INTRAOPERATIVE THERMAL DYNAMICS

Dissertation submitted in part fulfillment of the requirement of the award of the degree of Master of Medicine in Anaesthesiology at the University of Nairobi

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Declaration

This dissertation is my own original work and has not, to my knowledge, been presented for any degree in any other university.

Dr. Joseph K. Lelo MBChB Date: 29th October 2007

This dissertation has been submitted for the review of the KNH Ethics and Research Committee with my approval as university supervisor.

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3. My colleagues and classmates for all their support

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Abbreviations

ASA	American Society of Anesthesiologists
ICU	Intensive Care Unit
GA	General Anaesthesia
KNH	Kenyatta National Hospital
O.R.	Operating room
RA	Regional Anaesthesia
Temp	Temperature

Summary

The role of anaesthesiologists is to maintain physiologic homeostasis during the perioperative period, a time when alteration in body temperature is common. Anesthetics create a state of poikilothermia in which body temperature tends to equilibrate with ambient temperature. Nearly all patients under general anaesthesia become hypothermic, typically by 1–3°C,[1] depending on the type and dose of anesthetic, amount of surgical exposure,[2,3] and ambient temperature.[2-4]

Body temperature should be managed in a similar fashion as the other vital signs, with efforts made to maintain normothermia.

An observational cross-sectional study was conducted at the Kenyatta National Hospital main theatre. In this study all patients over the age of 12 years undergoing general or regional anaesthesia for orthopaedic procedures had their core temperatures measured immediately pre-operatively, every 15 minutes intra-operatively and immediately post-operatively. Ambient temperature within the operating room was measured and recorded every 15 minutes intra-operatively. Amount of intravenous fluids and type of surgery were also recorded with the raw data being captured on a standard questionnaire.

Perioperative hypothermia was found to be a common occurrence particularly intraoperatively and postoperatively. Large amounts of intravenous fluids infused at room temperature were also found to negatively impact on patients' core temperatures. Relatively cool operating environments were found to also cause significant lowering of patients' core temperatures. 81% of patients in this study were found to be hypothermic in the immediate postoperative period but only 45% reported actually feeling cold while in the recovery room.

The operating theatre poses a thermal challenge to the body. In the theatre, patients are exposed to a cold environment with little protection while thermoregulatory responses are impaired by anaesthesia; consequently, hypothermia is a common occurrence during surgery. Therefore, the importance of intraoperative temperature monitoring and prevention of hypothermia has been increasingly recognized during the past few years. With prevention and management of hypothermia, patients also experience a greater level of comfort, and avoid postoperative shivering and the unpleasant sensation of feeling cold.

Maintaining normal body temperature in the perioperative period has a significant impact on clinical outcome. Different studies have related mild intraoperative hypothermia (core body temperature <36°C), with significant complications, some of which occur well after surgery. Hypothermia is associated with adverse clinical events, including myocardial ischemia[5], cardiac morbidity[6], coagulopathies[7,8], prolonged drug effect[9], wound infection[10], and patient discomfort[11].

Effects of Anaesthesia on Body Temperature

Hypothermia develops in a characteristic pattern under general anaesthesia.[13] Core temperature decreases 1–1.5°C during the first hour.[14] This initial hypothermia is followed by 2 or 3 h of a slower, linear, decrease in core temperature.[15]Finally, patients enter a plateau phase during which core temperature remains constant. Each segment of this typical hypothermia curve has a different cause.

The initial rapid reduction in core temperature after induction of anaesthesia results from an internal redistribution of body heat. Redistribution results because anesthetics inhibit the tonic vasoconstriction that normally maintains a large core-to-peripheral temperature gradient.[20-25] Core temperature then decreases linearly at a rate determined by the difference between heat loss and production. Another mechanism is by direct (peripheral) vasodilatation caused by anaesthetic agents[26] However, when surgical patients become sufficiently hypothermic, they again trigger thermoregulatory vasoconstriction, which restricts core-to-peripheral flow of heat. Constraint of metabolic heat, in turn, maintains a core temperature plateau (despite continued systemic heat loss) and eventually reestablishes the normal core-to-peripheral temperature gradient. Together, these mechanisms indicate that alterations in the distribution of body heat contribute more to changes in core temperature than to systemic heat imbalance in most patients.

Neuraxial anaesthesia

Just as with general anaesthesia, redistribution of body heat is the major initial cause of hypothermia in patients under spinal or epidural anaesthesia. Neuraxial anaesthesia inhibits thermoregulatory control centrally, [27-29] but a far more important effect of major conduction anaesthesia is blocking of peripheral sympathetic and motor nerves, which prevents thermoregulatory vasoconstriction and shivering.[30-32]

Redistribution during neuraxial anaesthesia is typically restricted to the legs. Consequently, redistribution decreases core temperature about half as much during major conduction anaesthesia.[16] As during general anaesthesia, core temperature subsequently decreases linearly at a rate determined by the inequality between heat loss and production. The major difference, however, is that the linear hypothermia phase is not

discontinued by reemergence of thermoregulatory vasoconstriction because constriction in the legs is blocked peripherally. As a result, in patients undergoing long operations with neuraxial anaesthesia, there is the potential of development of serious hypothermia.

Complications of hypothermia

Perioperative hypothermia is associated with numerous adverse outcomes.

Myocardial ischemia

Myocardial infarction remains one of the leading causes of perioperative mortality and major morbidity.[5]Frank *et al*[6] demonstrated that patients assigned to only 1.3^0 C core hypothermia were three times as likely to experience adverse myocardial outcomes. The mechanism by which mild hypothermia triggers myocardial events remains unclear. Cold-induced hypertension in the elderly is associated with a threefold increase in plasma norepinephrine concentrations,[33] which may augment cardiac irritability and facilitate development of ventricular arrhythmias. Hypothermia also causes hypertension in elderly patients and those at high risk of cardiac complications.[34]

Coagulopathy

Mild hypothermia increases blood loss.[35]Three general mechanisms contribute to temperature related coagulation disorders: platelet function, clotting factor enzyme function, and fibrinolytic activity. Platelet numbers remains normal during mild hypothermia. However, Valeri *et al.*[36] demonstrated that mild perioperative hypothermia seriously impaired platelet function. Inhibition was a strictly local phenomenon: bleeding time was comparably increased by systemic or local hypothermia. However, wound temperature is largely determined by core temperature and is higher in normothermic than hypothermic patients. Subsequent work indicated that the defect resulted from reduced release of thromboxane A2.[37-39] One feature of hypothermic coagulopathy is that

standard coagulation tests, including the prothrombin time and the partial thromboplastin times, remain normal.[40] The reason is that the tests are normally performed at 37°C, regardless of what the patient's temperature is. These same times are prolonged by hypothermia when they are performed at the patient's actual core temperature.[41,42] Other data suggests that hypothermia impairs clot formation rather than facilitating clot degeneration.[43]

Wound infection and healing

Wound infections are serious complications of anaesthesia and surgery. Hypothermia may facilitate perioperative wound infections in two ways. First, hypothermia triggers thermoregulatory vasoconstriction.[44,45] This significantly decreases subcutaneous oxygen tension in humans,[46] and the incidence of wound infections correlates with subcutaneous oxygen tension.[47]

Second, considerable evidence indicates that mild core hypothermia directly impairs immune function, including T-cell–mediated antibody production[48,49] and nonspecific oxidative bacterial killing by neutrophils.[50] Bacterial killing by neutrophils is reduced as temperature decreases from 41 to 26°C.[51,52] Decreased killing results, in part, because production of oxygen and nitroso free radicals is oxygen-dependent in the range of oxygen partial pressures found in wounds.[53,54] Thus, hypothermia may directly impair neutrophil function or impair it indirectly by triggering subcutaneous vasoconstriction and tissue hypoxia. Perioperative normothermia has been shown to reduce the incidence of surgical-wound infection and shorten hospitalization.[10]

Effect on pharmacodynamics and pharmacokinetics

Muscle relaxants.

The enzymes that moderate organ function and metabolize most drugs are highly temperature sensitive. Drug metabolism therefore is temperature-dependent and hypothermia markedly alters drug kinetics.

The duration of action of vecuronium is more than doubled in patients with a 2°C reduction in core temperature.[55] This duration of action of vecuronium exceeds that of pancuronium in a normothermic patient. This prolongation of vecuronium action results from a pharmacokinetic effect, as pharmacodynamics of muscle relaxants are essentially unchanged by mild hypothermia.[56] Atracurium duration is less temperature-dependent than vecuronium: a 3°C reduction in core temperature increases the duration of muscle relaxation only by 60%.[57] With both atracurium and vecuronium, the recovery index (time for 25–75% twitch recovery) remains normal during hypothermia. As might be expected from the other muscle relaxants, the duration of action of rocuronium is prolonged during hypothermic bypass.[58]

Volatile anaesthetics

The tissue solubility of volatile anesthetics increases with hypothermia. At a given steady state plasma partial pressure, body anesthetic content thus increases at subnormal temperatures. This does not alter anesthetic potency because potency is determined by partial pressure rather than anesthetic concentration. However, it may slow recovery from anaesthesia because larger amounts of anesthetic eventually need to be exhaled. Nonetheless, volatile anesthetic washout rates were comparable in a study that directly compared normothermic and hypothermic individuals.[59]

Intravenous anaesthetics

Hypothermia has been shown to cause increment in steady state concentrations of propofol[60] and fentanyl.[61]

Duration to recovery and thermal discomfort

Mild hypothermia (34-36^{0}C) significantly causes delay of discharge of adult patients from the postanaesthesia care unit. Interestingly, similar prolongation of recovery duration was not observed in infants and children.[62]

Hypothermia produces marked postoperative discomfort.[63] It is also likely that thermal discomfort is physiologically stressful, and contributes to observed increases in postoperative blood pressure, heart rate, and plasma catecholamine[34] concentrations.

Other consequences of perioperative hypothermia

Hypothermia is associated with mild hypokalemia,[64,65] but the clinical significance of this observation appears trivial. The cardiotoxicity of bupivacaine is markedly increased by mild hypothermia.[66]

Pulse oximeter function is usually well maintained even in vasoconstricted patients.[67] However, sufficient vasoconstriction (usually resulting from the combination of hypothermia and vascular volume depletion) can obliterate the oximeter signal.

Justification for the study

All health care providers are responsible for preventing hypothermia in the patient undergoing surgery. Published research has correlated significant adverse consequences such as impaired wound healing, adverse cardiac events, altered drug metabolism, and coagulopathies with unplanned perioperative hypothermia. With prevention and management of hypothermia, patients also experience a greater level of comfort, and avoid postoperative shivering and the unpleasant sensation of feeling cold.

Patient outcomes can be improved by promotion of aggressive thermal management.

No study has so far been done at KNH in reference to thermal management and neither does KNH have written guidelines for practical approaches to the prevention, care, and management of the adult surgical patient with unplanned perioperative hypothermia.

Orthopaedic procedures are common at KNH owing to large numbers of trauma cases in this country. These surgical procedures are associated with large exposed body surface areas, long durations and liberally administered intravenous fluids secondary to significant blood loss all of which have been associated with perioperative hypothermia[71]. Orthopaedic trauma patients are also less likely to have other comorbidities which may cause fever.

This study aims to elucidate perioperative hypothermia in patients undergoing orthopaedic surgery and to contribute information to the field of surgery and anaesthesia that will enhance perioperative care of patients in Kenyatta National Hospital.

MAIN OBJECTIVE

To identify the temperature fluctuations in patients undergoing orthopaedic procedures under regional and general anaesthesia.

Specific objectives

1. To determine the prevalence of perioperative hypothermia in patients undergoing regional and general anaesthesia for orthopaedic procedures.
2. To determine the effect of ambient operating room temperatures on patient core temperature.
3. To determine the effect of intravenous fluid administration on patient temperature.
4. To identify the presence of core hypothermia in the immediate post operative period.
5. To determine the incidence of thermal discomfort in the immediate post operative period.

METHODOLOGY

Study area

Kenyatta National Hospital main theatres.

Study population

Patients undergoing orthopaedic procedures under general and regional anaesthesia in KNH main theatres.

Study design

A prospective descriptive analytical study

Inclusion criteria

1. Patients above the age of 12 years scheduled for orthopaedic procedures under GA and/or RA.
2. Patients with pre-operative core temperature of not more than 37.5^0C.
3. Patients who provide informed consent or where patient's next of kin or guardian gives his.

Exclusion criteria

1. Lack of consent.
2. Patients under the age of 12 years.
3. Patients with fever pre-operatively (more than 37.5^0C core temperature).
4. Patients with altered consciousness.

Sample size

Data from previous results was used to calculate the sample size.[1] To obtain a 95% confidence interval using a precision of 5% the required sample size *n* is calculated using the formula:

$$n=\frac{(Z_{\alpha/2})^2(p)(1-p)}{d2}$$

Where

$Z\alpha/2$ is the critical value, the positive z value that is at the vertical boundary for the area of $\alpha/2$ in the right tail of the normal distribution.[70]

p is the prevalence

n is the sample size

d is the margin of error

A 95% degree confidence corresponds to $\alpha=0.05$. In the table of the standard normal distribution this corresponds to a z value of 1.96. The critical value is therefore 1.96. Using the formula, we calculate thus;

$$n=\frac{(Z_{\alpha/2})^2(p)(1-p)}{d2} = \frac{(1.96)^2\,(0.95)(0.05)}{(0.05)^2} = 72.9904$$

The sample size required is 73.

Data Collection

Collection of data began at the main theatre receiving area when the patient is received to await admission into the operating room. This was done by the principal investigator and two research assistants (qualified nurses) who were trained on proper use of the thermometers.

After consent was obtained from patients satisfying the inclusion criteria, readings of the patient's core and peripheral temperature were taken using a digital ear thermometer to measure the core temperature and a mercury thermometer to measure the peripheral temperature. The data collected at this was be entered into a questionnaire (Appendix 3). While in the operating room the patient's core and peripheral temperature was recorded every fifteen minutes and entered into the chart provided in the questionnaire. The ambient temperature of the operating room was recorded continuously using a maximum-minimum thermometer on the wall of the operating room and entered into the chart every fifteen minutes at the same time with the core and peripheral temperature.

The total amount of intravenous fluids given to the patient intraoperatively was calculated from the anaesthetic chart as filled by the primary anesthetist for the surgery. Post-operative hypothermia and thermal discomfort were assessed in the post-anaesthesia recovery room. Patient's core temperature was measured every 15 minutes and up to 45 minutes postoperatively and recorded in the chart provided in the questionnaire. Thermal discomfort was determined by presence of shivering in the patient and if the patient admitted to feeling cold up to 45 minutes postoperatively.

Data management, quality control and analysis

Data was keyed from the forms into statistical analysis software on a personal computer by the principal investigator on a daily basis. Data entry screens were designed with built in logic and range checks to provide quality control. Data inconsistencies and errors were noted at this point and cleaned. In order to maintain data security and patient confidentiality, the statistical software provided access control secured by a password. All data thus entered was backed up on a daily basis.

Data analysis was carried out using the statistical software mentioned above (EpiInfo 2000 © WHO). This was accomplished with the assistance of a statistician. Data is presented using histograms and pie charts.

Materials

Equipment used during the study included:

1. Digital Ear thermometer. (GentleTemp® 510 from OMRON HEALTHCARE U.K. Ltd)
2. Maximum-minimum alcohol thermometer
3. Thermistor

Ethical considerations

Temperature measurement is a routinely performed procedure in all hospitals that poses minimal risk to patients. Patients were not exposed unduly to cold and were treated with utmost human dignity. The study was carried out with informed consent from the patients or their legal guardian.

All information obtained was treated in strict confidence.

Approval was sought and granted from the KNH Ethical and Scientific Review Committee before commencement of the study.

RESULTS

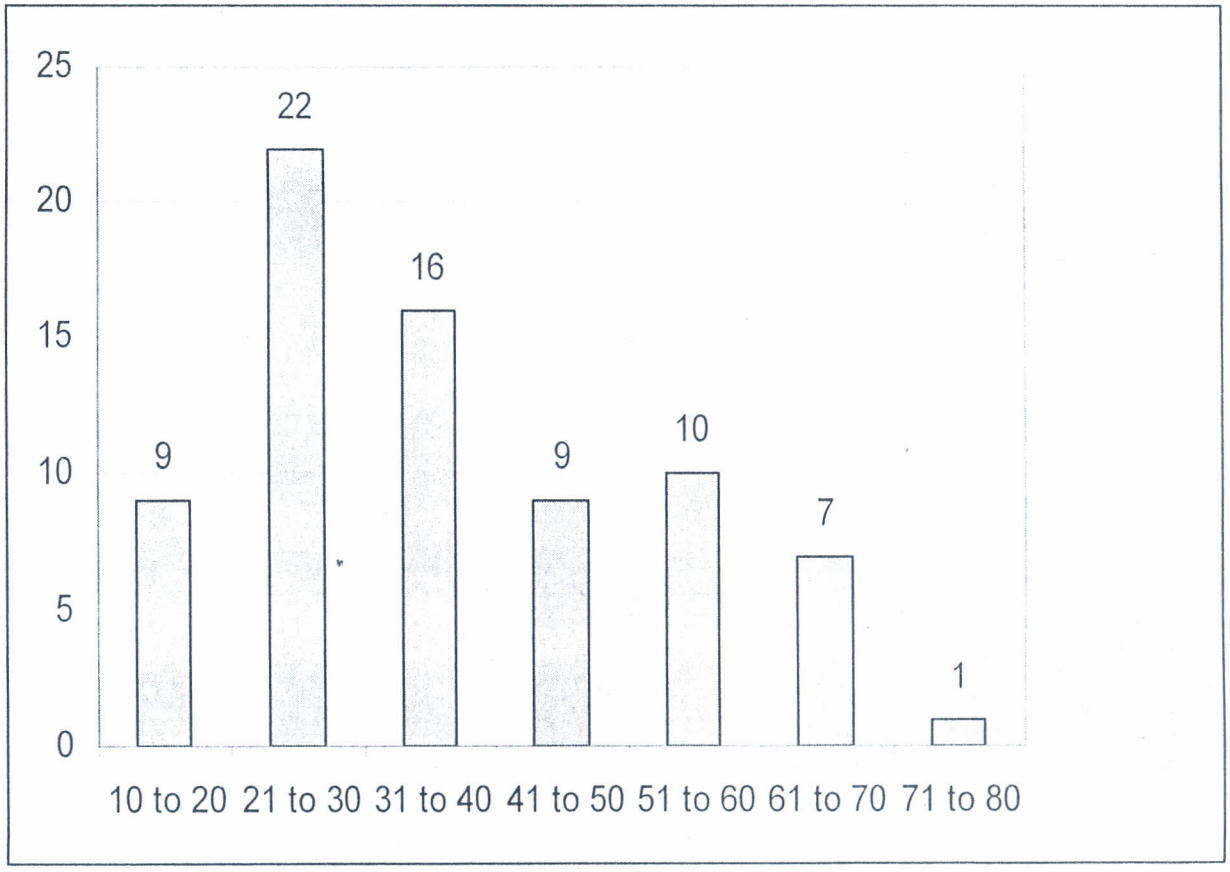
For the purposes of this study, 74 patients were recruited. Of these 27 were women and 47 were men. The average age of all patients in the study was 36.47 years (Standard Deviation 15.7 years).

The average age of the men was 37.02 years while that of women was 35.52 years. The median age of both sexes was 32.5 years.

The oldest patient was a woman aged 76 years while the youngest was a 13 year old male.

GRAPH 1:

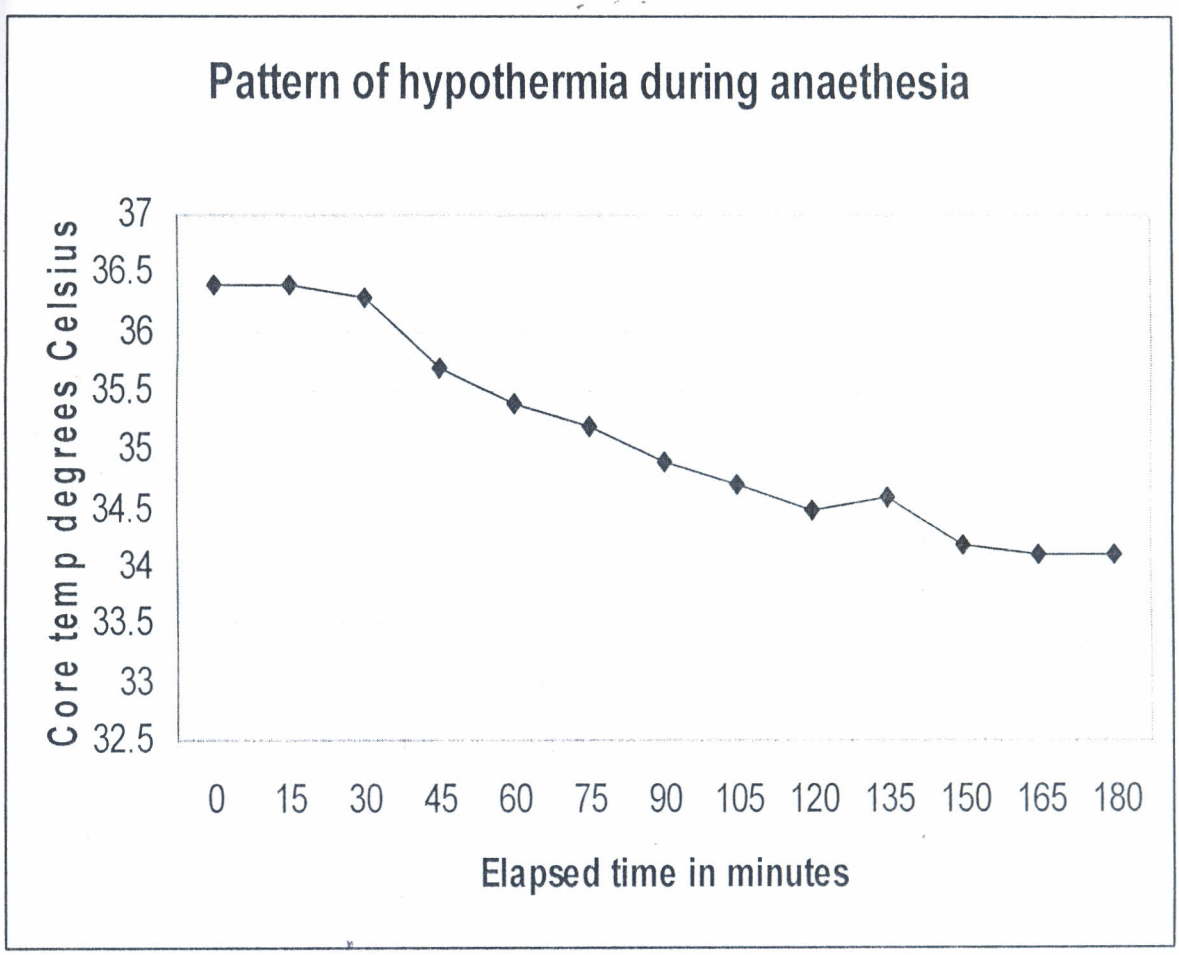
Graph showing number of patients versus age classes



Intra-operative core temperature changes

Hypothermia develops in a characteristic pattern. In the first 60 minutes, core temperature decreases by 1^0C. This is followed by a slower, linear decrease and finally a plateau after 2.5 hours after which it does not decrease further. The average temperature drop was noted to be 2.5^0C.

Graph 5:

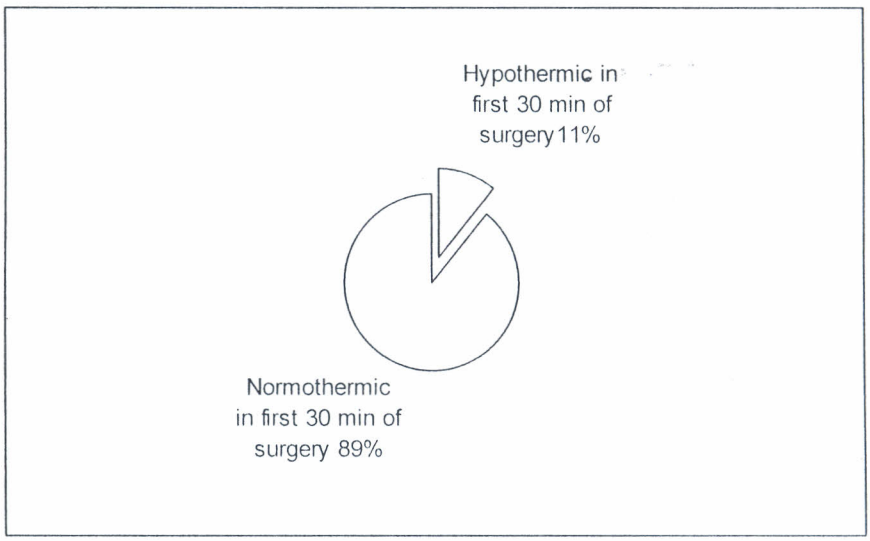


Hypothermia in the first 30 minutes of surgery

Only 8 patients (11%) were noted to be hypothermic (core temperature less than 36^0C) in the first 30 minutes of surgery compared to 60 (80%) after one hour of surgery.

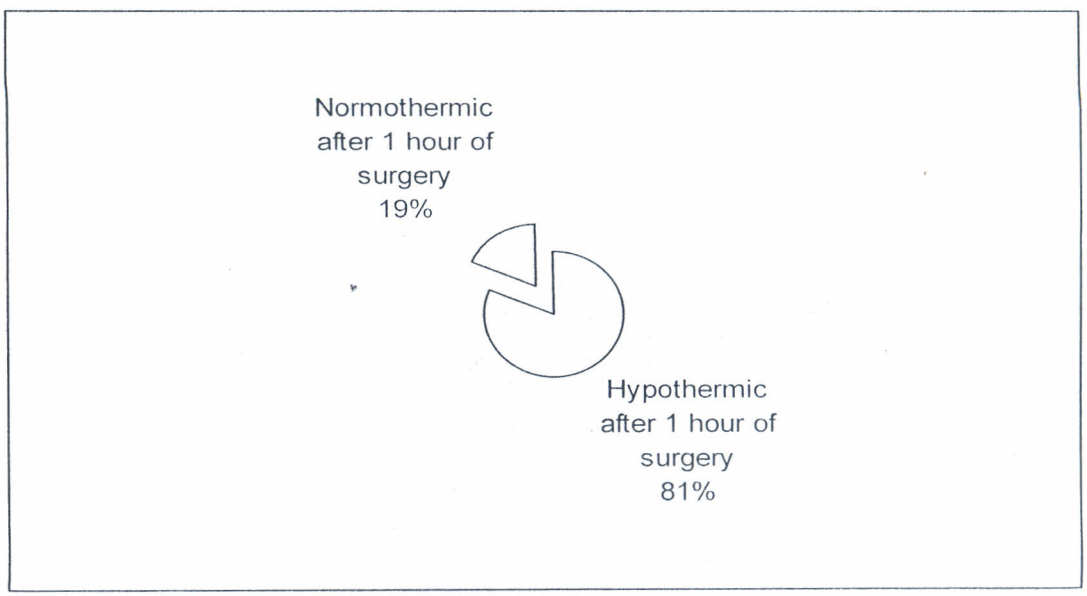
Graph 6:

Hypothermia in first 30 min of surgery



Graph 7:

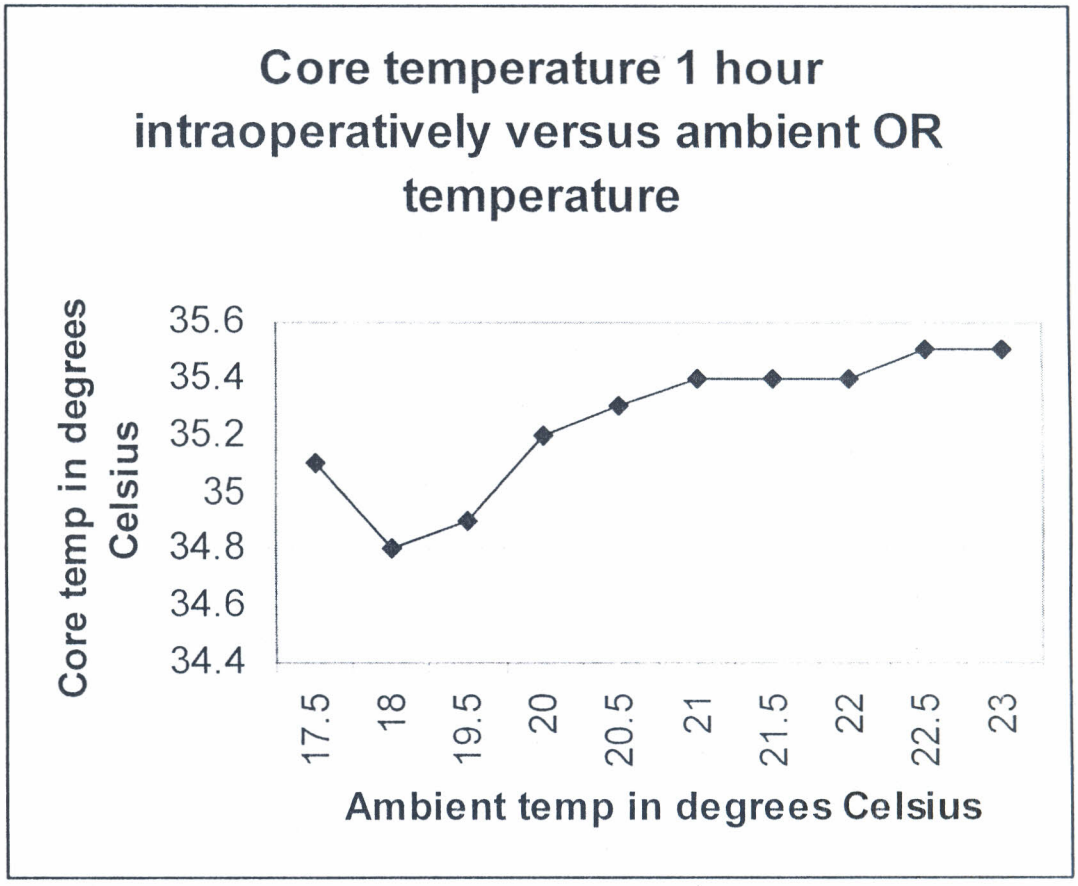
Hypothermia after 1 hour of surgery



Ambient operating room temperatures

Average temperature in the orthopaedic theatre was measured during the study period and was found to be 21^0C. The maximum temperature recorded was 23^0C while the minimum was 17.5^0C. These temperatures were recorded between 8am and 6pm.

GRAPH 8:



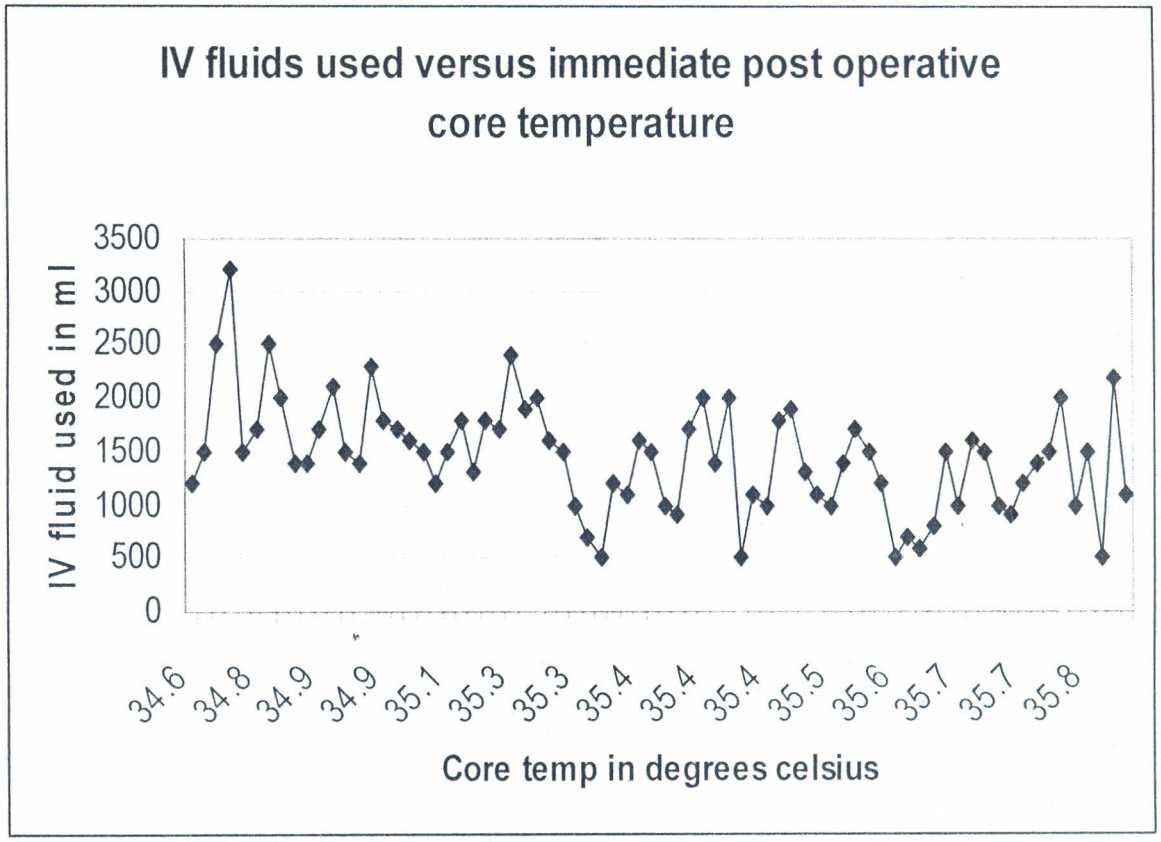
Ambient operating room temperatures thus have a linear relationship with patient core temperatures. The lower the operating room temperatures, the greater the fall in patients' core temperatures during both general and regional anaesthesia.

Intravenous fluid administration

Intravenous fluids used during the study consisted of normal saline, Hartmann's solution, whole human blood and colloids. The colloids included Gelofusine®, a succinylated gelatin and Hestar®, a hydroxyethyl starch. All patients who received colloids also received either normal saline or Hartmann's solution. All patients who received blood also received normal saline or Hartmann's solution.

Average fluid used intraoperatively was 1456.8 millilitres (Standard Deviation 517.4). Minimum fluid infused was 500 ml while the maximum was 3200 millilitres. All fluids were infused at room temperature.

GRAPH 9:



From the data used to create the graph above, the Karl Pearson Co-efficient of Correlation is calculated to be -0.43. This implies that there is a low degree of negative

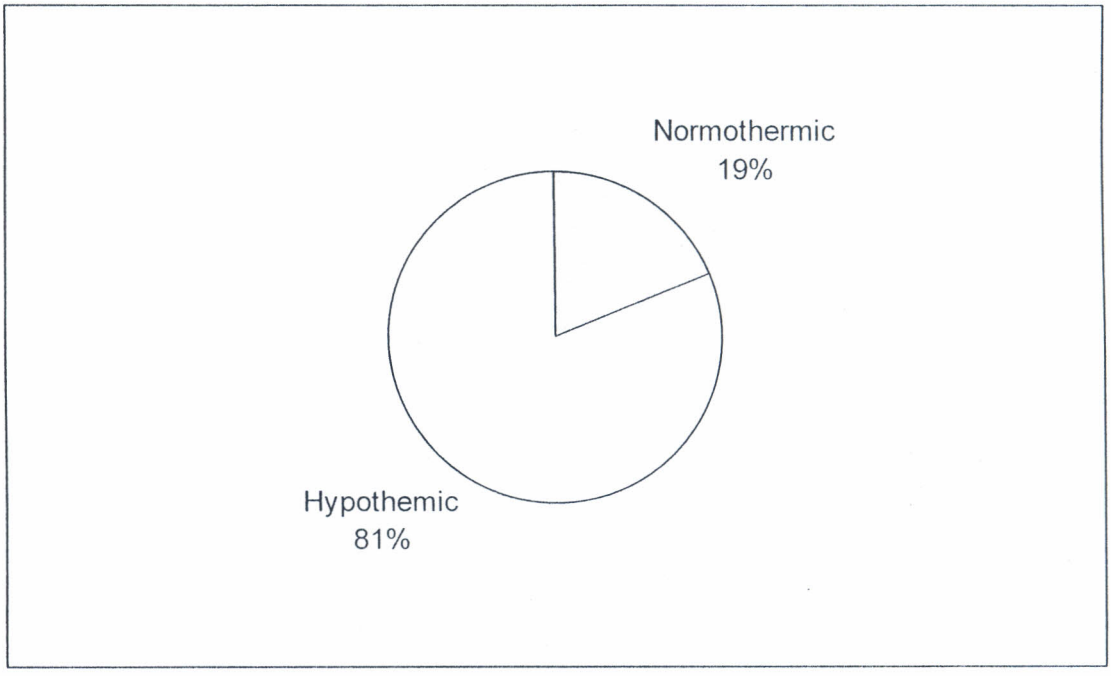
correlation between the volume of fluids used and the immediate post operative core temperature. The more the fluids infused at room temperature, the greater the drop in core temperature recorded in the immediate post operative period.

Post-operative hypothermia

60 (81%) patients had a recorded core temperature of less than 36^0C in the recovery room while 14 (19%) had temperature greater than 36^0C. The maximum temperature recorded in the recovery room was 36.3^0C.

GRAPH 10:

Graph showing the proportion of patients who were either normothermic or hypothermic in the recovery room

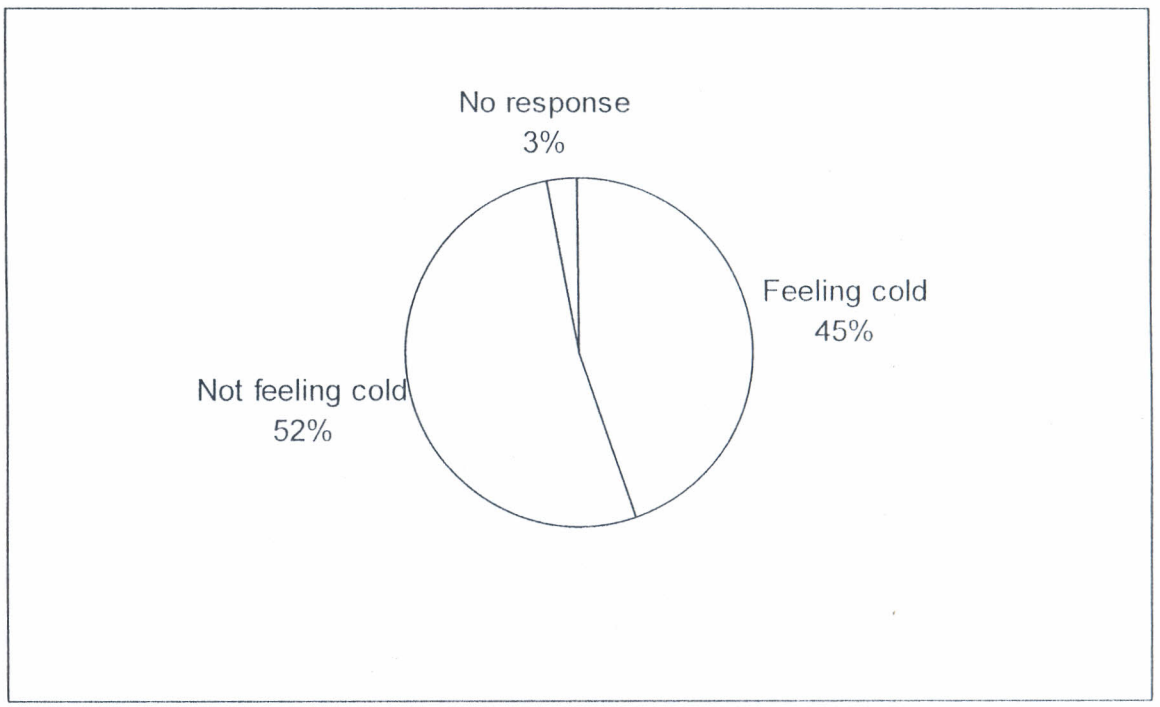


Thermal discomfort

While in the recovery room, patients who responded positively on being asked if they were feeling cold were 33 (44%) while 39 (52%) said they were not feeling cold. 2 patients did not respond to this question.

GRAPH 11:

Pie chart showing proportion of patients who experienced thermal discomfort in the recovery room



DISCUSSION

During anaesthesia, hypothermia may be defined as a core body temperature less than 36°C. This can cause physiological derangement in the operating theatre and in recovery, and may increase perioperative morbidity.

According to this study's findings, inadvertent hypothermia is a common occurrence within the orthopaedic theatre and in the recovery room. Pre-operatively 4 patients (5.4%) were noted to have temperature of less than 36^0C while in the receiving room. This may be attributed to exposure while in the receiving room or while in transit to the theatres. The average daily temperature of the receiving room was recorded as 21^0C. Core hypothermia was recorded in 80% of the patients after 1 hour of surgery compared to only 11% after 30 minutes of surgery. This implies that the greatest drop in temperature occurs during the first one hour of surgery. For patients undergoing long operations, the temperature drop was most significant in the first two hours intra-operatively after which a plateau phase was noted during which there were no significant temperature changes. This plateau phase of hypothermia may be explained by equilibration of heat loss and heat production. The longest operation done during the study was three hours and twenty minutes long.

Ambient temperature of the operating room, the receiving room and the recovery room (Post-anaesthesia care unit) were noted to be in the range of 17.5^0C to 23^0C with a mean of 21^0C (Standard deviation 1.2^0C). This temperature range is slightly lower than the recommended range of $20\text{-}24^0$C set by the American Society of Anesthesiologists. Low ambient temperature of the operating room has a direct negative effect on patients' core

temperatures (Graph 8). Hypothermia was more significant in patients who underwent surgery while ambient temperatures were low. Heat loss is increased because of a relatively cool operating room environment.

Intravenous fluid administration was also noted to impact negatively on patient core temperature but not to as large an extent as expected. Large volumes of fluids infused at room temperature had a low negative correlation with patients' core temperature. Fluids thus administered are warmed by body temperature by conduction from blood and tissues. This warming by the body therefore requires transfer of heat from body tissues to the cool fluid thus reducing heat content of the tissues and reducing their temperature.

Post-operative hypothermia was also noted to be common with 81% of patients having temperature of less than 36^0C within the first 15 min of being in the recovery room. This implies that in the early stages of post operative recovery, protective thermoregulatory responses may still be limited by residual volatile anaesthetics or other sedative drugs used intraoperatively.

Thermal discomfort (feeling cold) and shivering were noted in 45% of patients while in the recovery room. This is in contrast to 81% of the patients having core temperatures of less than 36^0C. This demonstrates than a patient may be hypothermic but may not shiver or complain of feeling cold.

Postoperative return to normothermia is thus delayed until brain anaesthetic concentration decreases sufficiently to again trigger normal thermoregulatory defenses.

RECOMMENDATIONS

1. All surgical patients should have their temperature measured in the preoperative holding area.
2. Patients with temperature < 36C should be warmed with blankets.
3. Body temperature should be measured whenever clinically significant changes in body temperature are intended, anticipated or suspected. This means all patients undergoing procedures longer than 30 minutes in the theatres.
4. IV fluids should be warmed during procedures involving significant fluid administration.
5. The operating room ambient temperature should be kept between 20 - 24^{0}C.
6. Fluids used by the surgeon on the patient should be warmed.
7. All patients should have a temperature measurement on arrival to the post-anaesthesia care unit (recovery room) and should be recorded every 15 minutes.
8. Hypothermic patients in recovery room should be warmed by application of an extra blanket or by active warming using an electric heater.
9. More studies should be done on the significance of thermal disturbances in patients undergoing neuraxial anaesthesia compared to those undergoing general anaesthesia.

CONCLUSION

Every patient undergoing surgery is at risk for developing perioperative hypothermia. Perioperative hypothermia has adverse effects on the cardiovascular system, coagulation cascade, recovery from anaesthesia, and on wound infection rates. Prevention of inadvertent hypothermia can improve patient outcomes and reduce the overall cost of care. Management of this condition requires the coordinated efforts of anesthesiologists, surgeons and perioperative, perianaesthesia, and critical care nurses.

Simple and inexpensive measures can be applied in the receiving room, the operating room and the recovery room to prevent perioperative hypothermia.

APPENDIX 1

Consent explanation

You have been invited to participate in this study titled INTRAOPERATIVE THERMAL DYNAMICS.

Study purpose

The purpose of this study is to find out to what extent hypothermia occurs in patients undergoing orthopaedic procedures and to attempt to elucidate the factors that affect it.

Number of people taking part in the study

If you agree to participate, you will be one of 73 patients who will be taking part in the research.

Patient Information

The thermometers being used to measure temperature have been tested and used before in this hospital. They are not new instruments being used for experimental purposes.

The process and procedures to be used in this study are aimed at getting the best outcome.

There is potential benefit to the patient in terms of close monitoring and early recognition of complications. Choosing not to participate in study will not lead to denial of surgery as planned. There is no interference with instructions given by the surgeon and/or the anesthesiologist.

The assessment of other vital signs and general condition of the patient will be done at regular intervals and staff will be available to give necessary assistance.

There is no financial gain for participating in this study.

This study is approved by appropriate hospital authorities before it starts. (KNH Ethics and Research Committee)

Procedure

The patient's temperature will be recorded from two sites pre-operatively and every 15 minutes intra-operatively up to 45 minutes post operatively. The temperature of the operating room will also be recorded. These measurements will not interfere with the work of the surgeon.

APPENDIX 2

Consent Form

I, _____ of _____ hereby consent to be included in the study titled "INTRAOPERATIVE THERMAL DYNAMICS". 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 3: Questionnaire

Patient No:
Age:_____years
Sex M F
Weight_____Kgs
Diagnosis:_____
Planned surgery_____
Pre-operative temperature:Core_____Periphery_____(degrees Celsius)
ASA status:_____
Premedication:_____
Regional anaesthetic: Yes/No: Type of block:_____
Dose/kg:_____
Sedation given? Yes/No Agent:
Dose/kg
Induction agents: IV_____Dose/kg
Volatile agent_____
Intraoperative Analgesics: Opioids _____
Muscle relaxants:_____
IV fluids in ml: Normal Saline_____

Hartmann's_____

Colloids_____

Blood_____

Plasma_____

Time in minutes versus temperature in ^{0}C.

	0	15	30	45	60	75	90	105	120	135	150	165	180
Core *temp*													
Peripheral temp													
Ambient temp													

Post operative recordings

Duration of surgery in minutes:_____

Does the patient feel cold? Yes/No

Is the patient shivering? Yes/No

Recovery room temperature observations in degrees centigrade	0min	15min	30min	45min
Core				
Peripheral				

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