A STUDY OF THE INCIDENCE OF PERIOPERATIVE HYPOTHERMIA IN CHILDREN UNDERGOING SURGERY IN PEADIATRIC OPERATING THEATRES AT THE UNIVERSITY TEACHING HOSPITAL IN LUSAKA, ZAMBIA

By

Jullien C. Chomba

A dissertation submitted to the University of Zambia as partial fulfillment for the award of the Master of Medicine Degree in Anaesthesia and Critical Care.

UNIVERSITY OF ZAMBIA

LUSAKA

2017

COPYRIGHT

DECLARATION

I, **JULLIEN. C. CHOMBA** do hereby declare that this dissertation herein presented for the degree of **Master of Medicine (Aneasthesia and Critical Care)** represent my own work. It has not been previously submitted either in whole or in part for any other degree at this or any other university, nor is it currently being submitted for any other degree.

Signed:………………………………………..

Date:…………………………………………….

CERTIFICATE OF APPROVAL

This dissertation entitled A Study of the Incidence of Perioperative Hypothermia in children undergoing surgery at the University Teaching Hospital (UTH), by **Jullien .C. Chomba** has been approved as fulfilling part of the requirements for the award of degree in **Master of Medicine in Anaesthesia and Critical Care** by the University of Zambia.

EXAMINER'S NAME	SIGNATURE	DATE
……………………………..	…………………	………………
……………………………..	………………….	………………
…………………………….	………………….	…………………

ABSTRACT

Preoperative hypothermia is a recognized risk in surgery with adverse effects on patient outcome. Children are no exception and are more susceptible because of their anatomy and physiology. To determine the incidence of perioperative hypothermia and associated risk factors in pediatric patients undergoing surgery at the University Teaching Hospital. A cross sectional study with study population consisting of pediatric patients undergoing elective surgery. Descriptive analysis of variables was used to summarize data. Multivariate logistic regressions were applied to explore the risk factors of developing hypothermia. A total number of 220 patients were recruited, of which males were 134(60.9%) and females 86(39.1%). Age ranged from 2 weeks to 14 year. Average age was 4.2 years (SD=3.8). The overall incidence of perioperative hypothermia was 88%, with calculated incidences at induction, 1 hour and 2 hours after induction as 49.6%, 91.6%, 97.1% respectively. Logistic regression analysis showed low operating room (OR) temperature, IV fluid at room temperature, duration under anaesthesia and preoperative temperature were predictors of hypothermia. The incidence of perioperative hypothermia is high at this hospital. Hence care for patients undergoing surgery should be taken especially in those undergoing long periods of anaesthesia, surgery done in low OR temp and receiving large volume IV fluids.

Keyword

Anaesthesia, body temperature, induction, perioperative hypothermia, surgery.

DEDICATION

To my loving husband Mwape S. and my children Lukwesa, Kasapo and Mwape J.

In loving memory of my beloved parents Mark and Winnie Chomba.

ACKNOWLEDGEMENTS

I thank God for His grace in my life.

To my loving and supportive husband, Dr. M. S. Mwewa, for his motivation, constant love and support. To my loving children Lukwesa, Kasapo and Mwape for their understanding and patience.

To my supervisors Dr. D Bould and Dr. F Ismialova for their guidance, support and supervision.

To my colleagues in the department of anaesthesia , Mr. G. Mudenda for helping with data collection and F. Chibuye for data entry.

University teaching hospital management for approval to conduct the study at the institution. Dr. Akakandelwa for data analysis and last but not the least the parents and patients who agreed to participate in the study.

Thank you all. May this study help the institution come up with policies to prevent and manage hypothermia in children undergoing surgery.

TABLE OF CONTENTS

CHAPTER TWO

LITERATURE REVIEW

CHAPTER THREE

METHODOLOGY

CHAPTER FOUR

RESULTS

CHAPTER FIVE

DICUSSION

CHAPTER SIX

CONCLUSION

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

ABBREVIATIONS

A0RN : Association of Registered Nurses

ASA : American society of Anaesthesiology

BSA : Body surface area

C.I : Confidence Interval

ENT : Ear Nose Throat

ERES : Excellence in Research Ethics and Science

ICU : Intensive Care Unit

IV : Intravenous

MC : Male Circumcision

MRI : Magnetic Resonance Imaging

NICE : National Institute for Health care of Excellence

OR : Operating Room

SD : Standard Deviation

UNZA : University of Zambia

UTH : University Teaching Hospital

OPERATION DEFINITION

Pediatric – patient aged between 0 – 14 years

Hypothermia – temperature of $< 36^0$c at any given time during anaesthesia.

Minor surgery -These are surgical procedures that involve little risk of life of a patient such as operations on the superficial structures of the body or manipulative procedures. e.g. vascular cut down for catheter placement, male circumcision, excision of lipoma cervical lymph node biopsy…etc.

Major Surgery - These are invasive procedures in which an extensive resection is performed e.g. a body cavity is entered, organs are removed, or normal anatomy is altered. In general if a mesenchymal barrier is opened (pleural cavity, peritoneum, meninges).

CHAPTER ONE

INTRODUCTION

1.1 Overview

The human thermoregulatory system maintains a core temperature of 37(+/- 0.5) C by effecting appropriate homeostatic response aimed at maintaining a balance between heat loss and heat production. General anaesthesia inhibits thermoregulation resulting in hypothermia.

Perioperative hypothermia, defined as core temperature of < 36°C can develop at any stage during the surgical pathway: preoperatively, intraoperatively or post operatively. Hypothermia may be classified in three categories: mild (34-35.9°C), moderate (30-34°C), severe (≤30°). (1)

The incidence is known to occur in 60-90% of all surgical patients and results when the body's ability to maintain normothermia is diminished by absence of protective reflexes such as shivering, piloerectiondue to anaesthesia and loss of heat during surgery. (1, 2)

Perioperative hypothermia has been implicatedin several of negative outcomes in adults, including intraoperative blood loss and increased risk of transfusion due to cold induced coagulopathy, prolonged drug metabolism leading to delayed recovery from anaesthesia, adverse cardiac events compensating cutaneous vasoconstriction that can impair wound healing, high infection rates due to immune system suppression and prolonged hospital stay which is costly for hospital management and patients. (2)

Several risk factors contribute to an increased risk of hypothermia. Impairment of thermoregulation by general anesthesia, low temperature of operating room, use of unwarmed fluids for intravenous infusion or wound irrigation and lack of warming devices are some of these factors.

Neonates, infants and children have been shown to be at an increased risk of developing perioperative hypothermia because of a number of factors. These include a high surface area to weight ratio, increased heat loss from the lead, limited stores of subcutaneous fat, and a poor thermoregulatory capacity (3, 4).

Several tools have been developed to combat hypothermia, from the simple very basic plastic, cotton or paper covering to the more sophisticated thermal drapes and forced air warmers. Prewarming patients and warming of fluids and blood products also help in preventing hypothermia (4).

Maintaining normothermia has become of great interest to anesthesia providers as well as national regulatory bodies. Hence recommendation for preventing hypothermia and improving its management has been made in adults by professional societies e.g. Association of Registered Nurses (AORN) and National Institute for Health and Care of Excellence (NICE)(5).

Though studies have been made regionally and globally, there has been nothing reported in Zambia and being a modifiable condition (perioperative hypothermia), understanding risk factor may help prevent hypothermia and its associated complication. Hence this observational single centered study at university teaching hospital of Zambia to ascertain the incidence of perioperative hypothermia and make recommendation on how to manage and reduce its occurrence.

1.2 Statement of the Problem

Hypothermia is a problem that warrants great consideration, because of its complications it affects the body in ways that can be detrimental, even life threatening. In the Paediatric operating theatres at the University Teaching Hospital, it has been noted that no measures are taken to pre-warm patients as they come in for surgical procedures. Patients awaiting surgery are made to wait outside theatre in the care of their parents, so as to keep them calm and stop them from crying.

Because of lack of staffing, on the ward as well as in theatre, patients only come into the waiting area when being handed over or just before surgery. This contributes to lowering of the patients' core body temperature, in that they are naked under a sheet and/or blanket provided by the hospital and later exposed to the environment. It is unknown whether hypothermia actually exists due to lack of monitoring and warming devices.

1.3 Study Justification

A study of this nature would help provide us with information on the presence or absence of hypothermia in children undergoing surgery at the University Teaching Hospital. In the advent that hypothermia is found to be present, it will provide information for health care providers and policy makers to improve health care provision and prevent the adverse effects of hypothermia.

1.4 Research Question

Hypothermia: Is it a problem in the Paediatric operating theatres, at the University Teaching Hospital, in Lusaka Zambia?

1.5 Main Objective

To describe the incidence of perioperative hypothermia in a pediatric perioperative setting of the University Teaching Hospital, Lusaka, Zambia.

1.6 Specific Objectives

1. To identify and quantify the number of children who suffer from perioperative hypothermia.
2. To determine the risk factors associated with perioperative hypothermia in children and how to prevent it.

CHAPTER TWO

LITERATURE REVIEW

2.1 Overview

People have evolved a highly integrated thermoregulatory system that maintains core body temperature in a relatively narrow temperature range. When the temperature is not within this range, the hypothalamus and consequently its thermoregulatory mechanisms are activated. These include vasoconstriction or vasodilatation of the peripheral arteriovenous shunts, non-shivering thermogenesis (involuntary muscle contraction) or increase in heat production of brown adipose tissue particularly in children, shivering and sweating. However according to studies done, these compensatory mechanisms are not enough in 50-90% of surgical patients resulting in hypothermia (6).

At induction of anaesthesia the thermoregulatory mechanism is inhibited leading to vasodilatation. Blood flow to the extremities is increased, body heat is lost much more quickly and patients become hypothermic. Perioperative hypothermia usually occurs in three phases of heat loss. The rapid distribution of heat from the core sites which include the abdomen, thorax and the brain, to the peripheries that is the extremities and occurs within 30-40 min. Then a linear phase, which usually begins at the start of surgery as patient is exposed to cold cleaning solutions and exposure to cold theatre. This is within 2-3 hours after induction and heat loss exceeds heat production. The various modes of heat loss include Radiation 40%, Convection 30%, Conduction 5%, Evaporation 8-15% and Respiration 8-10%. Finally the plateau phase which is characterized by an ongoing metabolic heat production and able to restore the normal gradient between several compartments (7).It means that a combination of anaesthetic induced thermoregulatory impairment and exposure to cold operating room may cause hypothermia in most patients.

2.2 Incidence

Several studies have been conducted to determine the incidence and associated risk factors to perioperative hypothermia. The risk factors of hypothermia identified in literature include age (children and elderly being more susceptible), low body mass index, patients with sepsis, trauma and burns, cold operating room temperature, length of surgery and type of surgery among others. An observational study compared outcome in children whose intraoperative temperature remained above 36C and those who become cold. The demonstrated incidence of inadvertent hypothermia was 52% despite the warming methods used (8).It was also observed that children are predisposed to hypothermia especially those undergoing long procedures, those exposed to cold theaters and type of surgery such as abdominal surgery as some of the risk factors. Another study done in Kenya observed an incidence of 30% despite not warming their patients actively. This observation could have been lower than one done in the USA due to different climates and that theatres were not air conditioned. The primary aim in risk identification during perioperative hypothermia period is to determine the potential risk of a patient developing hypothermia. One study defined risk factors as an independent predictor not an associated factor of an untoward event. They concluded that the risk factors for hypothermia implied correlation but not necessarily causation that is to say a patient may have the risk factor and not develop hypothermia (9).The importance of identifying risk factors is to be aware that patients with certain factors are likely to develop hypothermia and hence extra care and effort should be done to maintain normothermia in them. The phenomenon of heat loss in children during surgery is widely acknowledged and the type of surgery and the operating room temperature are the main factors for decrease in core temperature in neonates and infants which is in relation to their large surface area ratio to weight and increased heat loss through radiation. In neonates, the core temperatures are less stable, regardless of the operating room temperature and type of surgery. In high operating room temperatures, infants can stabilize their core temperature better than neonates (10).Other studies have also identified a combination of anaesthetic technique as risk factor. In case of regional anaesthesia, a peripheral blockade of vasoconstriction is observed below the level of the blockade which leads to heat loss. Therefore it has been concluded that a combination of the two types of anaesthesia leads to even more significant temperature deregulation (11).Anxiety has also been found to be one of the risk factors in patients undergoing surgery. An incidence of 51% was found in patients with high preoperative anxiety levels as compared to those patients' low levels. Children become anxious in new environments and later on separation from their patients. It's therefore important to reduce the anxiety levels to reduce the incidence of hypothermia (12).

2.3 Complications of Perioperative Hypothemia

Adverse outcomes have been associated with hypothermia. The three most common complications associated with mild hypothermia are a tree fold increase (i.e. 300%) in morbid myocardial events (13), a threefold increase in risk of surgical wound infection and prolonged hospitalization (14), and finally, increased blood loss and transfusion requirements (15).hypothermia will delay the recovery of the patients by decreased metabolic rate of the drugs, delaying awakening and altered mentation. In post-operative period, mild hypothermia and even lower levels of normothermia cause significant discomfort in the awake patient. The costs of perioperative hypothermia vary and can range from price of an extra cotton blanket to increased patient morbidity and mortality. Studies have shown that body temperature averaging 1.5C below normothermia cause cumulative adverse outcomes which added $2,500 to $7000 per surgical patient to hospitalization (16).

It is for these reasons therefore that, anesthesiologists need to be proactive in monitoring patients in cold operating rooms and use available technology to prevent gross disturbances in the core temperature. Prewarming patients reduces redistribution hypothermia and is an effective strategy for maintaining intraoperative normothermia. The identification of the most effective methods of warming will lead to improved patient comfort, decreased hemodynamic changes, and decreased length of stay in post anaesthesia care unit. There are several active and passive warming methods. Examples of passive include cotton blankets, heated surgical drapes, space blankets and increased temperature of operating room among others. The forced –air systems, heating blankets, circulating hot water mattresses and garments, and adjuvant measures(warmed intravenous and irrigation fluids) are the current active warming measures being used(17). The incidence of hypothermia remains high despite active warming of patients. A study done in Beijing by showed incidence of perioperative hypothermia to be 39.9%, of which 10.7% of patients were actively warmed (18). Heating intravenous fluids does not warm patients, but does prevent fluid-induced hypothermia in patients given large volumes of fluid. There are statistically significant thermal advantages to preoperative environmental warming. Core temperature is noted to drop within 30 to 60 minutes post induction, more so when epidural and general anaesthesia is combined. Therefore making it important to pre warm the patient and the environment prior to induction (19). The effect of anaesthesia in reduction of temperature is shown even in procedures like MRI were an incidence of 81.1% was recorded despite literature suggesting that there is an increase in temperature due to adsorption of radiofrequency radiation (20).

2.4 Monitoring

In view of the above, monitoring of body temperature in the perioperative period is essential. It may be measured in the body core sites or at more easily accessible peripheral sites in which temperature values are close to the core temperature. Body temperatures can be measured using a variety of thermometers; most clinically used thermometers are reasonably accurate. The most accurate site to depict body core temperature is measurement from the pulmonary artery using a thermistor catheter and this is said to the gold standard measure of core temperature. However, its use is limited because of its invasiveness. These catheters can also be placed in oesophagus and nasopharynx, and if placed properly can measure core temperature but these sites are affected by use of humidified gases during general anaesthesia and are not well tolerated if patients are awake. Tympanic membrane is now commonly used to measure core temperature because of its proximity to carotid artery and non-invasiveness but gives the risk of membrane perforation if not placed properly. Urinary bladder is also used for core temperature measurements provided there is high urine flow (21, 22).

Axillary temperature remains the most commonly used and convenient site for monitoring temperature. However the axillary site is unreliable because the probes are often misplaced within the axilla leading to erroneous temperature measurements depending on the environment. A study done by Charles J et al (2009) demonstrated that the axillary site may be accurate for core body temperature estimation if the probe is placed close to the axillary artery while maintain the arm in tight adduction.

Rectal site is easily accessed and associated with minimal morbidity, however measurements may be affected when the probe becomes embedded in feaces or exposed to cool venous blood return from the legs or if readings become influenced by the proximity of the probe to open abdominal cavity during laparotomies or bladder while its irrigation with either cold or warm fluids (23, 24). Fewer disturbances of the child's physiologic processes will result if temperature is constantly monitored. The same vigilance must be exercised in the post anaesthetic period. A showed a reduction in the incidence of perioperative hypothermia 8.9% to 4.2% after implementation of standardized temperature management bundle in operating theatre. This included warming of room temperature above 23C, use of forced warming devices and covering of patients as much as possible (25).

The practice of anaesthesia in sub-Saharan Africa is characterized by a shortage of qualified personnel to provide anaesthesia, drugs, and monitoring equipment, high morbidity and mortality rates, which are aggravated by the delay in patients' access to health care (26). In children, the problem is further compounded by a lack of adequate infrastructure, morbidity and mortality rates are high from common diseases such as congenital neonatal anomalies and typhoid with bowel perforation and peritonitis in older children (27, 28, 29).

On average, about 2000 patients are attended to in the peadiatric theatre. In the year 2012, 1889 patients underwent surgical procedures in the peadiatric operating theatre (un-published data). The bulk of the procedures fall under general surgery, followed by neurosurgery, plastic surgery, and ear-nose-throat (ENT) surgery. Others include urology, maxillofacial surgery, ophthalmology and orthopedic surgery. 1795 of these cases were done under general anaesthesia, the rest (95) using local anaesthetic (30).

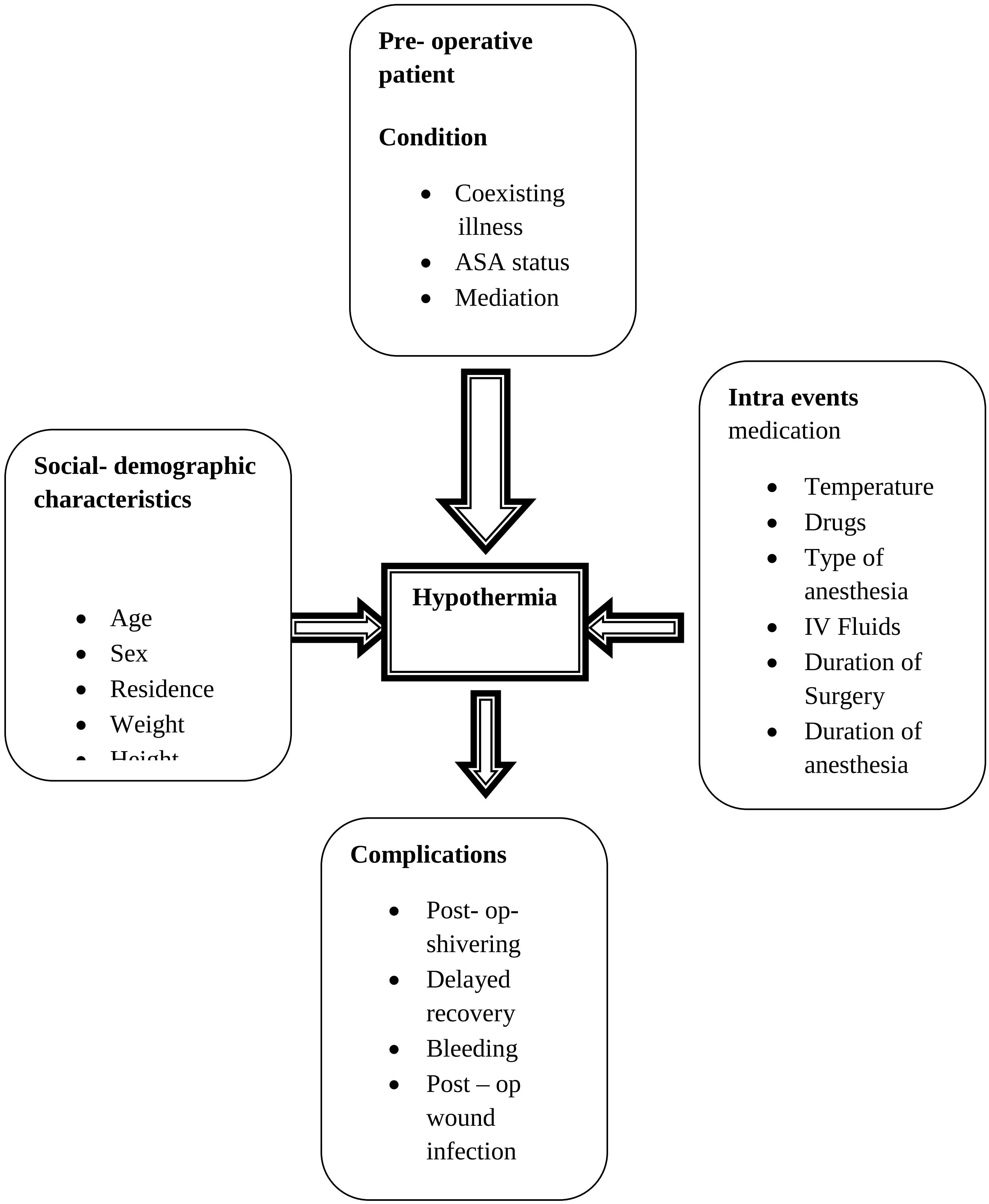

Figure 1 Conceptual frame work

Several peroperative and intra operative factors lead to hypothermia which further complicates to multiple adverse out comes as above.

CHAPTER THREE

METHODLOGY

3.1. Study Design

This was a cross sectional study carried out in peadiatric patients who underwent surgery.

3.2.Study Area + Period

This study was conducted from June to august 2016. It was conducted in the paediatric theatres (D-block) at the university teaching hospital in Lusaka, Zambia. There are 3 theatres and surgeries conducted include general surgeries, ENT, neurology and plastic surgeries.

3.3. Study population

This included all patients who met the inclusion criteria undergoing elective surgery in the pediatric theaters at the University of Zambia.

3.4.Sampling

Sampling strategy: Convenience (or opportunity) sampling was used. This means patients were recruited based on them being scheduled for operation and met inclusion criteria.

3.5Sample size

Using the Survey Systems software, a sample size of 245 was calculated as follows:- Sample Size (n) = $(z)^2(pq)/d^2$

Where p=estimated incidence in decimal(0.80)

d^2=confidence interval expressed in decimal (0.05).

q =1-p.

Thus (n) = $(1.96)^2 \times 0.8 (1 - 0.8) / (0.05)^2$ = 245

3.6. Inclusion criteria

Children aged between 0 to 14 years and consented.

3.7. Exclusion criteria

Children with fever and temperatures of higher than 38C.

Children with thermoregulatory abnormality e.g. malignant hyperthermia children. Children with epistaxis, nasopharyngeal masses.

3.8. Variables

3.8.1 **Dependent**

Perioperative hypothermia defined as temperature <360C at any time during anaesthesia.

3.8.2 **Independent**

- Socio demographic + pre-operative clinical condition- Age, Sex, Weight, Co-existing diseases, ASA status, and pre-operative temperature.
- Intraoperative related factors—type of surgery, type of anaesthesia, operating room temperature, amount of intravenous fluids given, blood transfusion duration of anaesthesia, duration of surgery.

3.9 Data collection tools

A questioner was filled in by trained data collectors pre- operatively and temperatures were recorded by anaesthesiologist attending to the patient.

3.10. Body temperature measurement

Preoperative temperature was obtained using the axillary temperature. To obtain the reading, axillary artery was palpated and thermometer placed over it. Intraoperatively core body temperature was measured using a nasopharyngeal probe (Re usable 400 series M1025683 with an accuracy of +/- 0.1C in the range 0C- 50C). Distance was measured using patients tip of the nose to the tragus of the ear. Temperaturereading were done every 15min. Post operatively temperatures were done using axillary temperatures until the patient left theater for the ward. Different sites of measuring temperature were used because nasopharyngeal probes are not well tolerated in awake patients.

3.11. Data analysis

Data was entered on an excel spreadsheet then exported to SPSS version 23 for analysis. Tables and figures were used for descriptive results. Logistic regression was used to test risk factors. Different times were evaluated by repeated measures analysis of variable test and Bonferroni post hoc test were used when a significant difference was obtained. A p-value < 0.05 at confidence interval of 95% was considered statistically significant.

3.12. Ethical considerations

After approved from the hospital administration ethical clearance was done by Excellence in research Ethics and Science (ERES). Contest was obtained from patients and guardians of the participants. The patients that were old enough to understand, the procedure was explained.

CHAPTER FOUR

RESULTS

4.1. Socio-Demographic characteristics and pre-operative clinical condition of the patients.

Two hundred and forty five (245) patients were enrolled for the study but only two hundred and twenty (220) participated. Reasons for those who did not participate include cancellation of surgery due to lack of time, patient found to have uninvestigated condition (e.g. cardiac disease) and not having adequate investigation for the procedure. The average age was 4.2 years (SD=3.8) with the youngest being one week old while the oldest being 14 years.

Table1 Preoperative characteristics

VARIABLE	CATEGORY	FREQUENCY	PERCENTAGE
AGE	0-30DAYS	8	3.6
	1-12MTHS	38	17.3
	1-2YRS	50	22.7
	3-5YRS	39	17.7
	(6-11YRS	60	27.3
	12-14YRS	25	11.4
	TOTAL	220	100
SEX	MALE	134	60.98
	FEMALE	86	39.1
	TOTAL	220	100
WEIGHT	<11KG	63	28.6
	11-20KG	99	45.0
	21-30KG	41	18.6
	>30KG	17	7.8
	TOTAL	220	100
ASA	I	101	45.9
	II	80	36.4
	III	32	14.5
	IV	7	3.2
	TOTAL	220	100

Intraoperative events of patients

Most of the patients 79.1 %(n=174) had received inhalational anaesthetic for induction whilst 16.8 %(n=37) had combination of propofol + inhalation and only 4.1 %(n=9) had IV induction only.74.1 %(n=163) of the patients received general anaesthesia while 25.9 %(n=57) had combination with regional (caudal block)

Table2 illustrates intraoperative events of pediatric patients who underwent surgery at the university teaching hospital from June - August 2016.

VARIABLE	CATEGORY	FREQUENCY	PERCENTAGE
INDUCTION AGENT	INHALATIONAL	174	79.1
	PROPOFOL, INHALATIONAL	37	16.8
	PROPOFOL	9	4.1
	TOTAL	220	100
CAUDAL BLOCK	YES	57	25.9
	NO	163	74.1
	TOTAL	220	100
DURATION OF ANAESTHESIA	<60MIN	124	56.4
	61-120MIN	74	33.6
	121-180MIN	16	7.3
	>180	6	2.7
	TOTAL	220	100
DURATION OF SURGERY	<60MIN	169	76.8
	61-120MIN	37	16.8
	121-180MIN	10	4.6
	>180MIN	4	1.8
	TOTAL	220	100
TEMPERATURE OF IV FLUIDS	ROOM TEMPERATURE	132	60
	WARMED	59	26.8
	NOT GIVEN	29	13.2
	TOTAL	220	100
OR TEMPERATURE	$<22^0$ C	43	19.5
	$22\text{-}25^0$ C	148	67.3
	>25	29	13.2
	TOTAL	220	

The mean duration of anaesthesia was 1hour 8minutes (38min-5hours). Of those who received IV fluids, the mean was 10.70ml/kg with only 26.8% receiving warmed fluids. 15 patients received blood transfusion with a mean of 17.05ml/kg given.

The majority of the cases done where inguinal/perianal 41%, laparotomy 22% ear/nose/throat procedures 17%, neurology 10% plastic procedures 6% and 4% for other case. The procedures were divided into 2 surgical categories (table 3).

Table 3 Illustrates categories of procedures done in paediatric patients undergoing surgery at the university Teaching Hospital from June – August

	FREQUENCY	PERCENT
MAJOR	144	65.5
MINOR	76	34.5
TOTAL	**220**	**100.0**

4.2. INCIDENCE OF HYPOTHERMIA

The overall incidence of core hypothermia was found to be 88.6% (figure 1).The trend of temperature under anaesthesia was measured at different time intervals and showed that patients became hypothermic from 30min post induction and incidence increased with progressive exposure to anaesthesia. All cases done for longer than 2 hours were hypothermic (figures 2 and 3).

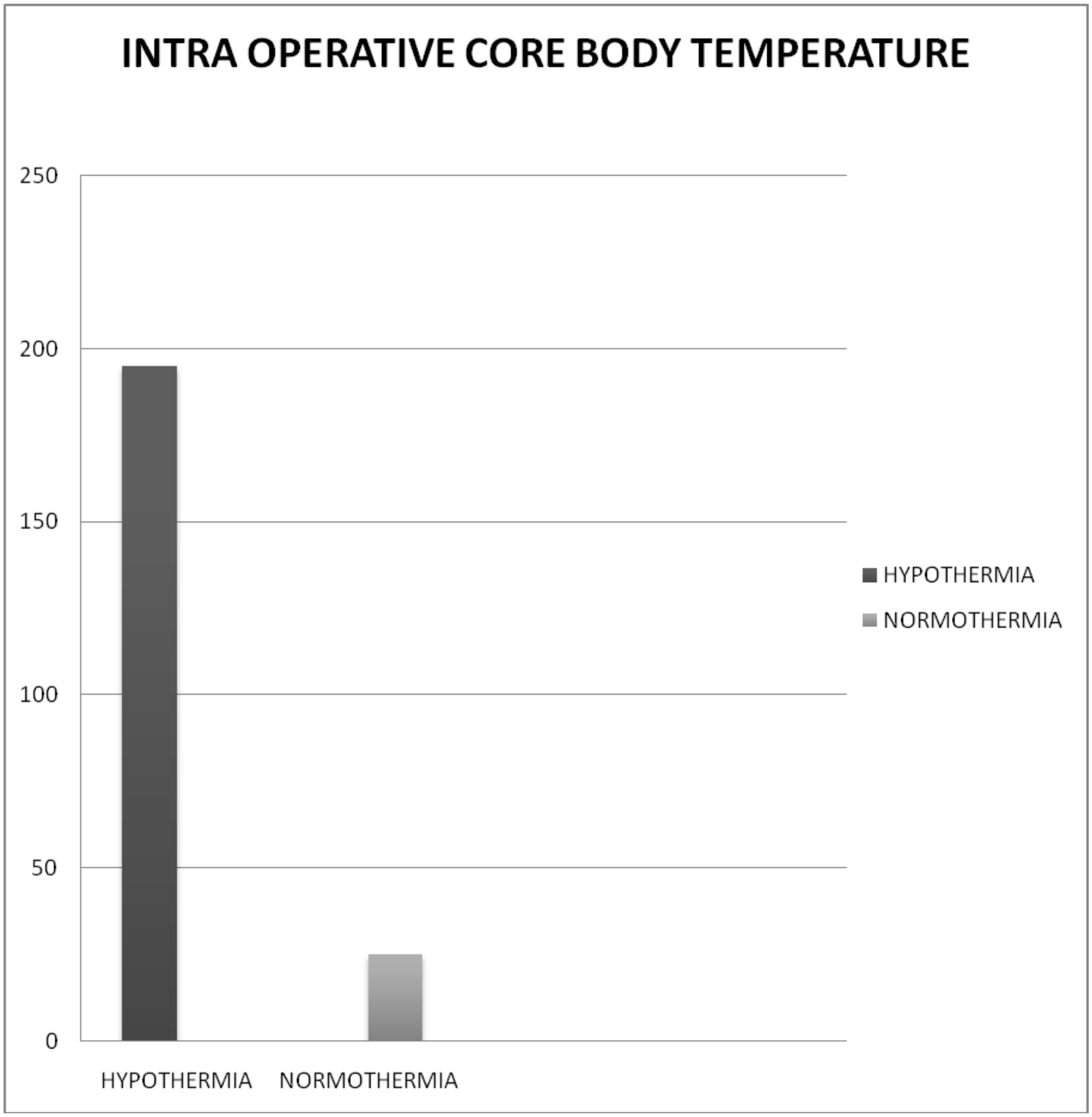

Figure 2 shows the average intraoperative body core temperature distribution

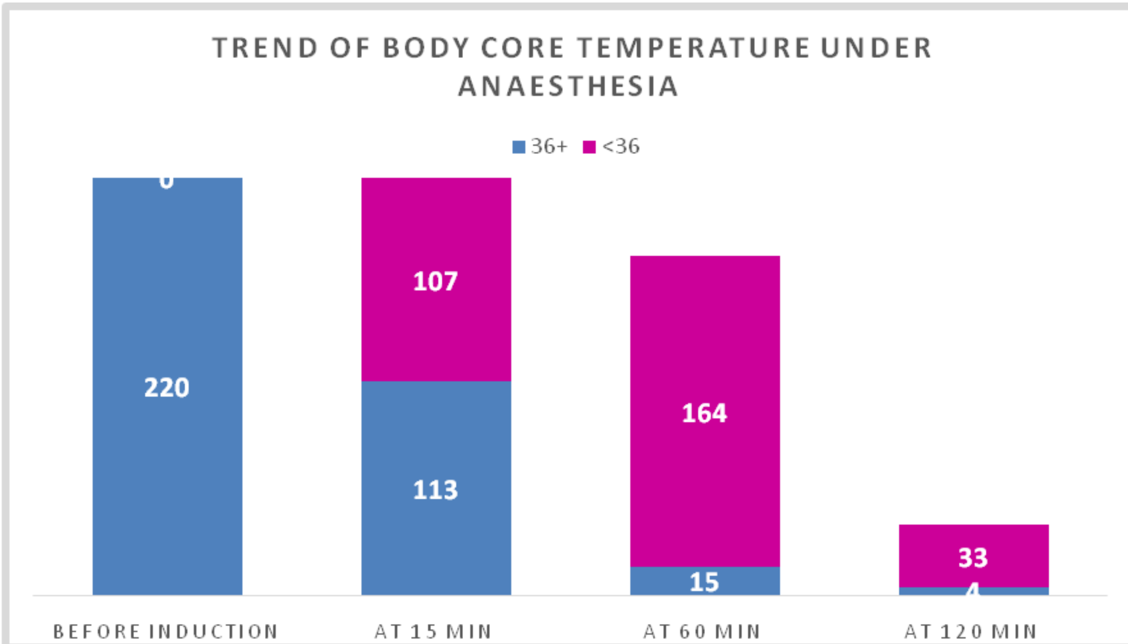

Figure3 Trend of body core temperature under anaesthesia

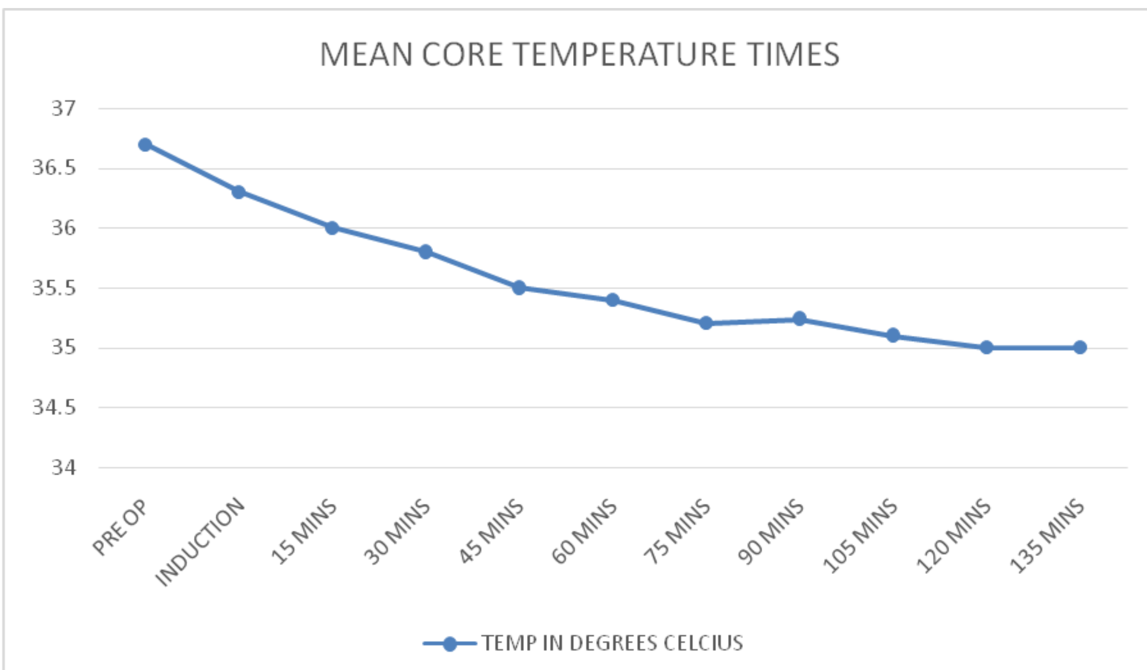

Figure 4 Mean core temperature under general anaesthesia a repeated measures ANOVA with a Greenhouse- Geisser correction determined that mean temperatures core times differed statistically significantly between time points (f[1.949,52.611] = 196.782, P<0.001). Post hoc

test using the Bonferroni correction revealed that there were significant reductions in temperature from induction to 2hours post induction.

4.3. Risk factors

The significant variables were entered in a binary logistic regression model using hypothermia as a dependent variable and the four independent predictors were found (table 4).

Table 4 Independent predictors of core hypothermia

PREDICTORS	Odds Ratio	95% CI of OR	P
PRE OP AXILLARY (°C)	0.12	0.002 - 0.077	0.001
TIME OF ANAESTHESIA (hrs)	1.045	1.027 - 1.068	0.001
MINIMUM OR TEMP (°C)	0.668	0.484 - 0.922	0.014
IV FLUIDS UNWARMED (10ml/kg)	1.9991	1.260 - 3.146	0.003

The odds ratio of a 1°c positive difference at induction was 0.12 and the inverse is that a 1°c negative difference in body temperature at induction (e.g. 35°c as opposed to 36°c) was predictive of a tenfold increase of developing hypothermia.

Patients receiving 10mls/kg of un warmed fluids were 2 times likely to become hypothermic than those not receiving. The volume of IV fluids infused showed a positive correlation to length of anaesthesia (p= 0.001), type of surgery (p=0.014) and operating room temperature (p=0.014).This constellation of factors taken together with total volume of IV fluids infused may therefore be more predictive of hypothermia. There was no significant difference between the two groups as to the ASA status, caudal block, weight and blood transfused (p=0.269, p=0.143, p=0.162 and p=0.928 respectively).

A Chi Square test was conducted to establish whether there was an association between procedure and hypothermia, at a significance level of 0.05. The results are presented in the table below. These results indicate that patients who had major procedure were more likely to be hypothermic than patients who had minor procedure.

Table 5 Chi-Square Tests results on procedure vs. hypothermia

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability
Pearson Chi-Square	7.403[a]	2	.025	.025		
Likelihood Ratio	9.106	2	.011	.015		
Fisher's Exact Test	8.414			.014		
Linear-by-Linear Association	4.908[b]	1	.027	.033	.020	.011
N of Valid Cases	220					

a) Cells (16.7%) have expected count less than 5. The minimum expected count is 4.66.

b) The standardized statistic is 2.215.

CHAPTER FIVE

DISCUSSION

5.1. Incidence

This study found that 88.1% of the pediatric patients undergoing general anaesthesia at the University teaching hospital were hypothermic. This incidence was higher than reported by P.M. Kioko et al in Kenya of 30%. This could be that despite having the same tropical settings, they did warming methods like warming mattress and cotton wool wrapping which were not done in this study.

The incidence of hypothermia after induction was found to be 48.6% as compared to 72.2% reported by M. Mossie et al in Ethiopia. This could be attributed to temperature variations in geographical area and intraoperative clothing style of patients. However the incidence was reported to be decreasing with time in their study as compared to this study where patients become more hypothermia with increasing time of anaesthesia. This can be attributed to lack of warming devices intraoperative in this study.

This study differed in the ASA status of patients with a higher number in those ASA III as14.5% and ASA IV being 3.2% as compared to 2% and 1% reported by P.kioko et al and1.1% reported by M. Mossie et al respectively. These are high risk group of patients who have been shown to be predisposed to hypothermia. Similar to these studies is that ASA status was found not to be a predictor of hypothermia. This could be due to the small representation of patients in the studies.

5.2. Risk factors

This study showed longer duration under anaesthesia, low operating room temperature , low pre-operative body temperature, large volume of unwarmed IV fluids and major surgery as independent predictors of core hypothermia which is in keeping with risk factors reported in other literature(3,6,7). However this study did not report caudal block (p= 0.071) as a risk factor as reported in literature and studies like that done by P .kioko et al (p=0.036).This perhaps, could due to the small sample size of combined aneasthesia (57 patients).

The most significant predictors of core hypothermia in this study was found to be pre op temperature and duration under anaesthesia which is in keeping with the study in Kenya which showed pre op temperature to be significant however did not show duration under anaesthesia as the risk factor. Things like patient covering/dressing, ward temperature, duration of waiting before induction, could contribute to pre op temperature whilst lack of humidified inspired gasses, irrigation of cold fluids could contribute to hypothermia in relation to duration however this study was not designed to exhaustively explore factors contributing to body temperature at induction.

Lower OR temperature was found to be significant (p=0.014, AOR 0.668 CI 0.484-0.922) in agreement with other studies done like M.Mossie(p=0.002, AOR 0.011 CI 0.001-0.145) and have shown that patients become hypothermic when operated in cold theatres and are not actively warmed. Perioperative core temperatures are modulated by changes in the internal distribution of body heat and by systemic heat balance which is largely determined by ambient exposure including the effects of passive insulation and active warming.

Total volume of IV fluids infused was found to be significant(p=0.003,AOR 1.999 CI 1.260-3.146) which is similar to the study done in Kenya(p=0.004,AOR 1.005,CI 1.00-1.01).However differed in that this study also showed that temperature of IV fluids infused was also a predictive factor as more received fluids at room temperature. This study had no in-line fluid warmers used and warmed fluids were considered to be those obtained from immersing the IV fluids in hot water which could allow heat dissipation via radiation during slow rate infusion hence failing to show the advantage conferred to warming fluids.

Major surgery (p= 0.014) was also found to be a risk factor which is similar to what was found in the study done in china (p=0.002). This was related to increased time under anaesthesia, prolonged exposure to cold operating room and increased loss of heat through radiation from the surgical site. It is therefore important to ensure that patients planned for major surgery are monitored and preventive measures of hypothermia are taken.

Zambia is a low income country with an average income of < $1000 per month. The impact of hypothermia therefore will be huge on the hospital as well as the relatives of the patients if not prevented. As shown in literature, that patients are predisposed to adverse outcomes which include delayed wound healing and infection culminating in prolonged hospitalization. A high incidence as observed in this study shows that patients are likely to be affected with one of these outcomes hence increasing the costs of managing the patients. It is therefore important that preventive measures are practiced and extra care to peadiatric patients is done to lessen the burden of hypothermia.

CHAPTER SIX

CONCLUSION

6.1 Conclusion

In conclusion, this study revealed a high incidence of preoperative hypothermia in children undergoing elective surgery at the university teaching hospital in Lusaka. This predispose children to effects of hypothermia like increased blood loss and requirements for blood products, post-operative shivering, delayed wound healing and infection which in turn will lead to long stay in hospital and increased costs for both hospital and guardian. These and many other complications of hypothermia make it mandatory to monitor the patient's core temperature under anaesthesia. Preoperative body temperature, longer duration under anaesthesia, unwarmed IV fluids, major surgery and low OR temperature were significant independent predictors of hypothermia.

6.2 Study Limitation

i. The study did not include emergency cases, less ASA IV, few cases of skin exposure. These high risk sub group may have been under represented.

ii. The study was not designed to measure the humidity of OR temperature and inspired gasses, and plasma drug concentration of anaesthetic agents which may also be predictors of hypothermia.

iii. No humidification of inspired gases e.g. HME was done due to lack of equipment. This could have contributed to the high incidence observed.

iv. The study was conducted during the coldest months and this may have increased the incidence of hypothermia recorded.

6.3 Recommendations

Based on the findings of the study the following recommendations are made:

I) All pediatric patients should have temperature monitored if surgery is lasting more than 30min.

ii) Prevent/minimize hypothermia by:

- Keeping patients warm preoperatively through adequate clothing and warming waiting rooms.
- Passive warming during surgery.
- Operating temperature to be between 23-25^{0}c.

iii) To equip operating rooms with forced-air warming systems.

iv) Further research on magnitude of complications of hypothermia.

REFERENCES

1. Burger L, Fitzpatrick J, (2009), Prevention of inadvent perioperative hypothermia: Br J Nurs18:1114, 1116-1119.

2. Insler SR, Sessler DI. (2008) Perioperative Thermoregulation and Temperature Monitoring. Anesthesiology Clin; 109: 318-338.

3. RajapopalaS,Macha E, Na J, Sessler D I (2008);The effects of mild perioperative hypothermia on blood loss and transfusion.anesthesiology 108:71-77.

4. NICE;(2003),The use of Perioperative test for elective surgery-evidence,methods and guidance

5. Lokossou Th, Zoumenou E, Secka G et al; Anaesthesia in French- speaking Sub-Saharan Africa: An overview. Acta Anaesthesiol Belg 2007; 58: 197-209.

6. Burns SM,Wojnakowsiki M,Piotrowski K,Caraffa G.Unintended Hypothermia:Implications for perianaesthesia Nurses.J perianasthesia Nurs.2009; 24:167-76.

7. Kurz A.Thermal care in the perioperative period. Best practice Res Clin 2008; 22:39-62.

8. Bridget Pearce,Robert Christen,Terri Voepel-Lewis (2010);Perioperative hypothermia in peadiatric population,prevalence,risk factors and outcomes.Journal of anaesthesia and clinical practice.

9. Hooper V,Robin Child T,Clifford:Evidence-based Clinical Practice,Guidelines for promotion of perioperative normothermia 2010 Journal of perianasthesia nursing

10. Cassey JG, King RA, Armstrong P. is there thermal benefit from perioperative warming in children? Paeditric Anaesthesia 2010; 20: 63-71.

11. Paul M Kioko (2015); Incidence and risk factors for intraoperative hypothermia in paediatric undergoing general anaesthesia at Kenyatta hospital, Nairobi.

12. Noriyoshi T,Yoko O,Megumi H,Mai U,Kenji I.High Preoperative anxiety level and risk of intraoperative Hypothermia;int journal of clinical medical,2012,3,461-468.

13. Tander B, Baris S, Karakaya D et al. Risk factors influencing inadvertent hypothermia in infants and neonates during anaesthesia; 2005; 15: 574-579.

14. FrankSM,Fleisher L.A,Breslaw MJ et al,Perioperative Maintenanceof normothermia to reduce the incidence of morbid cardiac events;A randomized clinical trial JAMA,277:1997 pg 1127-1134.

15. Kurz A,Sessler DL,Lenhardt PA;Perioperative Normothermia to reduce incidence of surgical wound infection and shorten hospitalization.A study of wound infection and temperature Group N.Engl Med 344:1996 pg 1209-1215.

16. Wicks T.C;Perioperative hypothermia<Take our patient warming quiz.Out patient surgery magazine,Herrin Publishing Partners lp Vol 3 April 2006 pg 36-43.

17. Shorrab AA, El-Sawy ME, Othman MM, Hammouda GE. Prevention of hypothermia in children under combined epidural and general anaesthesia: A comparison between upper and lower body warming. Paediatric Anaesthesiology 2007; 17: 38-43.

18. Jie Yi,Ziyong Xiang,Xiaoming Deng et al (2015) Incidence of In advent intraoperative hypothermia and its risk factors in patients undergoing general anaesthesia in Baijing.A retrospective regional survey.

19. Carolyn Griffith et al,Patient temperature during GA for peadiatric MRI,2014,John Radclifle hospital,UK.

20. Ezri T, Szmuk P, Weisenberg M, Serour F, Gorenstein A, Sessler DI. The effect of hydration on core temperature in paediatric surgical patients. Anaesthesiology 2003; 98: 838-841.

21. Bisonette B. Temperature monitoring in paediatric anaesthesia. Int Anaesthesiol Clin. 1992; 30: 63-76.

22. North WC. Control of body temperature in the paediatric patient. North Carolina Medical Journal 1961; 59-63.

23. Westman HR. Postoperative complications and unanticipated hospital admissions. Semin Paediatr Surg 1999; 8: 23-29.

24. Monrigal JP, Granry JC. The benefits of using heat and moisture exchanger during short operations in young children. Paeditric Anaesthesia 1997; 7: 295-300.

25. Kim p,BS Thomas,Taghan et al.Perioperative Hypothermia I the Peadiatric Population;A quality improvement projectm2013,American journal of medicine quality 28(5) 400-406.

26. Clinical Practice Guidelines. The Management of Inadvertent Perioperative Hypothermia in Adults. April, 2008. 94-126.

27. Murat I, Berni AJ, Constant I. Evaluation of the efficacy of a forced air warmer (Bair Hugger) during spinal surgery in children. J Clin Anaesth 1994; 6: 425-429.

28. World Alliance for Safety. WHO Guidelines for Safe Surgery (1st Edition), 2008.

29. Galante D. 2007. Intraoperative hypothermia. Relation between general and regional anaesthesia, upper and lower body warming: What strategies in paediatric anaesthesia 17, 821-823.

30. Clare C et al,2012:An audit on how many patients were done in the peadiatric theater and the bulk of procedures. (Un published data).

31. Bosenberg AT. Paediatric Anaesthesia in developing countries; Curr Opin Anaesthesiol 2007; 20: 204-210.

32. Hodges SC, Walker IA, Bosenberg AT. Anaesthesia in developing countries. Anaesthesia 2007; 62: 26-31.

33. Zoumenou E, Gbenou S, Assouto P, Aboudoul-Fatuou O, et al. Paediatric Anaesthesia in developing countries: Experience in the two main university hospitals of Benin, West Africa. Paediatric Anaesthesia 2010; 20: 741-747.

34. Diaz M. Hypothermia and temperature regulation, considerations during anaesthesia. 2-12.

35. Lenhardt R. Monitoring and thermal management. Best Practice and Research Clinical Anaesthesiology, 2003. 569-5.

APPENDICES

APPENDIX I

I. INFORMATION SHEET

INTRODUCTION: My names are “Chomba Jullien “,Iam a Medical Officer undertaking post graduate studies/training of masters of Medicine in Anesthesia and Critical Care.

PROCEDURE: Hypothermia will be investigated by taking temperatures from the axilla and nasopharynx (pushing a nasopharyngeal probe) before, during and after the surgical procedure.

CONFIDENTIALITY: Will be maintained by not capturing the names of the participant’s name and address on date collecting sheets.

RISKS: Minimal nasal bleeding may occurs and will be controlled by the attending doctor. In an event that uncontrolled bleeding happens, ENT specialties will be notified to take up management.

BENEFITS:

1. To provide data that will support the importance of temperature monitoring during and after surgery.
2. To provide recommendations for management of preoperative hypothermia in children.
3. To provide platform as basis for teaching students the importance of preventing preoperative hypothermia and subsequent adverse effects.

PARTICIPATION: Will be voluntary and consent will be sort. For older participants assent will be done.

RIGHT TO WITHDRAW/SEEK CLARIFICATION: At any time during the study.

PROVISION FOR STANDARD OF CARE: All participants will be attended to and cared for even when they withdraw from the study.

INVESTIGATIOR’S DETAILS: Chomba Jullien; University Teaching Hospital, Department of anaesthesia, P.O Box 50110, LUSAKA. Phone numbers 0977507526/0966026550.

ERES CONVERGE IRB CONTACT DETAILS:

33 Joseph Mwila Road

, Rhodes Park,

Lusaka. Zambia.

Tel: 260-955155633/4Email:eresconverge@yahoo.co.uk.

APPENDIX II

CONSENT FORM

Dear Parent/Guardian,

Iam a postgraduate student in the department of anaesthesia at UTH, conducting a research on Perioperative hypothermia in children undergoing surgery.

The study consists of taking temperatures during operation from the nose and armpit. This will be done by nurses and doctors attending to your child in theatre.

Passing of the probe in the nose may cause minor injury and if this happens the attending team will manage the problem. Your child will benefit by having an additional monitoring during the operation.

Participation in this study is voluntary. Your decision whether or not to allow your child to be part of the study will not affect the services normally provided by the staff of the hospital or lead to the loss of any benefits to which he/she is otherwise entitled. Even if you give consent your child is free to refuse to participate.

Any information obtained in connection with this study will remain confidential. We will not be taking names of the participants.

Should you have any questions or desire further information please call me on 0977507526.

Please fill the form below to indicate that you have granted permission for your child to be part of the study.

I………………………………………………………………………………………… …………(parent/ guardian) agree for the said temperature recording to be carried out on my child, after the procedure has been explained to me in full.

I understand that an assurance has not been given that the procedure will be performed by a particular individual.

Signature of parent/ guardian……………………………………………….………………..

Signature of witness………………………………………………………………….

Thumb print:

APPENDIX III

ASSENT FORM

My name is DR Chomba J from UTH, Lusaka.

We are asking you to take part in the study in which we are learning more about how the persons temperature of a person is affected when they are put to sleep(general anaesthesia)during surgery.

If you agree to be part of the study, your temperature will be measured from your armpit and the nose. We expect minimal risk if any like bleeding from the nose and if it occurs the doctors with you in theatre will take care of you.

Your parents have given permission that you be part of the study and even if they have said yes you can still decide not to do and no one will be upset.

You can ask any questions that you have about what we will be doing. If you have any questions later you can still ask.

Your doctors will continue taking care of you even if you don't take part in the study.

Signing below will mean you agree to take part in the study.

Name of participant

………………………………………………………………………………………

Thumb print………………………..

APPENDIX IV DATA COLLECTION CHART

RESEARCHER: DR. CHOMBA JULLIEN CHILANDO
SUPERVISORS: DR. DYLAN BOULD
DR. FERUSA ISMAILOVA

Demographic details

Date		
Sex	Male	Female
Age		
Procedure		
Starting time of anaesthesia		
Starting time of surgery		
Finishing time surgery		

Anaesthesia related information.

Type of anaesthesia	GA	SA		RA	COMBINED	
ASA grade	I	II	III	IV	V	

Drugs used	IV	Gas	Infiltration
		(%)	
	Volume given	Warmed	Not warmed
IVF			
Blood products			

Temperature monitoring

	Pre op	Induction	15m	30m	45m	60m	75m	90 m	105 m	120 m
Axillary										
Naso pharyngeal										
Operating room										
Recovery room										

APPENDIX V

Tables showing complied results

Axillary mean temperatures					
	N	Minimum	Maximum	Mean	Std. Deviation
15m	220	35	37	35.98	.346
30m	220	35.0	37.2	35.805	.3708
45m	219	34.9	36.9	35.657	.3584
60m	211	34	37	35.51	.376
75m	174	34.2	36.8	35.371	.3759
90m	128	34.2	36.6	35.270	.3766
105m	76	35	36	35.23	.353
120m	46	34.6	35.8	35.139	.3505
135m	35	34.6	35.9	35.117	.3408
150m	28	35	36	35.15	.400
165m	22	34.5	35.7	35.068	.3372
180m	15	34.5	35.7	35.000	.3645
195m	10	34.4	35.3	34.810	.2685
210m	10	34.3	35.1	34.780	.2440
225m	4	34.2	34.9	34.700	.3367
240m	2	34.1	34.9	34.500	.5657
255m	2	34.1	35.0	34.550	.6364
270m	2	34	35	34.50	.707
285m	1	34.1	34.1	34.100	.
300m	1	34	34	34.00	.
315m	1	34	34	34.00	.

NASO mean temperatures					
	N	Minimum	Maximum	Mean	Std. Deviation
15m	220	35.3	37.3	35.997	.3496
30m	220	35	37	35.85	.375
45m	215	35.0	36.8	35.692	.3686
60m	179	34.8	36.7	35.519	.3569
75m	122	34.6	36.7	35.431	.3764
90m	65	34.7	36.4	35.286	.3307
105m	41	34.6	36.1	35.210	.3323
120m	34	34.6	36.0	35.176	.3491
135m	25	34.6	35.8	35.124	.3491
150m	18	34.5	35.8	35.044	.3666
165m	14	34	36	34.94	.403
180m	6	34.2	35.7	34.900	.5797
195m	4	34.2	35.6	34.850	.5972
210m	2	34.1	34.9	34.500	.5657
225m	2	34.1	34.9	34.500	.5657
240m	2	34	35	34.40	.566
255m	1	34	34	34.00	.
270m	1	33.9	33.9	33.900	.
285m	1	34	34	34.00	.
300m	1	34	34	34.00	.
315m	1	34	34	34.00	.

Theatre mean temperature monitoring					
	N	Minimum	Maximum	Mean	Std. Deviation
theatre 15m	215	21.0	30.0	23.377	1.3543
theatre 30m	213	21.0	27.0	23.329	1.2034
theatre 45m	195	21.0	30.0	23.349	1.4858
theatre 60m	179	21.0	30.0	23.547	1.6833
theatre 75m	122	21.0	30.0	23.598	1.7891
theatre 90m	69	22.0	26.0	23.246	1.1556
theatre 105m	29	22.0	25.0	23.034	1.1797
theatre 120m	18	22.0	30.0	24.333	2.8491
theatre 135m	4	22.0	30.0	24.000	4.0000
theatre 150m	2	25.0	30.0	27.500	3.5355

Theatre mean temperature monitoring					
	N	Minimum	Maximum	Mean	Std. Deviation
theatre 15m	215	21.0	30.0	23.377	1.3543
theatre 30m	213	21.0	27.0	23.329	1.2034
theatre 45m	195	21.0	30.0	23.349	1.4858
theatre 60m	179	21.0	30.0	23.547	1.6833
theatre 75m	122	21.0	30.0	23.598	1.7891
theatre 90m	69	22.0	26.0	23.246	1.1556
theatre 105m	29	22.0	25.0	23.034	1.1797
theatre 120m	18	22.0	30.0	24.333	2.8491
theatre 135m	4	22.0	30.0	24.000	4.0000
theatre 150m	2	25.0	30.0	27.500	3.5355