PREVALENCE OF PERIOPERATIVE HYPOTHERMIA AMONGST PATIENTS UNDERGOING ANESTHESIA AT THE KENYATTA NATIONAL HOSPITALTHEATRES

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STUDENT'S DECLARATION

I hereby declare that this dissertation is my original work and that it has not been submitted to any university or institution for examination or any other purposes.

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ABSTRACT

Background

During surgical procedures, patients in operating suites are exposed to varying thermal challenges that can lead to perioperative hypothermia1 a core body temperature of ≤36.0°C. Hypothermia is also a common consequence of administration of anesthesia to patients. Rational medical practice demands therefore that anesthesiologists responsible for the patients preoperatively, intraoperatively and postoperatively should monitor their patients' temperatures regularly and maintain the patients in normothermic state by using warm intravenous fluids, thermal blankets, forced air warming and blankets.

Broad Objective:

This study sought to determine the prevalence of perioperative hypothermia under both general and spinal anesthesia at the operating theatres of Kenyatta National Hospital. The study sought to establish prevalence of hypothermia amongst adult patients undergoing spinal or general anesthesia and determine the associated risk factors present in our set up.

Study Design:

It was a prospective observational study.

Study Site:

The study was conducted at the Kenyatta National Hospital main theatre and satellite theatres.

Study population:

The study was conducted on male and female patients above 18years old undergoing elective or emergency surgery. The patients were of ASA 1,2 or 3.

Sampling Methods:

The sampling procedure was convenience sampling from the emergency and elective theatre lists until the desired sample size was achieved using Fischer's formula. The total number of patients being 165.

Study Duration:

The study took 3 months.

Data Analysis:

Data was entered and analyzed with the use of Statistical Package for Social Sciences (SPSS) version 21. Socio-demographic and clinical characteristics were summarized and presented as frequencies and proportions, as well as mean and standard deviations, and medians with interquartile ranges where applicable. The prevalence of hypothermia amongst adult surgical patients undergoing spinal anaesthesia and general anaesthesia was analyzed and presented as frequencies and proportions.

Result and Conclusions:

The study has shown that perioperative hypothermia was prevalent at 70.7% among all patients undergoing the study. It was noted that 90.9% of patients above 55 years had perioperative hypothermia. Contrary to other studies it was noted patients who had a BMI between 18.5-24.9 were more hypothermic at 70.1%. The study also showed that patients who underwent procedures between 1-2hours were more hypothermic at 71.9%.

The study further revealed that the use of spinal anesthesia had a higher prevalence of hypothermia at 76.9% than those who underwent general anesthesia. It was also noted that patients who underwent obstetric (41.7%) and orthopedic procedures(31.7%) had a higher prevalence of perioperative hypothermia. The study also showed that the use of adequate linen and warm intravenous fluids reduced the prevalence of hypothermia

CHAPTER 1: INTRODUCTION

1.1 Background

Hypothermia is defined as core body temperature of <36°C. It could be classified in to three as mild (35-35.9°C), moderate (34-34.9°C) and severe when core body temperature is ≤ 33°C[1.]

Inadvertent intraoperative hypothermia (core temperature <36°C) is the most common perioperative thermal disturbance. Incidence varies from 6% to 90%[2] depending on the surgical population and demographic characteristics of patients. There is increased risk with prolonged surgery, extremes of age, extensive burns, lower preoperative temperature, severe trauma, and major intraoperative fluid shifts.

Hypothermia has been shown to cause postoperative discomfort with increased plasma catecholamine levels, heart rates and blood pressure. There is also an associated increase in surgical site infection and postoperative hospital stay[3],[4].

Anselm Brauer[5] argues that perioperative hypothermia was first described by Ernst von Bibra and Emil Harlass in Germany in the book *Die Wirkkung des Schwefelathers in chemischer und physiologischerBeziehung* in the year 1847, a year after the first successful general anesthesia was performed by Thomas Green Morton in Boston. They described the results from animal experiments with sulfuric ether where the pharyngeal temperature of a rabbit had fallen to 30.6^0 C in contrast to a normal healthy rabbit that had a pharyngeal temperature of 39.4^0 C.

Development of perioperative hypothermia starts before patients enter the operating room. A low pre anesthetic core temperature is a risk factor for the development of intraoperative and postoperative hypothermia. Mehta and Barclay in their study noted that elective patients experienced the greatest drop in temperature between admission and commencement of surgery unlike emergency patients.[6] Therefore, patient's core temperature should be measured on admission to the receiving area in theatre before going into the operating room. The ideal core temperature for patient comfort in theatre and to reduce post operating shivering is $>36^0$ C before induction of anesthesia.[7]

Anesthesiologists are perioperatively responsible for patients' temperature monitoring and avoidance of inadvertent variance. Different warming and or devices may be utilized based on what is available at the clinical facilities. Unmanaged hypothermia has been seen to cause various

deleterious effects on patients undergoing surgery. Besides prolonging anesthetic drugs actions, hypothermia impairs coagulation and platelet function,[8] increases blood loss and transfusion requirements.[9]

Despite this existing set of literature in this field, gaps still exist in prevalence of hypothermia in patients undergoing spinal or general anaesthesia during surgery in Kenyatta National Hospital. There is no standardized protocol to handle and monitor the temperatures of these group of patients in the hospital operating theatres. Questions arise then as to the prevalence of perioperative hypothermia in patients undergoing general and spinal anesthesia during surgery in the Kenyatta National Hospital theatres.

The study result was expected to fill the gap in the existing knowledge and inform the practitioners in the sector any new dimensions for better management of patients undergoing spinal or general anaesthesia during surgery in the operating theatres in Kenyatta National Hospital.

CHAPTER 2: LITERATURE REVIEW

2.1 Background

Core body temperature is normally tightly regulated within a few tenths of a degree. General and spinal anesthesia greatly impair thermoregulation.[10]Normothermia which needs to be maintained through the surgery is considered temperatures between 36.5℃ and 37.5^0 C[11]. Perioperative hypothermia was first described by Ernst von Bibra and Emil Harlass in Germany in the year 1847 a year after the first successful general anesthesia was performed by Thomas Green Morton in Boston. The incidence of perioperative hypothermia had been recorded at 20% in the UK prior to guidelines on perioperative temperature monitoring. The National Institute for Clinical Excellence made a guideline on Management of inadvertent perioperative hypothermia in adults' guideline that includes preoperative, intraoperative and postoperative monitoring. It recommends that patients should not be discharged from recovery area until patients measured temperatures are at least 36^0c.[12]

2.1 Pre Anesthetic-Core Temperature and Premedication

Development of perioperative hypothermia starts before patients enter the operating room. A low pre anesthetic core temperature is a risk factor for the development of intraoperative and postoperative hypothermia.

Mehta and Kennedy noted that adult patients undergoing elective surgery, preoperatively would have sublingual temperatures ranging from 35.7 -37.8^0 C, with a skewed distribution more on the lower side due to preoperative cooling factors. [13]

Mehta and Barclay noted that elective patients experienced the greatest drop in temperature between admission and commencement of surgery unlike emergency patients.[14] Where core temperature was being monitored, low preanesthetic core temperature could also be demonstrated in the elderly who have delayed thermoregulatory vasoconstriction under anesthesia, malnourished patients as well as those presenting with anorexia nervosa.

In an observational study on pediatric patients in KNH, Kioko P. demonstrated up to 30% of the patients were hypothermic (temperature <36^0 C) intraoperatively where general anaesthesia was used or combined general/regional anesthesia used. In this study tympanic temperatures were

taken. Male gender, lower body temperature at induction, use of caudal block and the volume of intravenous fluids infused were significant independent predictors of core hypothermia. The most significant predictor was body temperature at the time of induction of general anaesthesia. [15,16]
A study done by J Andresjowki et al on effect of prewarming on post-induction core temperature and the incidence of inadvertent perioperative hypothermia in patients undergoing general anesthesia, showed there was a 0.3°C smaller decrease in mean core temperature in the prewarmed group at 40, 60, and 80 min post-induction ($P \leq 0.05$).

Patients core temperature was actually monitored indirectly using a temporal artery scanner. Temperature was maintained above the hypothermic threshold of 36°C in 21 (68%) patients in the prewarmed group, compared with 16 (43%) patients in the control group ($P<0.05$). Sixty-eight adult patients undergoing spinal surgery under general anesthesia were randomized to receive either normal care or prewarming for 60 min, at 38°C, using the Bair Paws® system. All patients received routine forced air warming intraoperatively. Thirty-one patients were prewarmed and 37 patients were in the control group. There was a 0.3°C smaller decrease in mean core temperature in the prewarmed group at 40, 60, and 80 min post-induction ($P \leq 0.05$). Temperature was maintained above the hypothermic threshold of 36°C in 21 (68%) patients in the prewarmed group, compared with 16 (43%) patients in the control group ($P<0.05$).[17]

Patients on antipsychotics have a lower core temperature attributable to a central inhibitory effect of these substances on autonomic thermoregulation via dopamine receptors. Pre-medicating patients with benzodiazepines or opioids can lead to a clinically relevant drop in core temperature before induction of anesthesia as they similarly attenuate autonomic thermoregulation.[18]
Toyota et al carried out a randomized control study on the effect of pre-operative administration of midazolam on the development of intra-operative hypothermia. Forty-five patients were randomly allocated to one of three groups to receive no premedication (Group C), IM midazolam 0.04 mg.kg(-1) (Group M1) or 0.08 mg.kg(-1) (Group M2) 30 min prior to anaesthesia. Sedation levels were assessed, and then general anaesthesia was induced and maintained using propofol and fentanyl. Patients core temperatures was measured at the tympanic membrane. During surgery, core temperature, which was similar for the three groups prior to induction of anaesthesia, decreased significantly less in the midazolam groups M1 and M2 compared to the control group

C. Patients who were more heavily sedated prior to induction of anaesthesia, had significantly lower core temperatures peri-operatively than those who were less sedated, and core temperatures in unpremedicated patients fell to significantly lower levels during surgery than those who were drowsy. They concluded that pre-operative administration of midazolam produces an effect on the development of peri-operative hypothermia. They found that moderate pre-operative sedation reduces the peri-operative heat loss, possibly by affecting core-to-peripheral heat distribution.[19]

2.2 Operating Room Transfer and Preparation for Surgery

In many institutions, as patients are made to change into light textured hospital gowns and transported along relatively cold corridors to the operating theatre, significant body heat loss occurs. The core body temperature is maintained while a gradient is created with the peripheries due to activated thermoregulatory vasoconstriction in response to the heat loss occasioned by the inadvertent exposure. However there is redistribution of heat from the core of the body to the periphery after induction of general anesthesia and/or neuraxial anesthesia due to the loss of autonomic thermal autoregulation .[20]

Wetz et al did a meta-analysis on unexpectedly high incidence of hypothermia before induction of anesthesia in elective surgical patients. Data from 7 prospective studies investigating core temperature previously initiated at their department was analyzed. Patients undergoing a variety of elective surgical procedures were included. Core temperature was measured before induction of anesthesia with an oral (314 patients), infrared tympanic (143 patients), or tympanic contact thermometer (36 patients). Available potential predictors included American Society of Anesthesiologists status, sex, age, weight, height, body mass index, adipose ratio, and lean body weight. A total of 493 patients were included in the study. Hypothermia was found in 105 patients (21.3%; 95% confidence interval, 17.8%-25.2%). The median core temperature was 36.3°C (25th-75th percentiles, 36.0°C-36.7°C). Two independent factors for preoperative hypothermia were identified: male sex and age (>52years).As a consequence of the high incidence of hypothermia before anesthesia, measuring core temperature should be mandatory 60 to 120minutes before induction to identify and provide adequate treatment to hypothermic patients.[21]

2.3 General Anesthetics

The induction of anesthesia causes a drop in core temperature by redistribution of heat from the core of the body to the periphery through vasodilatation, reduction of heat production due to attenuation of thermoregulatory centers. Positioning of the patient and the use of positive pressure ventilation with positive end expiratory pressures are also causes of hypothermia.

2.3.1 The Influence of Anesthetic Agents

General Anesthesia decreases the vasoconstriction threshold to approximately 34.5^0 C and decreases the shivering threshold to 1^0 C lower than the vasoconstriction threshold.

There are 3 phases for the development of perioperative hypothermia:[22]

- Redistribution phase that lasts about 1 hour after induction of anesthesia
- Linear phase in which the core temperature decreases at a slower rate than the initial redistribution phase. This occurs as the body loses heat faster than it can generate. It lasts approximately 2 hours after which the thermoregulatory vasoconstriction is reactivated by trigger of the low core temperature.
- Plateau phase is when the emerging thermoregulatory vasoconstriction keeps the core temperature stable again. It usually starts after 3 hours.

The different classes of anesthetic agents may precipitate hypothermia in complex mechanism as outlined below:

2.3.2 Volatile Anesthetics

These are known for attenuation of autonomic thermoregulatory mechanisms and reflexes at the hypothalamus and spinal cord. They also reduce the firing rate and thermosensitivity of warm sensitive neurons in the preoptic area of the hypothalamus in a dose dependent way.[23], Xiong J et al did a randomized control study on eight men showing if Isoflurane produces marked and nonlinear decreases in the vasoconstriction and shivering thresholds. Core temperatures were monitored through the tympanic membrane.

The eight men who were volunteers were divided into four arms, (1) a target end-tidal isoflurane concentration of 0.55%, (2) a target concentration of 0.7%, (3) control (no anesthesia) and a target end-tidal concentration of 0.85%, and (4) a target end-tidal concentration of 1.0%. Volunteers were surface-cooled until peripheral vasoconstriction and shivering were observed. Isoflurane

administration produced a dose-dependent reduction in the vasoconstriction and shivering thresholds, decreasing each approximately 4.6 degrees C at an end-tidal concentration of 1%. Residual analysis indicated that the vasoconstriction and shivering thresholds were decreased in a nonlinear fashion during isoflurane administration.[24]

2.3.3 Intravenous Anaesthetics

Propofol

This intravenous induction and maintenance agent shows a dose dependent effect on thermoregulatory thresholds and linearly reduces the vasoconstriction and shivering thresholds.[25] Ikeda D et al did randomized study showing, less core hypothermia when anesthesia is induced with inhaled sevoflurane than with intravenous propofol. They randomized 10 patients to be induced with sevoflurane and the other 10 to be induced with propofol. Both groups were maintained on sevoflurane and 60% nitrous oxide in oxygen. Core temperatures were measured at the tympanic membrane.

The study showed that core temperatures in patients who received intravenous propofol were consistently lower than those in patients who received inhaled sevoflurane, although anesthesia was subsequently maintained with sevoflurane in nitrous oxide in both groups. This suggests that even a brief period of propofol-induced vasodilatation during anesthetic induction causes substantial redistribution hypothermia that persists throughout surgery.[26]

Benzodiazepines

Midazolam usually causes little changes in the thermoregulatory thresholds[37].

Opioids

Studies have been done in on alfentanil and meperidine, which show a linear dose dependent effect on the thermoregulatory thresholds.[27] In patients undergoing surgery with total intravenous anesthesia with propofol and remifentanil vasoconstriction thresholds of 35°C to 35.7°C were observed. The incidence of postoperative shivering was noted with remifentanil than with alfentanil without any difference in the core temperature.

Sayid Sahar documented a case report on parturient mother undergoing caesarian section who received intrathecal morphine 200 micrograms and 12milligrams hyperbaric bupivacaine. Patient in the recovery room 3 hours after subarachnoid block was noted to have sublingual temperatures of 33.6℃. After receiving naloxone 400 micrograms her body temperature started increasing[28]

Muscle relaxants

Neuromuscular blocking agents have no effect on thermoregulatory thresholds because they cannot pass the blood brain barrier, however they prevent shivering, which is a thermogenic mechanism therefore inhibiting recovery in patients who are severely hypothermic.[38]

2.4 Regional Anesthesia

There are three main mechanisms through which neuraxial anesthesia causes a drop in core temperature;

- Vasodilatation and redistribution of heat from the body core to the peripheries,
- Thermal imbalance between heat generation and loss
- direct influence of the neuraxial blockade on thermoregulation[29]

The pathophysiology for spinal and epidural blocks is similar in development of hypothermia occurring a few minutes faster in spinal blockade than in epidural anesthesia due to faster onset.

There are 2 phases for the development of hypothermia similar to what happens with general anesthesia; a redistribution phase which occurs after injection into subarachnoid or epidural space, and a linear core temperature decreases phase due to thermal imbalance between heat loss and production. Vasodilation of the arteriovenous shunts occurs and this leads to a redistribution of the heat from the core of the body to cold legs, therefore decreasing the core temperature. A differential was seen between the regions affected by the blockade, usually the lower trunk and what prevails in the upper body. The lower body where the blockade has occurred is usually warmer than the upper body where there is no blockade.

Even though neuraxial anesthesia usually causes hypothermia, patients often feel warmer after the onset of blockade due loss of perception and neuronal transmission from the cutaneous cold

receptors to the brain. With resolution of the neuraxial blockade the patients feel cold and often start to shiver.

Arkilic et al in an observational study during neuraxial anesthesia concluded that temperature monitoring and management is inadequate. They noted that initial postoperative tympanic membrane measurement was < 36°C in 77% in some patients and < 35°C in 22% of patients. They found temperature was monitored intraoperatively in 27% of the patients and forced air warming was used in 31% of the patients. They found out that Anesthesiologists failed to accurately estimate whether their patients were hypothermic or not. Their results suggested that temperature monitoring and management during neuraxial anesthesia was inadequate.[30]

Horn P et al randomized adult patients preoperatively warming them before and after epidural block or general anaesthesia for major abdominal surgery lasting over 120 minutes to prevent perioperative hypothermia. A study population of 99 patients that were divided into 3 groups and received either only passive insulation, 15 min of active forced-air warming after epidural analgesia and before induction of general anesthesia, or two periods, each of 15 min, of active air-forced warming before and after epidural analgesia. Core and skin temperatures were measured at several time points throughout the study. Without prewarming (n=32), 72% of patients became hypothermic (<36°C) at the end of anesthesia. Fifteen minutes of warming after insertion of the epidural catheter and before initiation of general anesthesia reduced the incidence of postoperative hypothermia to 6% (n=33). After two periods of 15 min of warming before and after insertion of the epidural catheter, no patient became hypothermic (n=34). Prewarming in either 'warming' group prevents the initial temperature drop, which was observed in the control group.[31]

Shaw et al did a systematic review and met analysis of randomized control trials on Effectiveness of active and passive warming for the prevention of inadvertent hypothermia in patients receiving neuraxial anesthesia. Adults undergoing surgery with neuraxial anesthesia. There intervention was Perioperative active warming (AW) or passive warming (PW). PubMed, CINAHL, Embase, and Cochrane Central Registrar. Meta-analysis found that intraoperative AW is more effective than PW in reducing the incidence of inadvertent perioperative hypothermia (IPH)during neuraxial anesthesia (RR=0.71; 95% CI 0.61-0.83; p<0.0001; I2=32%). The qualitative synthesis revealed

that IPH continues despite current AW technologies. During neuraxial anesthesia, AW reduces IPH more effectively than PW. Even with AW, IPH persists in some patients. Continued innovation in AW technology and additional comparative effectiveness research studying different AW methods are needed.[32]

2.5 Surgical Environment and Surgery

The cold operating room temperatures in which surgical patients are presented with minimal covering and obtunded thermo-genesis as well as auto regulatory homeostatic pathways contribute to the development of perioperative patient hypothermia. To create a sensible compromise between the comfort of the surgeons and prevention of hypothermia the British NICE guideline recommend that the ambient temperature should at least be 21^0C when the patient is exposed, while the American ASPAN recommends ambient room temperature between 20 and 25^0C.
Surgical skin preparation results in short intense heat loss, with the total impact on the mean body temperature and perioperative heat balance being relatively small for most surgical procedures.

Heat loss from the surgical site is mainly by evaporation. It is accentuated with visceral exposure. Irrigation of large amounts of un warmed fluid as may occur in transurethral prostatic or bladder resections can cause significant patient hypothermia . Singh et al did a randomized prospective study at a tertiary centre on the effect of irrigation fluid temperature on core temperature and hemodynamic changes in transurethral resection of prostate under spinal anesthesia. This study was conducted on 40 male patients aged 50-85 years undergoing TURP under spinal anesthesia. Of which, 20 patients received irrigation fluid at room temperature 21°C and 20 patients received irrigation fluid at 37°C after random allocation. Core temperatures and hemodynamic parameters were assessed in all patients at preoperative, intra-operative, and postoperative periods. Intra-operative shivering was also noted in both groups.

For patients who underwent irrigation with fluid at room temperature Core temperature drop from 36.97°C in preoperative to 34.54°C in postoperative period with an effective difference of 2.38°C. Among patients who received warmed irrigation fluid at 37°C had core temperature drop from 36.97°C to 36.17°C and the effect of fall was 0.8°C. This difference was statistically significant ($P < 0.001$). Shivering of Grades 1 and 2 was observed in nine patients, of Group 1 while only

three patients had Grades 1 and 2 shivering in Group 2. The hemodynamic parameters were similar in the two groups and did not reach significant difference[33]

Replacement of lost blood by unwarmed fluids and blood causes hypothermia directly.[34] Locally, J Lelo in an observational cross sectional study on Intraoperative Thermal Dynamics amongst orthopedic patients noted that 81% of the patients were hypothermic in the immediate postoperative period and 45 % actually reported they were feeling cold. Patient's core temperatures were measured from the tympanic membrane and there peripheral temperatures were also taken. The hypothermia noted was attributed to the infusion of large amounts of intravenous fluid used and the relative cool operating environment.[35]

2.6 Null Hypothesis

Perioperative hypothermia is prevalent in patients undergoing general or spinal anaesthesia during surgical procedures at The Kenyatta National Hospital operating theatres.

2.7 Alternative Hypothesis

Perioperative hypothermia is not prevalent in patients undergoing general or spinal anaesthesia during surgical procedures in theatres at The Kenyatta National Hospital.

2.8.1 Main Objective of the study

To determine prevalence of perioperative hypothermia in patients undergoing anaesthesia during surgery at the Kenyatta National Hospital operating theatres

2.8.2 Specific Objectives

i. To determine the prevalence of perioperative hypothermia in patients undergoing general and spinal anesthesia during surgery at the Kenyatta National Hospital operating theatres.
ii. To determine whether the duration and type of surgery for patients under spinal or general anaesthesia contributes to perioperative hypothermia.
iii. To determine the methods used by anesthesia providers to prevent perioperative hypothermia.

2.8.3 Study Justification

Hypothermia is a known complication of anesthesia and surgery. It potentially leads to prolonged hospital stay with delayed wound healing, risk of impaired coagulation, increased risk of blood transfusion. In more subtle situations patient discomfort with significant shivering for thermo-genesis. The existing literature does not adequately address the prevalence of perioperative hypothermia for patients undergoing spinal or general anaesthesia in operating theatres at The Kenyatta National Hospital. An understanding of this prevalence will contribute to develop the appropriate mitigatory measures.

Many people undergoing surgery may be affected by perioperative hypothermia which due to lack of thermal monitoring mechanisms may be going unnoticed. This may lead to complications thus requiring further treatment leading to incurring additional costs and longer stay in hospital.
The outcome of this study will help Kenyatta National Hospital management to put in place a standardized protocol on perioperative thermal management. It will also create awareness amongst practitioners in the field on the prevalence of perioperative hypothermia and take the appropriate mitigatory measures.

Some information on pediatric occurrence of hypothermia and recovery process from anesthesia have been collected at Kenyatta National Hospital, however, the information was not conclusive as it was on specific patient population.
There is no protocol in Kenyatta National Hospital on acceptable thermal management for most surgical interventions and no clear analytical pathway of the effects of either surgical or anaesthetic interventions.

This study aimed to enumerate the circumstances in clinical occurrence of hypothermia, possible preventive and management techniques as well as use of simple resources available within the Kenyatta National Hospital theatre, which can be applied in perioperative management of hypothermia.

Data from this study would enable formulation of a Kenyatta National Hospital perioperative thermal management protocol. Benefits accrued from appropriate perioperative management would in the long term contribute to significant patient comfort and experience as well as reduce associate complications and cost factors related to inadequate insulation or thermal care.

CHAPTER 3: METHODOLOGY

This study was a prospective observational study.

3.1 Study Population

The study was carried out on male and female patients above 18 years old undergoing elective or emergency surgery. The patients were of ASA I, II or III.

3.1.1 Inclusion Criteria

- Consenting patients.
- Male and female patients above 18 years old.
- Patients scheduled for elective or emergency surgery in Kenyatta National Hospital theatres who were to be administered general anesthesia or spinal anesthesia.
- Patients in the ASA class I-III.

3.1.2 Exclusion Criteria

- Patients below the age of 18 years old.
- Patients who declined consent.
- Unconscious and uncooperative patients.
- Patients undergoing cardiac or neurologic procedures where thermal manipulation maybe part of the surgical and or anaesthetic protocol.
- Patients requiring post-operative ventilation in whom anaesthesia is not reversed at termination of surgery

3.2 Study Site

The study site was at the main theatres and satellite theatres of the Kenyatta National Hospital.

3.3 Sample Size

In a hospital based cross sectional study carried out at the Gondar Hospital, Ethiopia by Tadesse et al from January to March 2014 found that the incidence of perioperative hypothermia amongst patients undergoing general anesthesia to be 34.6%, while those patients undergoing spinal anesthesia to be 22.3%

Therefore, the sample size was calculated using Fisher's formula as follows-

- $n = \frac{Nz^2pq}{E^2(N-1)+ z^2pq}$
- n = Desired sample size
- N = population size (number of patients operated at the Kenyatta national hospital theatres per week)
- Z = value from standard normal distribution corresponding to desired confidence level (Z=1.96 for 95% CI)
- p = expected true proportion (estimated at 60% from a study conducted by Tadesse et al in 2014 looking at postoperative hypothermia in adults)
- $q = 1 - p$
- E = desired precision (0.05)
- $n = \frac{Nz^2pq}{E^2(N-1)+ z^2pq}$ $\frac{\text{n=300x3.842x0.6x0.4}}{\text{0.0025x299+3.842x0.6x0.4}}$
- n=165 patients

The study therefore required 165 patients in total.

3.4 Study Procedure

Tympanic membrane temperatures were taken using a handheld infrared thermometer. Temperature measurements were taken once the patient arrived in the receiving area, in theatre, on induction of anesthesia and every 15 minutes intraoperatively. Once the patient was in the post anesthesia care unit temperature monitoring was taken every 30minutes till the patient left the unit. The type of anesthesia used, the warming techniques used and type of surgery and duration of surgery done on the patient were either collected by the principal investigator or the two research assistants recruited for the study and documented this information. Temperature recordings were also taken from the anesthesia observation charts.

3.5 Measurement Tool

The handheld Braun IRT 6500 Thermoscan was used to measure tympanic membrane temperatures preoperatively, intraoperatively and postoperatively.

3.6 Data Management and Analysis

The questionnaires were coded, entered and managed in Microsoft Access 2013 database designed for the study. Data cleaning was performed continuously in the course of data entry and the cleaned data exported to SPSS version 21.0 for statistical analysis.

Descriptive data such as the demographic variables of the patients were summarized and presented as mean and standard deviations for continuous variables, while categorical data was summarized and presented as frequencies and proportions respectively.

Incidence of hypothermia amongst adult surgical patients undergoing spinal and general anaesthesia was reported as proportions. Paired t-tests was used to test differences in pre and post-operative temperature measurements.

To compare the occurrence of hypothermia between adult surgical patients exposed to spinal and those undergoing general anaesthesia, independent t-test as well as chi-square tests was used where applicable. Multiple logistic regression analysis was used to determine independent predictors of hypothermia.

All statistical tests were performed at 5% level of significance (p value less or equal to 0.05). P values < 0.05 was considered significant.

3.7 Ethical Consideration

- This was an observational study and was not harmful to the participating patients.
- Participation was on voluntary basis and withdrawal from the study was allowed at any one point.
- Participants' confidentiality and anonymity was ensured throughout the study.
- The cost of the study was not transferred to the patients participating.
- Any patient noted to be hypothermic the primary anesthetist was alerted on event to take appropriate measures.
- The researcher sought ethical approval from the Ethics and Research Committee Kenyatta National Hospital/University of Nairobi.
- Informed consent was obtained from patients who met the inclusion criteria.
- Pre anesthesia assessment was conducted by the anesthesia provider on consenting patients.
- Data collected was presented to the Kenyatta National Hospital and University of Nairobi departments of anesthesia.

CHAPTER 4: RESEARCH FINDINGS

This study was designed to determine the prevalence of perioperative hypothermia in adult patients at the Kenyatta National Hospital operating theatres. After study protocol approval by the KNH-UON Ethics and Research committee, 167 consenting clients who met the inclusion criteria were recruited.

Demographic Profiles

Table 1: Demographic Profiles

	General	Spinal	Total	p-value
Gender				
Male	37 (41.6)	40 (51.3)	77 (46.1)	0.209
Female	52 (58.4)	38 (48.7)	90 (53.9)	
Age				
18-25	15 (16.9)	19 (24.4)	34 (20.4)	0.229
26-35	27 (30.3)	27 (34.6)	54 (32.3)	0.555
36-45	24 (27.0)	16 (20.5)	40 (24.0)	0.330
46-55	10 (11.2)	7 (9.0)	17 (10.2)	0.630
>55	13 (14.6)	9 (11.5)	22 (13.2)	0.531
BMI				
<18.5	7 (7.9)	3 (3.8)	10 (6.0)	0.275
18.5-24.9	44 (49.4)	33 (42.3)	77 (46.1)	0.356
25.0-29.9	27 (30.3)	25 (32.1)	52 (31.1)	0.811
≥30	11 (12.4)	17 (21.8)	28 (16.8)	0.103
ASA				
1	61 (68.5)	45 (57.7)	106 (63.5)	0.146
2	23 (25.8)	33 (42.3)	56 (33.5)	0.025
3	4 (4.5)	0 (0.0)	4 (2.4)	0.058
	General	**Spinal**	**Total**	**p-value**
Surgery				
Elective	77 (86.5)	53 (67.9)	130 (77.8)	0.004
Emergency	12 (13.5)	25 (32.1)	37 (22.2)	
Comorbidity				
Present	13 (14.6)	7 (9.0)	20 (12.0)	0.263
Absent	76 (85.4)	71 (91.0)	147 (88.0)	

More female patients (53.9%) that underwent surgery at the operating theatres than male patients (46.1%) were recruited during the study period. There was however no statistical difference in the gender distribution (P= 0.209). The modal age group of the patients was between 26-35 years, with 46.1% of the recruited patients having a modal BMI of 18.5-24.9. The elective surgery cases represented 77.8% of all enrolled patients with were more than the emergency patients being 22.2% of the study population. This was significantly skewed with a P value of 0.004. Only 20% of the recruited patients had co-morbidities apart from those indicated for primary surgical intervention.

Ward Preoperative temperature profiles in elective patients

The mean pre-operative ward temperature in elective patients recruited in the study was 36.8^0C (SD=0.4). Thus there were no patients who had pre-operative hypothermia in this group of patients

Prevalence of hypothermia in receiving area of elective patients

On transfer from the wards to the theatre holding receiving area, most (93.1%) elective patients in the receiving area were normothermic with a mean temperature of 36.7^0C. 6.9% of the patients however were hypothermic patients with a mean temperature of 35.6^0C.

Table 2: Prevalence of hypothermia in receiving area of elective patients

	Frequency	Percent	Mean	SD
Hypothermia	9	6.9	35.6	0.5
Normothermia	121	93.1	36.7	0.4

Prevalence of hypothermia in receiving area of emergency patients

On the other hand only 3 patients of the emergency patients who were brought to the receiving area were found to be hypothermic. The mean temperature of all the emergency patients at the recovery area was noted at 36.7^0C℃.

Table 3: Prevalence of hypothermia in receiving area of emergency patients

	Frequency	Percent	Mean	SD
Hypothermia	3	8.8	35.5	0.3
Normothermia	31	91.2	36.7	0.5

Comparison of elective and emergency surgery patients' temperatures in receiving area

An independent samples t-test was conducted to compare elective and emergency surgery temperatures in receiving area. There was no significant difference in the temperatures for elective (M=36.59, SD=0.50) and emergency (M=36.55, SD=0.59) arms, *t* (162) = .422, p=.673.

Table 4: Comparison of elective and emergency surgery patients' temperatures in receiving area

	Frequency	Mean	SD
Elective	130	36.6	0.5
Emergency	34	36.6	0.6

Prevalence of Perioperative Hypothermia

Prevalence of hypothermia amongst patients under study was noted to be at 70.7%(118) with those undergoing spinal anesthesia at 76.9%.

Table 5: Prevalence of Perioperative Hypothermia

	General	Spinal	Total
Hypothermia	58 (65.2)	60 (76.9)	118 (70.7)
Normothermia	31 (34.8)	18 (23.1)	49 (29.3)

Table 6: Prevalence of hypothermia amongst patient age groups and BMI

	Hypothermia	Normothermia	Total	p-value
Age				
18-25	22 (64.7)	12 (35.3)	34 (100)	0.393
26-35	35 (64.8)	19 (35.2)	54 (100)	0.252
36-45	27 (67.5)	13 (32.5)	40 (100)	0.615
46-55	14 (82.4)	3 (17.6)	17 (100)	0.264
>55	20 (90.9)	2 (9.1)	22 (100)	0.019
BMI				
<18.5	5 (50.0)	5 (50.0)	10 (100)	0.139
18.5-24.9	54 (70.1)	23 (29.9)	77 (100)	0.890
25.0-29.9	35 (67.3)	17 (32.7)	52 (100)	0.522
≥30	24 (85.7)	4 (14.3)	28 (100)	0.055

Duration of Surgery

A high prevalence of hypothermia was noted amongst the surgical cases that lasted between 1.1hr – 2 hours at 71.9%.

Table 7: Duration of Surgery

Duration of surgery (hours)	Hypothermia	Normothermia	Total	p-value
≤1.0	16 (69.6)	7 (30.4)	23 (100.0)	0.901
1.1-2.0	46 (71.9)	18 (28.1)	64 (100.0)	0.786
2.1-3.0	29 (65.9)	15 (34.1)	44 (100.0)	0.420
>3.1	17 (65.4)	9 (34.6)	36 (100.0)	0.970

Prevalence of Perioperative Hypothermia in different surgical procedures

The study showed patients who had undergone obstetric (41.7%), general surgery (34.5%) & orthopedics (31.7%) procedures had a high prevalence of hypothermia.

Table 8: Comparison between type of surgery and type of anesthesia on perioperative hypothermia

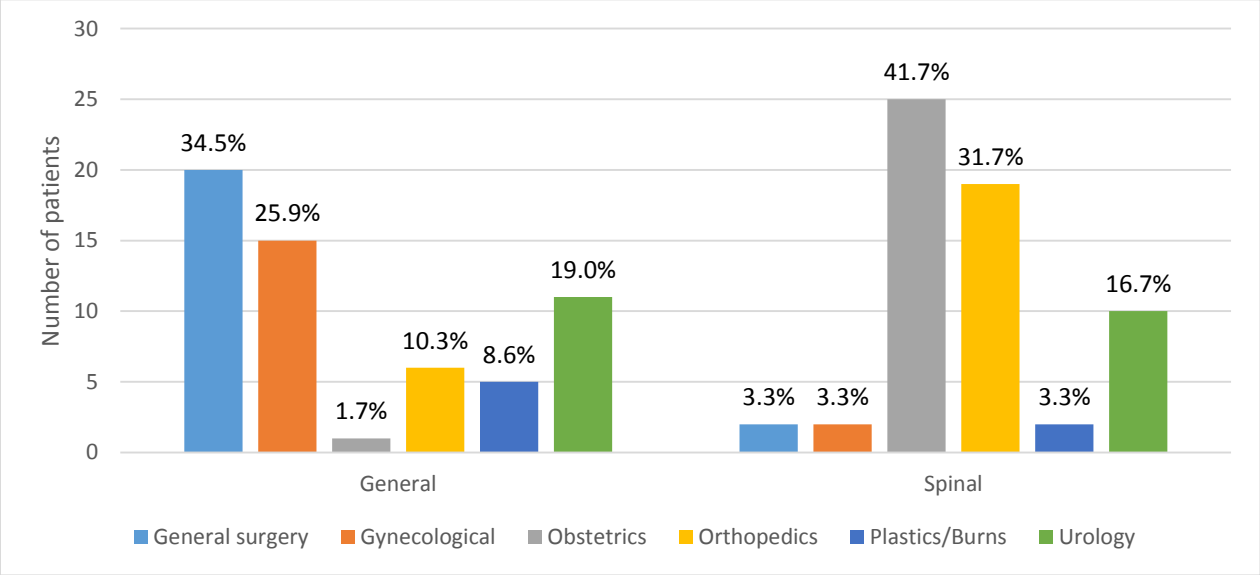
	General				Spinal			
Type of Surgery	**Hypothermia**	**Normothermia**	**Total**	**P-Value**	**Hypothermia**	**Normothermia**	**Total**	**P Val**
General surgery	20 (34.5)	7 (22.6)	27 (30.3)	**0.282**	2 (3.3)	0 (0.0)	2 (2.6)	**0.433**
Gynecological	15 (25.9)	6 (19.4)	21 (23.6)	**0.541**	2 (3.3)	1 (5.6)	3 (3.8)	**0.667**
Obstetrics	1 (1.7)	0 (0.0)	1 (1.1)	**0.469**	25 (41.7)	1 (5.6)	26 (33.3)	**0.004**
Orthopedics	6 (10.3)	10 (32.3)	16 (18.0)	**0.008**	19 (31.7)	13 (72.2)	32 (41)	**0.002**
Plastics/Burns	5 (8.6)	2 (6.5)	7 (7.9)	**0.739**	2 (3.3)	2 (11.1)	4 (5.1)	**0.168**
Urology	11 (19)	5 (16.1)	16 (18.0)	**0.770**	10 (16.7)	1 (5.6)	11 (14.1)	**0.215**

The table shows the type of surgery and type of anesthesia on perioperative hypothermia. It was noted that in those patients that underwent general surgery under general anesthesia had a high number who were hypothermic at 34.5% and those that underwent spinal anesthesia at 3.3%.

The patients that underwent gynecological procedures under general anesthesia were hypothermic at 25.9% and those under spinal anesthesia were hypothermic at 3.3%. The obstetric patients who received spinal anesthesia were hypothermic at 41.7% and under general anesthesia at 1.7%. In the orthopedic patients who received spinal anesthesia they were hypothermic at 31.7% and those that received general anesthesia were hypothermic at 10.3%.

The patients who were undergoing various plastic surgery procedures under general anesthesia were hypothermic at 8.6% and those that received spinal anesthesia were hypothermic 3.3%. The urology patients who received general anesthesia were hypothermic at 19% and those under spinal anesthesia were hypothermic at 16.7%.

Comparison between type of surgery and type of anesthesia on perioperative hypothermia



Methods used to prevent Perioperative Hypothermia

All patients who were undergoing surgery at the operating theatres were brought to the theatre from the wards covered with a standard blanket. The patients who had less than two linens intraoperatively were hypothermic at 53.8% and those that did not use warm fluids at 51.7%.

Table 9: Methods used to prevent Perioperative Hypothermia

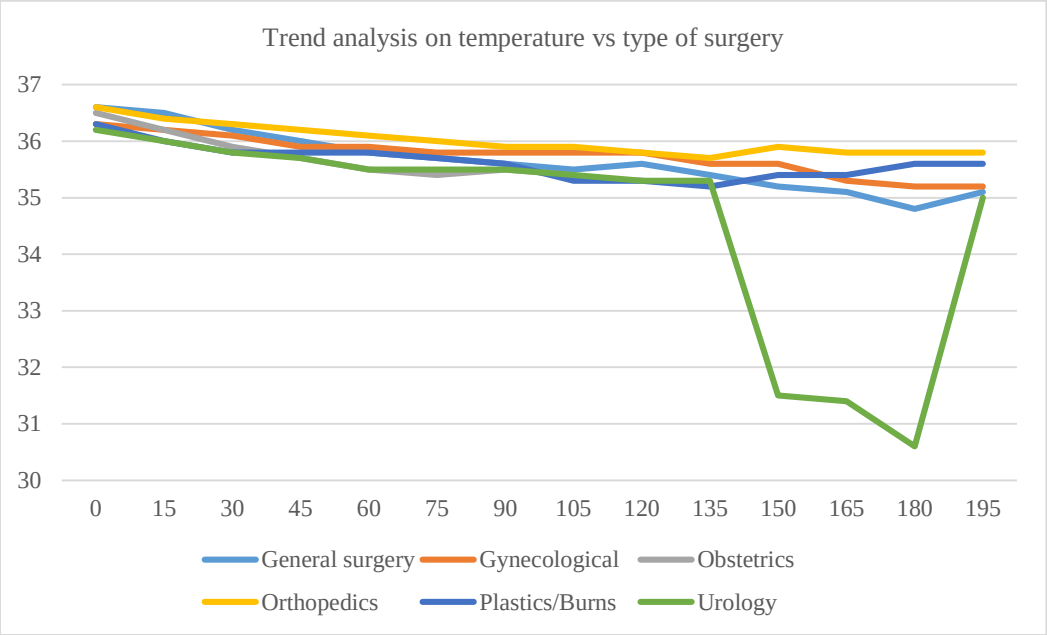
		Frequency	Percent
Blankets	Yes	166	99.4
	No	1	0.6
Linens	1	12	7.2
	2	80	47.9
	3	66	39.5
	4	5	3.0
	5	3	1.8
	None	1	0.6
IV Fluids ^{0}C	≥36.0	93	55.7
	<36.0	74	44.3

Table 10: Prevalence of Perioperative Hypothermia in relation to warming techniques

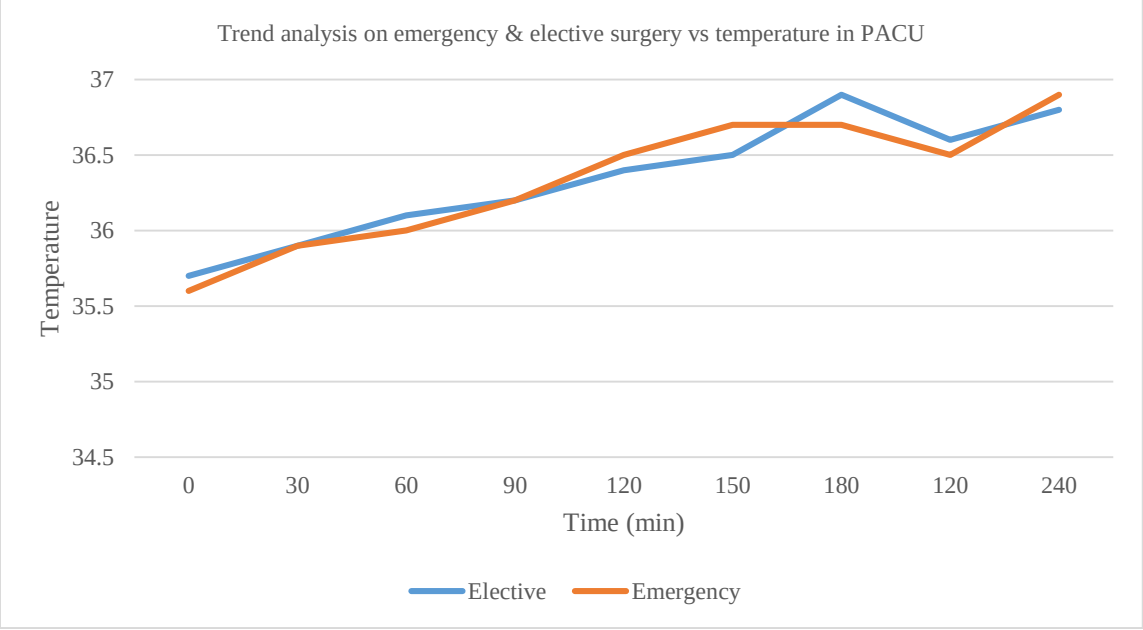
	Hypothermia	Normothermia	Total	p-value
Linens				
≤ 2	63 (53.8)	29 (59.2)	92 (55.4)	0.528
>2	54 (46.2)	20 (40.8)	74 (44.6)	
Warm fluids				
≤ 36℃	61 (51.7)	16 (32.7)	77 (46.1)	0.025
>36℃	57 (48.3)	33 (67.3)	90 (53.9)	

Trend analysis comparison between general & spinal anesthesia based on the time of surgery.

The graph below gives the overall trend analysis.

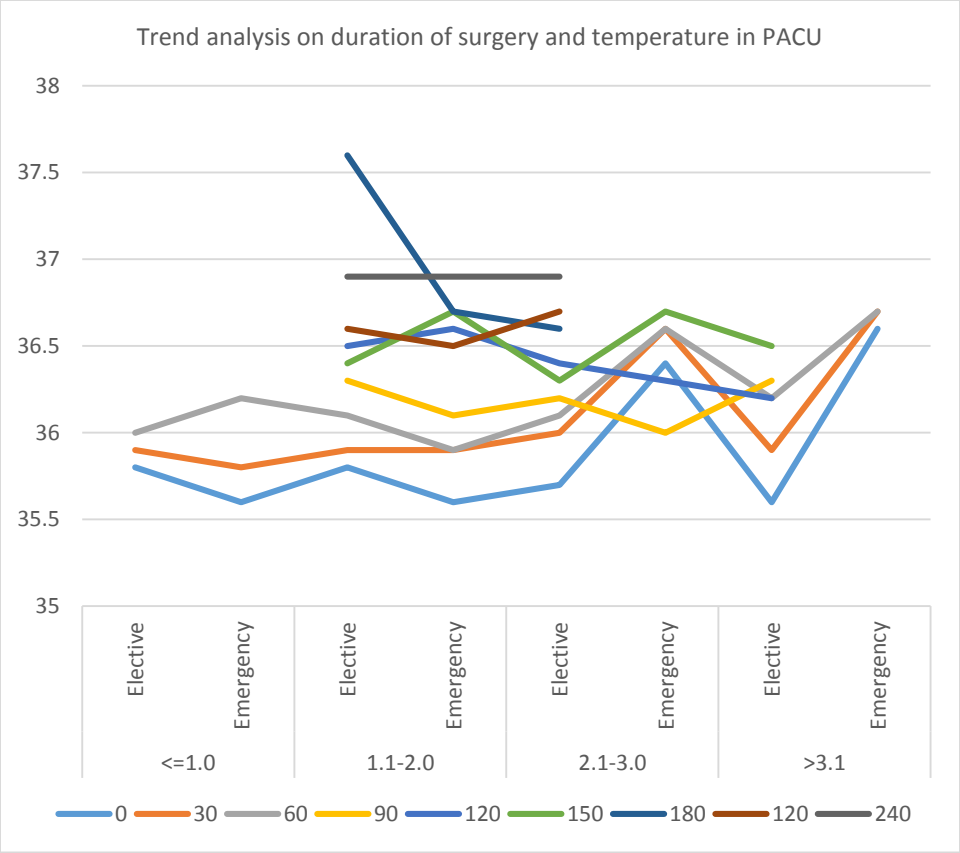


In the above graph the dip in temperature that was noted among urology patients was among the donor transplant patients with a mean temperature of 34.4^0C.



An independent t-test was used to ascertain if there were differences between the temperatures for elective and emergency, there was no statistical differences between the groups (p=0.956)

Trend analysis using one way ANOVA revealed that there was no statistical differences (p=0.347), between the groups.


Trend analysis on duration of surgery and temperature in PACU
38
37.5
37
36.5
36
35.5
35
Elective
Emergency
Elective
Emergency
Elective
Emergency
Elective
Emergency
<=1.0
1.1-2.0
2.1-3.0
>3.1
0
30
60
90
120
150
180
120
240

CHAPTER 5: DISCUSSION

The main objective of the study was to determine prevalence of perioperative hypothermia in consenting adult patients during anesthesia-facilitated surgery at the Kenyatta National Hospital operating theatres. The study excluded patients who declined consent, those undergoing cardiac or neurologic procedures where thermal manipulation were expectedly part of the interventional procedure protocol and those who would require postoperative ventilation where anesthesia was not reversed.

Age over 55 years, median BMI of between 18.5 and 25 as well a spinal anesthesia and obstetric interventions seemed to show more predisposition to hypothermia in the patients enrolled to this study.

The study found that 90.9% of patients above 55 years had perioperative hypothermia. This finding corresponds to the study by Frank et al who conducted a study on predictors of hypothermia during spinal anesthesia [39]where he noted advanced age >55 years was a significant risk factor. More similarity is to be found in the study by Vaughn MS[40] et al on postoperative hypothermia in adults in relation to age, anesthesia and shivering to rewarming. He noted that elderly patients >60 years had more hypothermic episodes than younger patients and had a longer recovery time in PACU to return to normothermic levels.

In this study patients who had a BMI of 18.5-24.9 were hypothermic at 70.1% this is contrary to a study done by Ji et al who did a cross sectional study on incidence of inadvertent intraoperative hypothermia and its risk factors in patients undergoing general anesthesia in Beijing [41], where patients with BMI <25 were hypothermic with an OR 0.39.

In this study patients who used intravenous fluids at temperatures < 36^0C were hypothermic at 55.7%. These findings are contrary to the study done by Jie et al who did a cross sectional study on incidence of inadvertent intraoperative hypothermia and its risk factors in patients undergoing general anesthesia in Beijing[41].The patients who used intravenous fluids <36^0C had an OR 0.245.

This study further found that Hypothermia was more prevalent in patients who received spinal anesthesia at 76.9%. This compares with the findings by Arkillic et al[31] who carried out an observational study and noted that temperature monitoring and management is inadequate in spinal anesthesia where post-operative temperature of < 36^0C in 77% and <35^0C in 22%.

This study further found that all patients who underwent surgery between 1-2 hours were the most hypothermic at 71.9% unlike Ji et al on incidence of inadvertent intraoperative hypothermia and its risk factors in patients undergoing general anesthesia in Beijing where patients who underwent surgery > 2hours were hypothermic OR 3.44.

In the current study we noted that obstetric patients who were administered spinal anesthesia were the most hypothermic at 41.7%. These findings closely compare with the study conducted by Fabricio[42]et al in Brazil who did a cross sectional study on risk factors for postoperative hypothermia in PACU where the incidence of temperature <36℃ was 69.2%. The highest risk factors being spinal anesthesia (p =<0.0001) and caesarian section (p=<0.003).

CONCLUSION

- Perioperative hypothermia was prevalent at 70.7% among all patients under study.
- Spinal anaesthesia , obstetric procedures as well as orthopedic surgery had higher prevalence of Perioperative hypothermia
- The use of adequate linen cover, warmed intravenous fluids mitigated the occurrence of perioperative hypothermia.
- Whereas a higher proportion of emergency patients were hypothermic preoperatively, there was no statistically difference in post-operative temperature trends in comparison to elective patients.

RECOMMENDATIONS

- Care providers need to be more aware of hypothermia prevention in spinal anesthesia since most patients undergoing spinal anesthesia were hypothermic.
- All patients undergoing surgery should receive warm fluids intra-operatively and at least more than two linens.
- Intraoperative warming devices should be made available in operating theatres.

STUDY STRENGTHS

The study was carried out in the largest referral hospital with an established healthcare system. All care givers including consultants, registrars and clinical officers and patients were receptive to the study making data collection easier.

STUDY LIMITATIONS

This study, being an observational study, the principal investigator was limited in the choice of the various warming techniques used in the operating theatres.

REFERENCES

1.C. M. Harper, J. C. Andrzejowski, R. Alexander; NICE and warm, BJA: British Journal of Anesthesia, Volume 101, Issue 3, 1 September 2008, Pages 293–295

2.Kurz A (2008)Physiology of thermoregulation, BestPract Res ClinAnaesthesiol,22 (2008),pp. 627-644.

3.Monzon CG, Arana CA, Valz HA, Rodriguez FA, Mejia JJ, Gomez JA. Temperature management during the perioperative period and frequency of inadvertent hypothermia in a general hospital 2013; 41:97-103

4.Van Oss CJ, Absolom DR, Moore LL, Park BH, Humbert JR. Effect of temperature on the chemotaxis, phagocytic engulfment, digestion and O2 consumption of human polymorphonuclear leukocytes. J Reticuloendothel Soc .1980:27:561-5.

5.Doufas AG. Consequences of inadvertent perioperative hypothermia. Best Pract Res Clin Anaesthesiology . 2003;17:535-549

6. Anselm Brauer, Perioperative Temperature Management (Cambridge University Press, 2017)

7. Mehta OH, Barclay KL. Perioperative hypothermia in patients undergoing major colorectal surgery, ANZ J Surg. 2014 Jul-Aug; 84(7-8):550-5.

8.Denu AZ, Semple P, Tawuye HY, Kassa AA (2015) Perioperative Hypothermia and Predictors of Intra-Operative Hypothermia among Patients Operated at Gondar university Hospital from March to April 2015. J Anesth Clin Res 6:556. doi: 10.4172/2155-6148.1000556

9.Michelson AD, MacGregor H, Barnard MR, Kestin AS, Rohrer MJ, Valeri CR. Reversible inhibition of human platelet activation by hypothermia in vivo and in vitro. Thromb Haemost 1994-71,633-40.

10.Rajagopalan S, Mascha E, Na J, Sessler DI. The effects of mild perioperative hypothermia on blood loss and transfusion requirement. Anesthesiology . 2008; 108:71–7.

11.Sessler DI Perioperative thermoregulation and heat balance. Lancet 2016, 387-2655.

12. C. M. Harper J. C. Andrzejowski R. Alexander,Nice and warm, British Journal of Anaesthesia, 2001;101:293-295

13.NICE guidelines on prevention and management of hypothermia in adult patients undergoing surgery.Clinical guideline CG 65, Published date April 2008,Last updated December 2016.

14.Mitchell AM, Kennedy RR. Preoperative core temperatures in elective surgical patients show an unexpected skewed distribution. Canadian Journal of Anesthesia, 2001 Oct; 48(9):850-3.

15. Mehta OH, Barclay KL. Perioperative hypothermia in patients undergoing major colorectal surgery, ANZ J Surg. 2014 Jul-Aug; 84(7-8):550-5.

16. Kioko P The incidence and risk factors For intra-operative Hypothermia among paediatric Patients undergoing general anaesthesia at the Kenyatta National Hospital , East African Medical Journal August 2013;Vol 90;No 8

18. J Andrzejowski,Effect of prewarming on post-induction core temperature and the incidence of inadvertent perioperative hypothermia in patients undergoing general anaesthesia ,British Journal of Anaesthesia 2008;101:627-631

19.Kudoh A,Takase H & Takazawa T. Chronic treatment with antipsychotics enhances intraoperative core hypothermia. Anesth Analg 2004;98: 111-115.

20 .Toyota K, Sakura S, Saito Y, Ozasa H, Uchida H. The effect of pre-operative administration of midazolam on the development of intra-operative hypothermia. Anaesthesia. 2004 Feb;59(2):116-21.

21.Matsukawa T, Sessler DI, Sessler AM et al. Heat flow and distribution during induction of general anesthesia. Anesthesiology 1995;82:662-673.

22.Unexpectedly high incidence of hypothermia before induction of anesthesia in elective surgical patients,Wetz AJ, J Clin Anesth. 2016 Nov;34:282-9.

23.Anselm Braur Perioperative temperature management,chp7 pg 52-56. Published by Cambridge University Press 2017.

24. Kushikata T, Hirota K,Kotani N, Yoshida H,Kuso M and Matsuki A. Isoflurane increases norepinephrine release in the rat preoptic area and the posterior hypothalamus in vivo and in vitro:relevance to thermoregulation during anesthesia. Neuroscience 2005; 131:79-86.

25.Xiong Ji,Kurz A,Sessler DI, Plattner O,Christtensen R,Dechert M, Ikeda T, Isoflurane produces marked and nonlinear decreases in the vasoconstriction and shivering thresholds. Anesthesiology. 1993 Sep;79(3):465-9.

26.Matsukawa TI, Kurz A Propofol linearly reduces the vasoconstriction and shivering thresholds. AnesthAnalg. 1995 Aug;81(2):393-8.

27. Ikeda T1, Sessler DI, Kikura M, Kazama T, Ikeda K, Sato S. Less core hypothermia when anesthesia is induced with inhaled sevoflurane than with intravenous propofol. Anesth Analg. 1999 Apr;88(4):921-4.

28. Kurz AI.Go JC,. Alfentanil slightly increases the sweating threshold and markedly reduces the vasoconstriction and shivering thresholds. Anesthesiology 1995;83(2)293-9.

29.Sayid Sahar et al. Hypothermia and Excessive Sweating Following Intrathecal Morphine in a Parturient Undergoing Cesarean Delivery. Regional Anesthesia and Pain Medicine 28(2):140-3
.

30.Anselm and Brauer. Perioperative temperature management chp 6 pg 59-61. . Published by Cambridge University Press 2017.

31. Arkillic CF,Temperature monitoring and management during neuraxial anesthesia: an observational study, Anesth Analg. 2000 Sep;91(3):662-6.

32. Horn EP,Warming before and after epidural block before general anaesthesia for major abdominal surgery prevents perioperative hypothermia,, Eur J Anaesthesiol. 2016 May;33(5):334-40.

33. Shaw CA, Steelman VM, DeBerg J, Schweizer ML. Effectiveness of active and passive warming for the prevention of inadvertent hypothermia in patients receiving neuraxial anesthesia: A systematic review and meta-analysis of randomized controlled trials. J Clin Anesth. 2017 May;38:93-104.

34. Rajeev Singh, Veena Asthana, Jagdish P. Sharma, and Shobha Lal. Effect of irrigation fluid temperature on core temperature and hemodynamic changes in transurethral resection of prostate under spinal anesthesia. Anesth Essays Res. 2014 May-Aug; 8(2): 209–215.

35.Anselm Brauer . Perioperative temperature management chp 11 pg 74. . Published by Cambridge University Press 2017.

36.J Lelo, Intraoperative Thermal Dynamics, Published 2007, College of Health Sciences(3037),University of Nairobi repository.

37. Anselm Brauer Perioperative temperature management, chp 7 pg 50. . Published by Cambridge University Press 2017.

38. Anselm Brauer Perioperative temperature management,chp 7 pg 52. . Published by Cambridge University Press 2017.

39.Frank SM .Predictors of hypothermia during spinal anesthesia.Anesthesiology.2000 May;92(5):1330-4.

40.Vaughn MS. Postoperative hypothermia in adults: relationship of age, anaesthesia, and shivering to rewarming.Anesth Analg. 1981 Oct;60(10):746-51.

41.Medonca FT.Risk factors for postoperative hypothermia in the post-anesthetic care unit: a prospective prognostic pilot study. Rev Bras Anestesiol. 2019 Mar - Apr;69(2):122-130.

APPENDICES

|Appendix 1: Data Collection Tool

Prevalence of perioperative hypothermia amongst patients undergoing anesthesia at the kenyatta national hospital theatres

BIO DATA

Serial No: Ip No:

Age: Gender:

Weight: Height:

Preoperative temperature in ward:

Patient Factors:

Type of Surgery:

Duration of Surgery:

Temperature in Receiving Area:

Warming Technique in Receiving Area:(blankets, warm gowns)

elective surgery emergency surgery:

ASA status:

Co-morbids:

Anesthesia care provider:

Pre medication:

Type of Anesthesia:

General	
Induction agents:	
Inhalational agent:	
Muscle relaxant:	
Analgesia-opioids:	

Spinal	
Heavy bupivacaine/plain bupivacaine	
Fentanyl,morphine or pethidine (intrathecal)	
Sedation	

Warming Technique:

Linen	
Blankets	
Warm iv fluids (specify temperature)	
Warm blood	
Forced air warming device	
Ambient room temperatures	

Temperature monitoring intraoperatively:

Minutes	o	15	30	45	60	75	90	105	120	135	150	165	180	195
Core body temperature														

Temperature monitoring postoperatively:

minutes	0	30	60	90	120	150	180	210	240
core body temperature									

Appendix 2: Explanation of Consent

You have been invited to participate in this study titled prevalence of perioperative hypothermia amongst patients undergoing anesthesia at the Kenyatta National Hospital theatres.

Study Background: Hypothermia which is defined as coretemperature less than 36℃. Inadvertent intraoperative hypothermia which is the most common perioperative thermal disturbance.

Study objective: The purpose of this study is to find out to what extent hypothermia occurs in patients undergoing various surgical procedures using either spinal or general anesthesia and to attempt to elucidate the factors that affect it. Number of people taking part in the study is165.If you agree to participate you will be one of the 165 patients who will be taking part in the research.

Voluntariness of participation: Your participation in this research is entirely voluntary as such no remuneration or compensation will be offered to the participants of the study. Whether you choose to participate or not, all the services you receive at this hospital will continue and nothing will change. If you choose to participate in this research project, no extra cost will be incurred.

Confidentiality: All patient information will be coded and no names will be used throught the study.

Benefits: The study will improve patient close monitoring and early recognition of complications.

Risks: The study poses no risk to the participant.

Right to withdraw: You do not have to take part in this research if you do not wish to do so and refusing to participate will not affect your treatment in any way. You will still have all the benefits that you would otherwise have at KNH.

Patient Information:

The thermometers being used to measure temperature have been tested and used before in this hospital. There is no interference with instructions given by the surgeon and/or the anesthesiologist. The assessment of other vital signs and general condition or the patient will be done at regular intervals and staff will be available to give necessary assistance. This study is approved by appropriate hospital authorities before it starts. (KNH-UoN Ethics and Research Committee).

Procedure: The patient's temperature will be recorded from the tympanic membrane using an infra-red thermometer, pre-operatively and every 15 minutes intra-operatively and every 30 minutes post operatively till they leave the post anesthesia care unit. The temperature of the operating room will also be recorded. These measurements will not interfere with the work of the surgeon

Appendix 3:Consent form

I……. of hereby consent to be included in the study titled.prevalence of perioperative hypothermia amongst patients undergoing anesthesia at the Kenyatta National Hospital theatres.

The purpose and procedure have been explained to me by…… I have had a chance to ask questions. I have all the information I desire and my questions have been answered satisfactorily. My signature below acknowledges that I have read, understood and agree to the foregoing statements.

Signature of patient/parent/guardian……. Date…….

Signature of witness……Date……

The nature, risks, purpose of the study to be performed on this patient has been explained to him/her.

Signature of doctor…….. Date……

Appendix 4: Fomu ya Makubaliano ya Kujiunga

Umealikwa kujiunga na utafiti inayoitwa prevalence of perioperative hypothermia amongst patients undergoing anesthesia at the Kenyatta National Hospital theatres.

Kujifunza usuli: Hipothemia ambayo hufafanuliwa kama coretemperature chini ya 36℃. Mibonyezo ya bahati mbaya intraoperative hipothemia ambayo ni kawaida perioperative joto msukosuko.

Kujifunza lengo: Lengo la somo hili ni kujua kwa hipothemia gani kiasi hutokea katika wagonjwa wakiendelea taratibu mbalimbali za upasuaji kutumia anesthesia ya uti wa mgongo au mkuu na kujaribu elucidate mambo yanayoathiri ni. Idadi ya watu wanaoshiriki katika utafiti ni 165. kama unakubali kushiriki utakuwa mmoja wa wagonjwa 165 ambao utakuwa kuchukua sehemu katika utafiti

Voluntariness ya ushiriki: ushiriki wenu katika utafiti huu ni hiari kabisa kama vile Hakuna malipo au fidia zitatolewa kwa washiriki wa utafiti. Ikiwa utachagua kushiriki au la, huduma zote kupokea hospitali hii itaendelea na Hakuna mabadiliko. Ikiwa utachagua kushiriki katika mradi huu utafiti, ziada hakuna gharama mapenzi kuwa wakastahiki.

Usiri: Habari zote mgonjwa itakuwa kuwa m zunguko na majina hakuna itakuwa kutumika throught utafiti.

Faida: Mafunzo ya kuboresha mgonjwa ufuatiliaji karibu na mapema utambuzi wa matatizo.

Hatari: Utafiti akiwa hakuna hatari kwa mshiriki.

Haki ya kuondoka: Huna kushiriki katika utafiti huu kama hupendi kufanya hivyo na kukataa.

Taarifa ya mgonjwa: Thermometers kutumika kupima joto wamekuwa kupimwa na kutumika kabla katika hospitali hii. Kuna hakuna kuingiliwa na maelekezo yanayotolewa na upasuaji na/au

anesthesiologist ya. Tathmini ya ishara nyingine muhimu na hali jumla au mgonjwa itafanyika kwa vipindi vya kawaida na wafanyakazi itapatikana kutoa msaada unaohitajika. Utafiti huu ni kupitishwa na mamlaka ya hospitali sahihi kabla ya matengenezo. (KNH-UoN maadili na kamati ya utafiti).

Utaratibu: Joto ya mgonjwa yatarekodiwa kutoka utando tympanic kutumia f ya kimfumo-nyekundu, pre-operatively na kila baada ya dakika 15 intra-operatively na kila baada ya dakika 30 baada ya operatively mpaka kuondoka posta anesthesia care unit. Joto ya chumba ya uendeshaji pia yaandikwe. Vipimo hivi haitaingilia na kazi ya upasuaji.

Appendix 5: Fomu ya Idhini

I..... wa hili kukubali kujumuishwa katika masomo yenye kichwa cha habari. prevalence of perioperative hypothermia amongst patients undergoing anesthesia at the Kenyatta National Hospital theatres.

Kusudi na utaratibu wamekuwa alielezea kwangu na..... Kuwa na nafasi ya kuuliza maswali. Nina wote habari natamani na maswali yangu yametolewa kuridhisha. Sahihi yangu hapa chini inatambua kwamba nimesoma, kuelewa na kukubaliana na kauli za kuunga mkono.

Sahihi ya mgonjwa au mzazi/mlezi..... Tarehe.....

Saini ya shahidi..... Tarehe.....

Asili, hatari, madhumuni ya somo ili zifanywe mgonjwa huyu limeelezwa kwake.

Sahihi ya daktari…… Tarehe…….[36]