**International Journal of Medical Science and Clinical Invention 6(2): 4332-4336, 2019**
**DOI:10.18535/ijmsci/v6i2.10** **ICV 2016: 77.2**
**e-ISSN :2348-991X, p-ISSN: 2454-9576**


## Research Article

# Magnitude and associated factors of Perioperative hypothermia in patients who underwent Elective surgery at Tikur Anbessa Specialized Hospital, Addis Ababa, Ethiopia.

**Mulualem S. Fekede[1], Wosenyeleh A. Sahile[2]**

[1,2]Department of anesthesia Addis Ababa University School of medicine, Addis Ababa, Ethiopia

**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.**

**Methods: Institutional based cross-sectional study was conducted. Patient interview, chart review and temperature measurement were employed for data collection. Temperature was measured using tympanic membrane thermometer. SPSS version 20 software was used for analysis. binary logistic regression was used to look at associations anda p-value of <0.05 was considered 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 (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 (AOR=1.91; 95 % CI, 1.04; 3.5) and 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 perioperative hypothermia remains high. Measures should focus on improving room temperature and warming up fluids. Susceptible patients like the aged and those with coexisting disease should be given extra attention.**

**Keywords: Hypothermia, Perioperative, Magnitude, Risk factors, Ethiopia**

### Introduction

Humans require near constant internal body temperatures at 37℃ 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).

During Anesthesia and surgery, patients' thermoregulation can be altered due to different reasons. These include 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 (3).

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 (4). The magnitude of hypothermia differs significantly from 4 to 90% among several studies. (5, 6)

Hypothermia during anesthesia and surgery is associated with multitude factors that include Age, Sex, ASA class, amount of intravenous fluids administered, associated co-morbidity, type of anesthesia, surgical and anesthetic duration, and preoperative temperatures (7, 8, 9). Studies have proven that mild hypothermia increases the incidence of wound infection, prolongs hospitalization, increases the incidence of morbid cardiac events, and impairs coagulation. It also enhances anesthetic drugs effects, prolonges recovery room stays, shivering, and impairs immune function (10, 11). Studies that show the magnitude of such problems are sparse in developing countries, hence this study is aimed at showing the magnitude and contributing factors for perioperative hypothermia in surgical patients.

### Methods

After obtaining ethical approval from Addis Ababa university ethical review board. The study was conducted in Tikur Anbessa specialized hospital, Ethiopia's largest referral hospital located in Addis Ababa. All patients who were above 18 years and underwent elective surgery with in the period of March 6 to May 12/2017 were selected as the study population. Patients with preexisting fever, with severe preoperative hypothermia, patients with polytrauma, burn patients and anesthesia duration < 30min were excluded from the sample. The independent variables were Age, sex, body mass index, ASA physical status, type of anesthesia, duration of anesthesia and surgery, preoperative temperature, OR temperature and coexisting illness presence. The final sample size was calculated using single proportion formula with a

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. The final sample size with 5% non-response rate was 269. Patients were selected using systematic random sampling. First case on the day of surgery was selected via lottery and latter every second patient was included in the study. Data was collected using chart review via structured questionnaire, patient interview and temperature measurement. Data was analyzed using SPSS® version 20 software. Descriptive analysis for the sociodemographic variables, Kolmogorov-Smirnov test for normality of distribution and binary logistic regression for the association was used, afterwards variables were taken to multivariate analysis and those with a p value of 0.05% were considered statistically significant.

### Temperature measurement

Temperature was measured using tympanic membrane thermometer (Braun pro 3000) which researches suggest as having best accuracy for core body temperature (30). The measurement was done until the patient leaves the recovery room. First with in thirty minutes before surgery in the waiting room, second 30 minutes after induction and every hour afterwards until end of surgery and also in the recovery room until patient discharge to ward or ICU (usually on average takes two hours).

## Result

### Socio-demographic characteristics

From a sample of 269 patients, 265 were included in this study.Four patients were excluded from the study because they were sent to intensive care unit. The mean age of participants was 42 years with standard deviation of 15.7.The proportion of male participants was high (55.8%).54.7% (145) of participants were ASAI, 41.9%(111) were ASA II and 3.4%(9) were ASA III, respectively.The mean temperature of the operation room was 23 $^{o}$Cwith standard deviation of 1.25 and median temperature of 23$^{o}$c.The mean BMI of participants was 22.2 with standard deviation of 3.46 and median of 21.7. The most common coexisting diseases were hypertension (11.7%) and Diabetes mellitus (4.9%). (Table 1)

**Table 1: Socio-demographic characteristics of patients (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%) |

Key - BMI – body mass index, ASA – American society of anesthesiologists

### Anesthetic and surgical characteristics

Regarding the type of anesthesia used, 71.7% of patients were undergoing surgery using general anesthesia and the rest 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.Urologic procedures were the most commonly performed procedures, which accounted for 28.3% (75), followed by neurosurgery (18.1%) and Orthopedics (13.2%) procedures (Figure 1).

**Table 2: Anesthetic and surgical characteristics of patients (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%) |
| **Duration of surgery(Range30-540minute)** | ≤1hr. | 69(26%) |
| | >1hr. | 196(74%) |
| **Intraoperative blood loss (ml)** | ≤ 500 | 217(81.9%) |
| | >500 | 48(18.1%) |
| **Operation room temperature** | ≤ 23 | 167(63%) |
| | >23 | 98(37%) |
| **Amount of crystalloids fluid administered intraoperatively (lt.)** | ≤ 2 | 149(56.2%) |
| | >2 | 116(43.8%) |

Key GA - general anesthesia, SA - spinal anesthesia

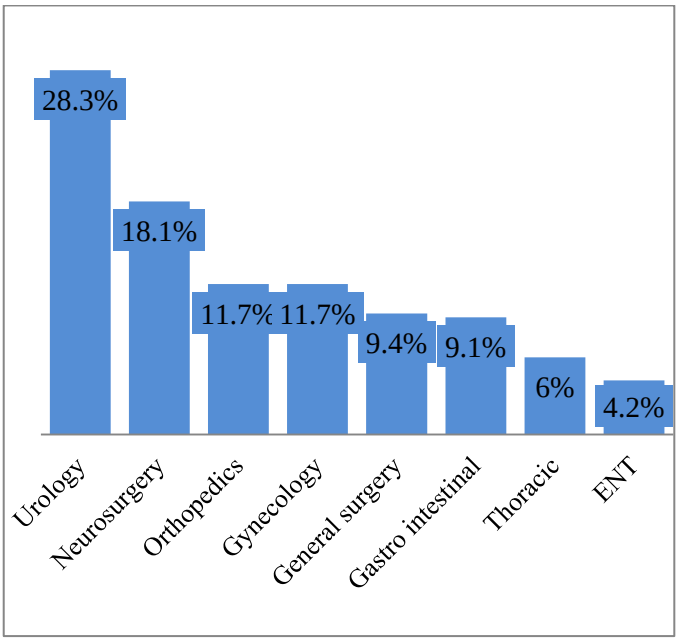

**Figure 1**: **Type of surgical procedures performed at Tikur Anbessa specialized hospital**

**Magnitude of perioperative hypothermia**

**Preoperative period**

The magnitude of preoperative hypothermia was 16.2%. Of these, 14.3%(38) and 1.9%(5) of patients developed mild and moderate hypothermia with no severe hypothermia occurred. About83.8% of patients had normal body temperature in the preoperative time, i.e., before induction of anesthesia. Themean temperatureof patientsduring this time was 36.5$^{o}$cwith standard deviation of 0.57.

A paired-samples t-test to show the impact of induction of anesthesia in the temperature differences in the preoperative time and after 30 minutes of induction of anesthesiafound a statistically significant difference in temperature in the preoperative time (Mean=36.5, SD=0.57) and after 30 minutes of induction of anesthesia (Mean= 35.95, SD = 0.7), t (264) =18.2, p< 0.001 (two-tailed). The mean decrease in temperature was 0.52$^{o}$Cwith a 95% confidence interval ranging from 0.46 to 0.57.The eta squared statistic (0.56) indicated a large effect size.

**Intraoperative period**

The overall magnitude of intraoperative hypothermia was 53.2%. Ofthis; mild hypothermia had occurred in 34.7%, moderate and severehypothermia had occurredin 13.6% and 2.6% patients,respectively.

The amount of intraoperative crystalloids replaced ranges from 400–7000 ml (mean 2303 ml). All crystalloid fluids were administered without warming but blood was utilized after warming. The magnitude of hypothermia in patients who were given more than 2 liters of crystalloids was higher (65.5%) than those who received less than 2 liters(43.6%).

**Post operativeperiod**

The overall magnitudeof post-operativehypothermia was31.3%. Of these, mildand moderatehypothermia comprised 23% and 8.3%, respectively. There was nosevere hypothermiaoccurred.

In the post-operative period 27(10.2%) personsdeveloped shivering. of these patients 25(92.6%) and 12(44.4%) persons were hypothermic in the intraoperative and postoperative time, respectively. (Figure 2)

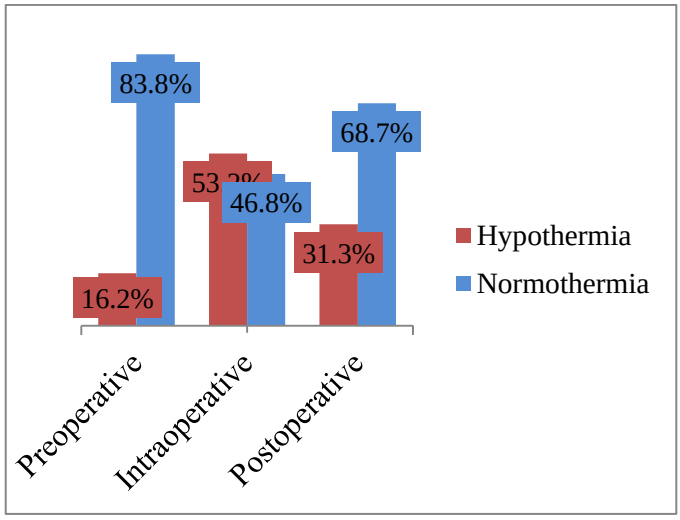


**Figure 2: Proportion of perioperative hypothermia of patients (n=265).**

**Factors Associated with Intraoperative hypothermia**

In multivariate logistic regression ASA status, gender, type of anesthesia,duration of surgery and duration of anesthesia were not statistically significant.

When adjusted for other variables Age(AOR=7.15, 95% CI, 1.16, 43.99; p= 0.034), coexisting illness(AOR, 3.32, 95% CI, 1.06; 10.36), operation room temperature(AOR= 1.91; 95 % CI, 1.04; 3.5; p=0.007), crystalloid fluids administered(AOR; 2.3; 95% CI, 1.07, 4.9, p=0.032), and preoperative hypothermia(AOR; 57; 95% CI; 7.1, 455.4)were found to be factors associated with intra-operative hypothermia (Table 3).

**Table 3: Factors associated with intraoperative hypothermia in surgical patient (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) | |
| 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 | |
| Preoperative temperature ($^{o}$C) | ≥ 36 | 99 (44.6%) | 123(55.4) | 1 | 1 | <0.001 |
| | < 36 | 1 (2.3%) | 42 (97.7%) | 52.2(7.06;385.9) | 56.9(7.1;455.4) | |
| Fluidadministered (lt.) | <=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) | |
| ORtemperature ($^{o}$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 | |

Hint 1=Reference group, COR= Crudes Odds Ratio,AOR=Adjusted Odds Ratio, CI = Confidence Interval

## Discussion

The overallmagnitude of preoperative, intra and post-operative hypothermia was 16.2%, 53.2% and 31.3%, respectively. Presence of coexisting illness, preoperative hypothermia, number of colloids administered and operation room temperature were all found to be risk factors for hypothermia.

Recorded hypothermia values differ widely among studies. To reduce underestimation of the value we recorded hypothermia on all three phases of anesthesia. Preoperative values were lower than a study conducted in northern Ethiopia which was 23.4% (12). the fact that patients usually lie either on the stretchers or the floor for hours in the waiting room without any active warming strategy might contribute to the hypothermia. Half (53.2%) of all patients in the study period developed hypothermia intraoperatively. The finding lies in the middle when compared to most findings, it was lower when compared to some studies (13, 14) which reported an incidence ranging from 50-90% but still much higher to others which showed a 25 and 39.9% incidence (15, 16). the higher results could be attributed to the absence of any warming strategies either to the operating room or to the patient and also the lack of warming of IV fluids administered. The same reasons could be attributed to the 31.3% of hypothermia reported postoperatively.

There was a significant difference in temperature between preoperative time and after 30 minutes of induction of anesthesia, and the mean decrease in temperature 30 was $0.52^{o}$c (P <0.001). Those patients who were hypothermic in the preoperative period were at higher risk of developing intraoperative hypothermia. Studies seem to largely agree on the finding that a preexisting hypothermia will reduce temperature after induction and throughout the intraoperative period (17, 12). This is supported by the evidence that 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 caused by vasodilatation by anesthetics (4).

Older patients (>65) were 7 times more likely to develop intraoperative hypothermia when compared with adults. This study is consistent with previous studies which have shown that older patients had an increased risk for hypothermia, older patients may have lost physiological thermoregulation coping mechanisms and have less subcutaneous tissue, also the thermoregulatory mechanisms of vasoconstriction and shivering are less effective, all which contribute to the hypothermia (8, 18, 19).

Patients who were operated in operation room temperature less than 23$^{o}$c were more likely develop intraoperative hypothermia. The finding is consistent with previous studies which showed at typical OR ambient temperatures (20°–23°C) an approximately 50% average incidence of hypothermia could occur (20). A sufficiently warm ambient temperature (>26 $^{o}$c) is an effective means of preventing hypothermia (21). Those patients with associated coexisting medical illness were 3 times more likely develop intraoperative hypothermia.This study is consistent with previous studies done in Tokyo, Japan (22) Ethiopia (12).Because the occurrence of hypothermia which initially results from core-to-peripheral redistribution of body heat and from heat loss exceeding heat production, the progression of hypothermia is prevented by the reemergence of thermoregulatory vasoconstriction, which decreases cutaneous heat loss and retains metabolic heat in the core thermal compartment. But coexisting medical diseases can delay the onset of thermoregulatory vasoconstriction and reduces its efficacy (4).

Studies largely agree that administration of cold fluids were associated with development of perioperative hypothermia (7, 16). 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 (23). It was found that those patients who received more than 2 liters of cold crystalloid fluids were about 2 times more likely to develop hypothermia in the intraoperative time. But, it is inconsistent with a study done by Belayneh et al. (24) and Denu et al (12) where there was no relation between amounts of intravenous fluids infused and hypothermia. The smaller sample size was the primary limitation of our study as we could have found more associations.

As a summary, the magnitude of perioperative hypothermia is high in an Ethiopian hospital. Age, coexisting medical disease, preoperative hypothermia, operation room temperature and un warmed crystalloid fluids administered were found to be factors associated with intra-operative hypothermia. The development of warming strategies to room and fluids, age targeted preventative active warming strategies and selection of high risk patients like those with coexisting illness for prewarming is highly recommended.

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