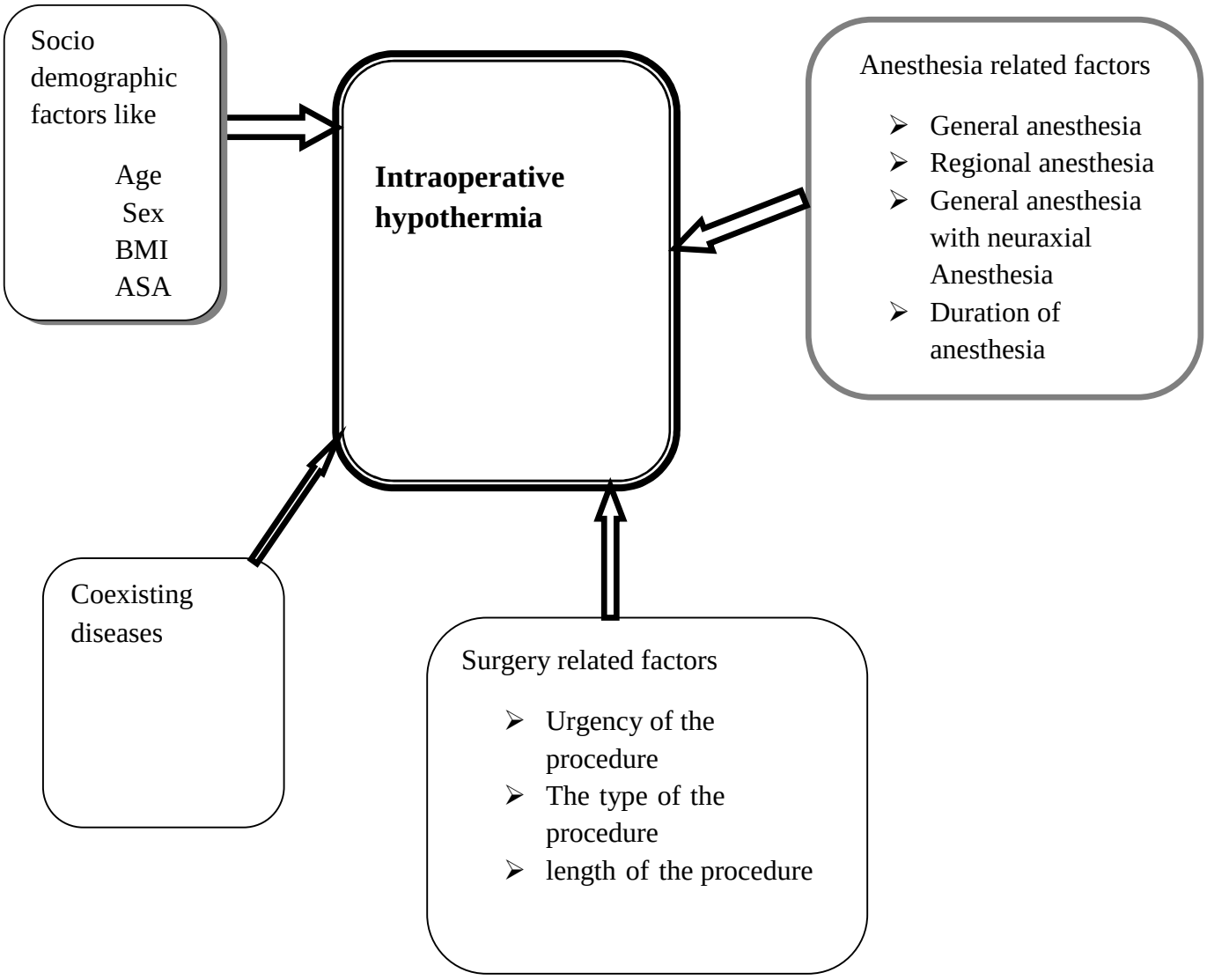

Figure 1: Conceptual framework on assessment and associated risk factors of perioperative hypothermia

Annex II: Amharic information sheet

አድስ አበባ ዩኒቨርሲቲ ጤና ሳይንስ ኮሌጅ፣ ህክምና ትምህርት ቤት፣የአንስቴሽርያ ትምህርት ክፍል

የመጠይቅ ፈቃደኛነት ቅጽ

ስሜ _____ ይባላል፡፡እኔ በአዲስ አበባ ዩኒቨርሲቲ በአንስቴዝያ ትምህርት ክፍል የምርምር ቡድን ዉስጥ አንድ አባል ነኝ፡፡የዚህ መጠይቅ አላማ ከኦፕራሲዎን በፊት፣በኦፕራሲዎን ጊዜና በኋላ ተከትሎ ስለሚከሰት የሙቀት መጠን መቀነስ እና መንሴዎች ለሚደረገው ምርምር/ጥናት /መረጃ ለመሰብሰብ ነው፡፡

እርስዎን አንድ የጥናቱ ክፍል አድርጌ ስመርጠዎ አስፈላጊ የሆኑ መረጃዎችን እንደሚሰጡኝ በማሰብ ነዉ፡፡በጥናቱ ለመሳተፍ ፈቃደኛ ከሆኑ ከእርስዎ የሚገኘው ማንኛውም መረጃ በሚስጥር ይጠበቃል፡፡ለዚህም ሲባል የእርስዎሥምም ሆነ አድራሻ አይገለጽም፡፡ የእርስዎ ፈቃደኛነት ከኦፕራሲዎን በፊት፣በኦፕራሲዎን ጊዜና በኋላ ተከትሎ ስለሚከሰት የሙቀት መጠን መቀነስ እና መንሴዎች ለሚደረገው ምርምር/ጥናት / በከፍተኛ ሁኔታ ያግዛል፡፡እንድሁም ከጥናቱ በኋላ ኦፕራሲዎን ለሚደረግላቸዉ ታካሚዎች ከኦፕራሲዎን በፊት፣በኦፕራሲዎን ጊዜና በኋላ ተከትሎ ስለሚከሰት የሙቀት መጠን መቀነስ ተገቢ የሆኑ እርምጃዎችን ለመዉሰድ ይረዳል፡፡

የቃል ሥምምነት

የዚህ ጥናት ዓላማው ገብቶኝ በጥናቱ ለመሣተፍ

ሀ. ፈቃደኛ ሆኛለሁ ለ. ፈቃደኛ አይደለሁም

በጥናቱ ለመሳተፍ ፈቃደኛ ከሆኑ ቃለመጠይቁን መቀጠል ይቻላል፡፡

ፈቃደኛ ከሆኑ የመጠይቁ መለያ ቁጥር_____መጠይቁ የተካሄደበት ቀን _____

የጠያቂው ሥምና ፊርማ _____

የሱፐርቫይዘር ስምና ፊርማ _____

ጥናቱን በተመለከተ ማንኛዉም አይነት ጥያቄ ካላችሁ የሚከተለዉን አድራሻ ተጠቀሙ::

በዋናነት ምርምሩን የሚያካሂዉ ሰዉ ስም፡ ሙሉዓለም ስጦት

ስ.ቁ.፡ 0921523614 **ኢሜል፡** mulualemsitot@gmail.com

Annex III: English version Questionnaire

Addis Ababa University college health sciences, school of graduate studies, department of anesthesia

Questionnaire prepared to assess the magnitude and associated factors of perioperative hypothermia

Consent form

My name is _____. I am one of the members of the research team in Addis Ababa university department of anesthesia. The purpose of this questionnaire is to gather information on the magnitude and factors that predispose to perioperative hypothermia. I have identified you as a study participant hoping that you would be willing to help me by providing with some information. All information obtained from you will be kept confidential. I will not include such as your name or exact address. Your role in this research is important and this study will provide base line information will help to determine the magnitude, associated factors and to take appropriate measures for other patients who undergo operation after the study.

I understood about the purpose of the research. Are you voluntary to participate in the study?

A. Yes B. No

If respondents are voluntary to participate, the interview as well as the data collection will be started.

Questionnaire Code _____

Date of data collection _____

Name of data collector _____ signature_____

Name of supervisor _____ signature _____

For any question or concerns you can contact the principal investigator using the following address.

Phone number: 0921523614

E-mail: mulualemsitot@gmail.com

Instruction: For each of the questions, please circle the number of alternative(s) that fit the response, fill the blank space provided or provide appropriate response accordingly.

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

No.	Factor	Response	Go to
101	Age in years	_____ year	
102	Sex of participants	1. Male 2. Female	
103	ASA physical status	1. ASA I 2. ASA II 3. ASA III 4. ASA IV	
104	Weight in Kg	_____Kg	
105	Height in meter		-
105	BMI in kg/m^2	1. <18.5 (underweight) 2. 18.5 - 24.9 (normal) 3. 25 – 29.9 (overweight) 4. >30 (Obese)	
106	Is there any co existing medical disease?	1. Yes 2. No	
107	If yes; specify the disease		

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

	Factor	Response	Go to
201	Type of surgery	1. Orthopedics 2. Neurosurgery 3. ENT 4. Gastrointestinal 5. Gynecology 6. Thoracic 7. Urology 8. General surgery 9. Others	
202	Types of anesthesia used	1. GA 2.SA 3. Combined	

Part III: Questions about perioperative body temperature of patients

301	Baseline Body temperature of patients _____(^{0}C) At 30 minutes of induction ____^{0}C After 1 hour of procedure ____^{0}C After 2 hours of surgery _____^{0}C Continue every hour till the surgery complete		
302	OR temperature_____ ^{0}C		
303	Post operative temperature	After 1 hour _____0C	After 2 hour _____ 0C

Part IV: Questions about intra operative characteristics of patients

No.	Factor	Response	Go to
401	Total amount fluids administered	_____ml	
402	Is administered fluid warmed?	1. Yes 2. No	
403	Amount of intraoperative blood loss in ml		
404	Is blood transfused?	1. Yes 2. No	**If yes go to**
405	Amount of blood transfused in ml	1. ≤ 500 ml 2..>500 ml	
406	Duration of surgery in minute		
407	Duration of anesthesia in minute		
408	Complication of hypothermia if any		

Assurance of principal investigator

The undersigned person agrees to take any responsibility for the scientific ethical and technical conduct of the research project and for provision of required progress reports as per terms and conditions of the Research Publications.

Name of the student: _____

Date_____ Signature _____

Approval of the primary Advisor

Name of the primary advisor: _____

Date_____ Signature _____