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Effectiveness of Hypothermia Prevention Protocol Among Patients Subjected to Major Surgeries at KMCH, Coimbatore.

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Abstract - Hypothermia is a significant risk factor for peri-operative complications. Whatever method is used for maintaining normothermia, first and foremost, it should be remembered that careful and thoughtful actions directed at maintaining normothermia can significantly affect the course of the patient's peri-operative experience. Objective of the study is to assess the incidence and extent of hypothermia among patients subjected to major surgeries, to determine the effectiveness of hypothermia prevention protocol among patients subjected to major surgeries and to associate the demographic, clinical variables and risk factors of hypothermia with core body temperature among patients subjected to major surgeries. The methodology adopted for this study was a Quasi-experimental one group pre test and post test design. Hypothermia prevention management strategies (active and passive warming as per core body temperature) were implemented and were observed by using Hypothermia prevention protocol checklist by the investigator. Descriptive and inferential statistics were used to analyze the data. Repeated measures ANOVA of core body temperature, heart rate, respiratory rate, blood pressure and SPO2 over a period of time revealed that there is a statistically significant difference in the mean scores of vitals parameters were measured at various time periods in peri-operative period at the level of $p<.05$.

Keywords: hypothermia, peri-operative period, active warming device, passive warming device.

INTRODUCTION

Core temperature is the temperature of the central circulatory system. It is one of the most closely maintained physiological parameters as enzyme systems in the body have narrow temperature ranges in which they function optimally. Strict temperature control is important for normal organ, enzymatic, and cellular function. Temperature control is tightly regulated by the body within 0.2oC. This is referred to as the inter threshold range (Insler, 2006). Within this range, active methods of heating or cooling are not triggered. In addition, a set point temperature exists in which the body maintains steady changes in core body temperature (0.5-1.0 ^{o}C) based on circadian rhythms (Horosz, 2013).

Temperature tends to be decreased during sleep and increased with physical activity. Under normal conditions, the human body would initiate mechanisms to preserve or create heat. Balance of heat production and loss by thermoregulation is the essential mechanism of maintaining normal body temperature that optimizes the patient's chances of avoiding postoperative complications (Buggy & Crossley, 2000).

Hypothermia refers to the cooling of the body below the normal temperature range. Usually, a lower limit of 36°C is accepted. Below this value, dysfunction of various homeostatic mechanisms set in. This hypothermia is important in a perioperative setting for various reasons. According to the American Society of PeriAnaesthesia Nurses (ASPAN), a temperature < 36°C (96.8°F) is used to define perioperative hypothermia (Hooper et al 2009). According to the United States National Library of Medicine, a temperature within 36.1°C-37.2°C (97-99°F) is used to designate a normothermic core body temperature. Hypothermia is defined as a body temperature of <36°C (96.8F) and may be classified as mild (35.0°C-35.9°C), moderate (34.0°C-34.9°C) and severe (≤ 33.9°C) (Burns 2009). Temperatures between 35.0°C to around 35.9°C are considered mildly hypothermic (Brock et al., 2013).

Perioperative hypothermia, is a common consequence among patients undergoing surgery with core temperature below 36.0 °C, due to disruption of thermoregulation during general anesthesia. It decreases the heat production (inhibited vasoconstriction) while at the same time increases heat loss (induced vasodilatation), as in a result, causing a decrease of body temperature. The reported incidence of hypothermia varies from 6-90% of surgical procedures (Monzón et al., 2013). One recent source suggests as many as 50-70% of all surgical patients experience IPH (Roberson et al., 2013). This number is alarming to the perioperative care physician who deals with the deleterious complications of hypothermia. This implies the fact that research directed towards evidence-based practice for maintaining normothermia and prevention of IPH is warranted. Risk factors for hypothermia includes, extremes of age (infants, children and elderly), thin patients and patients with large body surface area,

preoperative hypothermia (patient in sepsis), prolonged duration of surgeries, surgeries with large amounts of fluid shifts, body cavity surgeries (open thoracic, abdominal, uro-gynaecological procedures), unregulated operating room temperature, reluctance to routine temperature monitoring & warming strategies, anaesthesia in patients with central regulatory depression, more area of body exposed during surgery, more amount of intravenous, irrigation fluids used.

The body reacts with thermoregulatory mechanisms such as cutaneous vasoconstriction and shivering. Hypothermia can result with undesirable effects during intra and postoperative period. Established complications of hypothermia include patient discomfort, increased sympathetic drive, increased incidence of myocardial events (Frank et al., 1997), impaired immune function (Beilin et al., 1998), wound infection (Kurz et al., 1996), coagulopathies, blood loss (Schmied, 1996), increased duration of ICU and hospital stay (Sessler et al., 2000). There are various factors which cause drop in body temperature of an anaesthetized patient. Impaired heat regulation from the higher centers (Sessler, 2000), transfer of core body heat to the peripheries, reduced metabolism under anaesthesia, exposure of the body cavities to the environment, cold operating room temperature are all the causes of intraoperative hypothermia Patients undergoing major procedures including body cavity surgeries, surgeries involving major fluid shifts and pediatric patients are at risk of dangerous levels of hypothermia (Forstot, 1995).

In addition, symptoms such as tachycardia, tachypnea, hypovolemia and coordination disturbances like ataxia, apathy appear. Moderate hypothermia, or temperatures between 34.0°C and 34.9°C, cause respiratory depression (hypoventilation) slow pulse (bradycardia), decreased blood pressure (hypotension), reflex suppression (hyporeflexia), enlarged pupils and an ever- increasing loss of consciousness and seizures. Shivering ceases. At even lower temperatures, severe hypothermia, the human organism reacts with circulatory and respiratory collapse (Bräuer 2006, Wartzek 2011, McCullough 2004, Stanhope 2006). Hence it becomes important in maintaining normothermia during the perioperative period.

The effective perioperative temperature management begins with accurate temperature measurement. The body temperature of the patients will be measured every 5 minutes after 33 when they are admitted to the operating theatre department. The body temperature will be measured by tympanic thermometer at the tympanic membrane. Findings have shown that the core temperature of surgical patients usually drops by 0.5°C to 1.5°C at the first hour of anaesthesia (Purssell, 2009).

International Journal of Evidence Based Healthcare (2011) reported that 50% to 90% of surgical patients had perioperative hypothermia. In local setting all patients underwent abdominal surgery experienced hypothermia. Shivering was observed in almost half of the patients postoperatively. Hypothermia causes shivering which in controlled settings can increase the metabolic rate up to 5 times the basal rate (Eyolfson, 2001).

Increased metabolism, minute ventilation, and activation of the sympathetic system make avoidance of shivering necessary (De Witte 2002). Hypothermia is also associated with up to a 25% increase in minute ventilation, which may be detrimental in certain subsets of patients such as those with underlying lung disease (Marion, et.al 2009). The body's natural ability to warm itself is disrupted by anaesthetic agents (Torossian, 2015). General anesthesia causes tonic vasoconstriction of the peripheral vasculature, which causes vasodilation; thus, the patient's core temperature can decrease during the surgical procedure (Kurz, 2008).

In addition to causing discomfort for the patient, hypothermia may contribute to myocardial events, no increase in the use of vasopressors, arrhythmias (other than sinus bradycardia), myocardial ischemia, or infarction most likely due to an increase in the amount of circulating catecholamines. However, adverse cardiac events have been demonstrated only in patients with probable coexisting coronary atherosclerotic disease (CAD) (Frank, 2003).The authors further hypothesized that with adequate adrenergic blockade, even patients with a history of CAD would suffer a low incidence of cardiac events when cooled (Todd 2005 & Nguyen 2010). Furthermore, postoperative cardiac events occur at a higher rate; although it is unclear whether this is due to increased oxygen consumption or norepinephrine levels. Hypothermia can also induce coagulopathy and inhibit platelet function which may lead to an increase in the amount of surgical bleeding, and potentially leading to greater transfusion requirements. Patient with a mean temperature of 35.6°C was likely to lose 16% more blood and was 22% more likely to receive a blood transfusion (Rajagopalan, 2008).

Evidence, hypothermia should be permitted only when clinically indicated for neuro protection. Also, to be consistent with the American Heart Association's guidelines for the induction of hypothermia, "ongoing bleeding should be controlled before decreasing temperature" (Peberdy, 2010). Hypothermia in the post-operative period is thought to be a risk factor for surgical site infections (SSI) and delay wound healing and may result in a longer hospital stay. Infectious complications are more likely associated with an increased duration of hypothermia (Badjatia, 2009). Hypothermia causes

the blood vessels to constrict, decreases blood flow to tissues and decreases oxygenation of surgical wounds, allowing a more favourable environment for bacterial growth. Recently, a large retrospective study found that documented adherence to postoperative normothermia in patients undergoing colorectal surgery. The results implied that there is an association with an increase in infectious complications involving hypothermia outside of the operating room (Shiozaki, 2001).In 1996, a randomized controlled trial reported that patients who were hypothermic at the end of surgery experienced a three-fold increase in the incidence of SSI.

Hypothermia may also affect pharmacokinetics and prolong postoperative recovery times and hospital length of stay. It alters medication metabolism, causing metabolic acidosis, hypokalemia, and nitrogen imbalance. Hypothermia has been linked to additional adverse outcomes such as prolonged time to recovery from general anaesthesia. Drug effects are prolonged because of decreased metabolism and increased potency secondary to decreased body temperature. The clearance of midazolam and vecuronium is reduced approximately 11% for every degree Celsius drop in body temperature. Similarly, the metabolism of remifentanil is reduced by approximately 6% for every one degree Celsius drop in temperature. Likewise, the metabolism of fentanyl and propofol are reduced (Fritz, et.al 2005). When a temperature of 36°C was added to discharge criteria, discharge time was prolonged by 90 minutes (Hooper 2010). A randomized controlled trial demonstrated that hypothermic patients (average intraoperative temperature 34.8°C) took approximately 40 minutes longer to meet discharge criteria from the post anaesthesia care unit compared to normothermic patients (average intraoperative temperature 36.7°C) (Cattaneo, 2000). Factors such as the patient's age, weight, and health conditions can contribute to unplanned hypothermia. In addition, (Kurz, 2008 & Sessler, 2000) environmental factors specific to the OR, including low room temperatures, lack of clothing on the patient, administration of room-temperature IV and irrigation fluids, evaporation of skin preparation solutions, and air movement, can contribute to heat loss and a decrease in core body temperature.

Perioperative hypothermia is a multi-disciplinary/multispecialty problem. Management of this nursing and medical diagnosis requires the coordinated efforts of anaesthesia providers, surgeons, and perioperative, peri- anaesthesia, and critical care nurses. Inadvertent perioperative hypothermia is a common but
preventable complication. Currently, there are multiple warming methods used during and after the surgical operations for prevention and treatment. One effective strategy for maintaining normothermia involves warming the patient preoperatively. This strategy has been shown to significantly attenuate, and prevent, hypothermia from redistribution of blood from the patient's core to periphery while under general anesthesia (Horn, 2012).

Perioperative hypothermia is a condition that affects most surgical patients and may lead to an increase in recovery time, length of hospital stay and costs, and also, a decrease in patient satisfaction. In order to combat perioperative hypothermia, many prevention strategies have been examined. With respect to temperature, it is easier to prevent temperature changes than to treat undesirable changes (Moola, 2011).

Maintaining normothermia can be achieved by adopting various warming strategies which includes usage of patient warming devices. Various methods of patient warming during preoperative, intraoperative and postoperative settings have been introduced and are in clinical practice (Welch 1994). They work on different mechanisms like conduction, convection or radiation. Different studies give different results on the efficacy of various warming strategies in maintaining normothermia in the patient. Different studies give different conclusions on the efficiency of these warming devices in various settings(Russell et al., 1995)

The recommended practice for the prevention of unplanned perioperative hypothermia is "pre-warming the patient for a minimum of 15 minutes immediately prior to induction of anesthesia or warming should be started before the patients being transferred to the operating table or provision of a minimum of 30 minutes of preoperative warming [American Society of Perianesthesia Nurses] (ASPAN, 2009).

Active and passive cutaneous warming are likely the most common and aim to both warm and prevent heat loss; many consider active warming a standard of care for surgeries over one hour. During surgical anaesthesia, approximately 90% of the patient's body temperature loss occurs from the skin to the environment. Active warming systems such as forced-air system, blankets, warming blankets, circulating water mattresses and garments, and radiant warming system are commonly used to prevent hypothermia during anaesthetic/surgical procedures.

In an article published by Lista, et al., (2012) it was concluded that use of simple measure like use of warmed fluids, limiting the area exposed to surgical site alone, forced air warming improved clinical outcomes, patient comfort and recovery following surgery. They also showed an association between the perioperative hypothermia and the deleterious outcomes like cardiac injuries, wound infection and impaired wound healing. It is a big

challenge for perioperative nursing staff to maintain normal body temperature of the patients in perioperative setting. One of the duties of nurses is to maintain the patient's body temperature within the normal range. A methodological trend that has been gaining momentum is the temperature monitoring. Regular measurement and recording of temperature is the key to prompt identification and its management with prevention and management of hypothermia. Anesthesiologists are expected to be proactive in recognizing and managing temperature derangements throughout the perioperative period. (National Quality Measures Clearinghouse, 2007).

OBJECTIVES

1. Assess the incidence and extent of hypothermia among patients subjected to major surgeries.
2. Determine the effectiveness of hypothermia prevention protocol among patients subjected to major surgeries.
3. Associate the demographic variables, clinical variables and risk factors of hypothermia with core body temperature among patients subjected to major surgeries.

METHODS: Design adopted for the study was one group pre and post-test quasi experimental design. **Variables of the study** a) Independent variable: In this study was hypothermia prevention protocol implementation. b) Dependent variable: In this study was hypothermia.

SamplingTechnique: Non probability convenient sampling technique was adopted for sample selection. Those who fulfilled the selection criteria and willing to participate were recruited for the study.

Sample Size: The sample size for the study was 50 patients and the hypothermia prevention protocol was implemented for them.

Ethical consideration: Ethical clearance was obtained from the institutional ethical committee to conduct the study. Informed written consent was obtained individually from the patients participated in the research study. Permission was obtained from Head of the Department in OT and in charges of the operation theatres for conducting the main study.

Validity and reliability of the tool: All the instruments were reviewed for face and content validity by medical and nursing experts and they were pilot tested to assess the usability and ease of administration. Content validity of the tool was established by experts comprising of experts from the fields of nursing, anaesthetists. The researcher gave a copy of the tool and explained the purpose and objectives of the study to them individually. A panel of content experts were asked to rate the tool that measures the signs and symptoms, risk factors and core body temperature and observational checklist on hypothermia prevention protocol.

Implementation of hypothermia prevention protocol

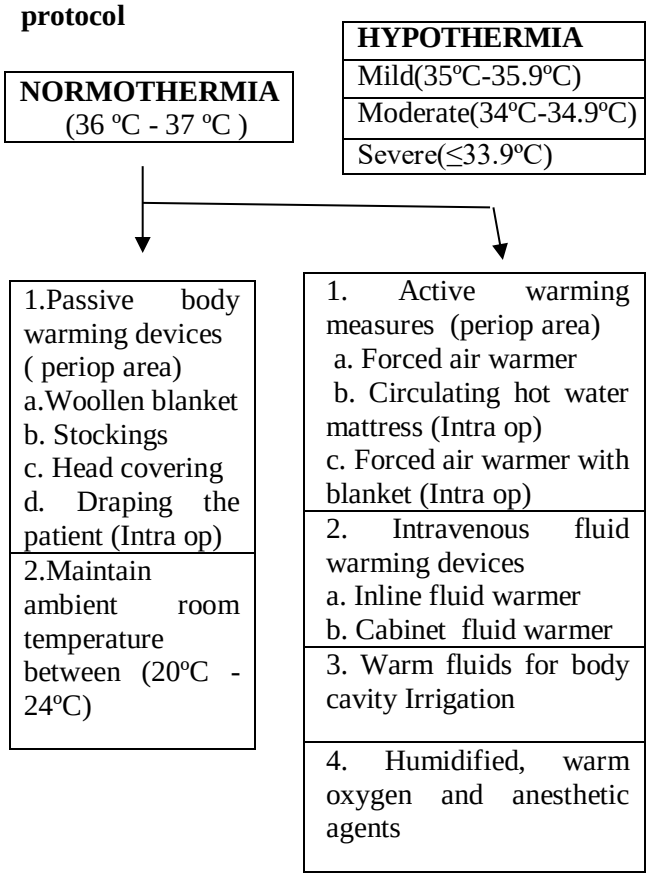


Fig1: Implementation of Hypothermia Prevention Protocol

Fig 1 describes that Based on the literature review, research evidence, existing management strategies, hospital facilities and equipment, the hypothermia prevention protocol was prepared and modified as per expert's guidance. The protocol covers the management strategies among patients with normothermia or hypothermia during pre, intra and post-operative period.

Description of the tool : Extensive review of literature, discussion and views of experts enhanced the development of the tool. The tool consisted of 4 sections.

Part I: Demographic Variables such as age, sex, educational status, diet pattern and unhealthy habits.

Part II: Clinical variables such as Co morbidity (Diabetes mellitus. Hypertension, Chronic kidney

disease, Ischemic heart disease & Hypothyroidism), ASA classification on Level of physical status (Healthy patient (ASA – I), Mild systemic diseases (ASA- 2),Severe systemic diseases (ASA- 3), body mass index, Surgical procedures (Upper abdominal, Lower abdominal, Upper & lower abdominal, Thoracic and Extremities), nature of surgery (Elective or Emergency), Blood Investigation (Haemoglobin <10 mg / dl, WBC >11000 cells/cu mm).

Part III: Risk factors of hypothermia such as, Duration of patient stay, Volume of IV fluid administration, Type of anaesthesia, Blood loss during surgery, Blood transfusion during surgery and PACU).

Part IV: Signs and symptoms of hypothermia such as Shivering, Cold extremities & Pilorection in holding area, intra operative and PACU area.

Part V: Assessment on measurement of vital parameters such as core body temperature, heart rate, respiratory rate, blood pressure & SPO2 every half an hourly on arrival in and transfer out from holding area, OT and PACU.

Part VI: Hypothermia prevention protocol implementation included observational checklist on measures implemented to prevent and manage hypothermia for the study subjects. The observational criteria included the passive body warming measures such as woolen blankets, stockings, head covering was used and the ambient room temperature was maintained between ($20^{\circ}C$) – 24 $^{\circ}C$) and core body temperature was checked every 30 minutes. Active body warming measures such as forced air warmer or circulating hot water mattress or forced air warmer with blankets were applied along with passive body warming measures, intravenous warm fluid irrigation was administered, and humidified warm oxygen and anesthetic gases was used.

PROCEDURE FOR DATA COLLECTION

On the first day of the holding area, while subjects were comfortable or when the physician and nurse completed the routine procedure, patients who met the inclusion criteria were approached consecutively by the researcher and were explained the study purposes and procedures in detail and informed written consent was obtained individually from the subjects. The subjects were assured that they were free to withdraw during the study without any compromise in subsequent treatment. The study subjects were clearly explained about the hypothermia prevention protocol and were asked to answer by self-reporting. Strict confidentiality was maintained throughout the process of data collection and analysis.

Patients' Demographic Variables such as age, sex, educational status, diet pattern and unhealthy habits and Clinical variables such as Co morbidity (Diabetes mellitus. Hypertension, Chronic kidney disease, Ischemic heart disease & Hypothyroidism), ASA classification on Level of physical status (Healthy patient (ASA – I), Mild systemic diseases (ASA-2),Severe systemic diseases (ASA- 3), body mass index, Surgical procedures (Upper abdominal, Lower abdominal, Upper & lower abdominal, Thoracic and Extremities), nature of surgery(Elective or Emergency), Blood Investigation (Haemoglobin <10 mg / dl, WBC >11000 cells/cu mm) were collected by the investigator from the patient medical record.

The potential risk factors of hypothermia(Duration of patient stay, Volume of IV fluid administration, Type of anaesthesia, Blood loss during surgery, Blood transfusion during surgery and PACU), risk factors, also were collected: duration of patient stay, volume of IV fluid administration, type of anaesthesia, Blood loss during surgery, Blood transfusion), and Signs and symptoms of hypothermia such as Shivering, Cold extremities & Pilorection in Holding area, intra operative and PACU area were assessed by the investigator and recorded.

Pretest assessment on monitoring vital parameters such as core body temperature, heart rate, respiratory rate, blood pressure & SPO2 in time sequences of every 30 minutes on arrival to each area (holding area, OT and PACU). The core body temperature was measured by using infrared tympanic thermometer (model DL8740, 2016. Philips) it gives the measurement within 2-4 seconds after placing thermometer into ear canal. Before using the infrared tympanic thermometer, the investigator was explained the procedure to the patient and obtained verbal consent. To monitor temperature, cleaned the ear with cotton buds and inserted the ear speculum into ear canal by pulling ear pinna backward, up and out. The thermometer probe was left in place until patient's temperature appears on digital display then carefully removed from auditory meatus and cleaned the speculum lens with the alcohol swab. Documented the displayed temperature. Assisted the patient in assuming a comfortable position and Performed hand hygiene.

Hypothermia management strategies was implemented based on vital parameters especially the core body temperature. If the patient's temperature is within the normothermic range (ie, 36° C to 37° C [96.8° F to 98.6°F]), the passive body warming measures were instituted, including maintaining the patient's temperature and the ambient room temperature, minimizing skin exposure by providing woolen blankets, stocking and head coverings in holding as well as in PACU area, draping was applied only in operation theatre.

If the patient is within the hypothermic temperature range (ie, <36° C [<96.8° F]), then active warming measures were instituted. In holding area, forced air warming devices and inline warming devices, cabinet warming devices were applied. In intraoperative area, forced air warming devices,

circulating hot water mattress, cabinet warming devices, inline warming devices, fluid warm irrigation were instituted. In PACU, forced air warming devices, cabinet warming and inline warming devices were instituted.

Post-test assessment on monitoring vital parameters such as core body temperature , heart rate, respiratory rate, blood pressure & SPO2 in time sequences of every 30 minutes on exit from each area (holding area, OT and PACU).

RESULTS: The data was analysed on the basis of objectives and hypotheses. Descriptive and inferential statistics (Chi square Paired t test and independent test, RM ANOVA) were used for analysing the data. Data were analysed using the statistical package for the social sciences (SPSS version 22). Level of significance (p) value of <0.05 and less than that was considered to be significant.

Section A: Table .1 Distribution of demographic and clinical variables among subjects in perioperative period

S. No	Variables	Study group No.	%
Demographic variables			
1.	**Age in years**		
	a) 21-40	17	34
	b) 41-60	17	34
	c) 61-70	16	32
2.	**Sex**		
	a) Male	24	48
	b) Female	26	52
3.	**Educational status**		
	a) No formal education	18	36
	b) Primary	02	04
	c) Secondary	16	32
	d) Higher secondary	03	06
	e) Collegiate	11	22
4.	**Diet pattern**		
	a) Vegetarian	02	04
	b) Mixed diet	48	96
5.	**Unhealthy habits**		
	a) Smoking	02	04
	b) Alcohol consumption	07	14
	c) Nil	41	82
Clinical Variables:			
6	**Comorbidity**		
	a) Diabetes mellitus	10	20
	b) Hypertension	20	40
	c) Chronic kidney disease	09	18
	d) Ischemic heart disease	01	02
	e) Hypothyroidism	04	08
	f) Nil	06	12
7.	**Level of physical status (acc to ASA)**		
	a) Healthypatient (ASA–I)	10	20
	b) Mild systemic diseases (ASA- 2)	31	62
	c) Severe systemic diseases (ASA- 3)	09	18
8.	**Body Mass Index (kg/m^2)**		
	a) Underweight<18.5	01	02
	b) Normal18.5- 24.99	30	60
	c) Overweight>25	05	10
	d) Obesity>30	14	28
9.	**Surgical procedures**		
	a) Upper abdominal	10	20
	b) Lower abdominal	36	72
	c) Upper &lower abdominal	01	02
	d) Thoracic	02	04
	e) Extremities	01	02
10.	**Nature of surgery**		
	a) Elective	48	96
	b) Emergency	02	04
11.	**Blood investigation**		
	a) Haemoglobin (<10 mg/dl)	05	10
	b) WBC(>11000mcells/mm)	11	22
	c) Nil	34	68

Table 1 demonstrates the distribution of demographic variables among study subjects. The mean age of the subjects were 41.20 years where 64 years was the highest and 21years was the lowest with the mean score of 41.20 SD 14.68. With regard to gender, Male: Female ratio was 1:1. (n=24) 48% were male and (n=26) 52% were female. Concerning with the educational status, dietary pattern & unhealthy habits majority of subjects 32% (n=16), 96% (n=48) & 82% (n=41) had secondary education and were on mixed diet they had no such unhealthy habits of Smoking & alcohol consumption respectively. 17.3 was the lowest with the mean score of 22.7SD 3.01. All subjects were categorized according to ASA's (American Society of Anesthesiologists) classification as level of physical status 1 to3. 20% (n=10) were healthy ASA grade-I, 62% (n=31) with mild systemic diseases (ASA-II), 18% (n=9) were with severe systemic diseases (ASA-III). Concerning with the surgical procedures, majority 72% (n=36) of the subjects were subjected to the lower abdominal surgery, 96% (n=48) had elective surgery. Majority of study subjects 90% (n=45) & 78% (n=39) had normal haemoglobin & white blood cells respectively.

SECTION B:Distribution of subjects based on presence of risk factors

Table.2 Distribution on risk factors among patients

S. No	Criteria	Study group No.	%
Duration of stay			
1.	**Duration of patient stay in holding area**		
	a) <1hr	32	64
	b) >1hr	18	36
2.	**Duration of patient stay in intraoperative period**		
	a) <2hrs	05	10
	b) >2hrs	45	90
3.	**Duration of patient stay in PACU**		
	a) <2hrs	24	48
	b) >2hrs	26	52
Volume of Fluid Administration			
4.	**Volume of IV fluid administration in holding area**		
	a) <500ml	35	70
	b) 500ml-1litre	01	02
	c) Nil	14	28
5.	**Volume of IV fluid administration in intraoperative period**		
	a) <500ml	02	04
	b) 500ml–2litre	29	58
	c) >2litres	19	38
6.	**Volume of IV fluid administration in PACU**		
	a) <500ml	09	18
	b) 500ml-2litre	35	70
	c) >2litres	06	12
7.	**Type of anesthesia**		
	a) GA	46	92
	b) RA	03	06
	c) GA&RA	01	02
8.	**Blood loss during surgery**		
	a) <100 ml	17	34
	b) 100–200ml	18	36
	c) >200ml	15	30
9.	**Blood transfusion**		
	i. Intraoperatively.		
	a. Yes	03	06
	b. No	47	94
	ii. PACU		
	a. Yes	02	04
	b. No	48	96

Table 2 denotes the duration of stay among subjects in each area during perioperative period. Duration of stay among subjects in holding area varied greatly from 15 minutes to a maximum of up to 45 minutes.

The average of this time for majority 64% (n=32) of subjects was 36.5 minutes and 31.25 minutes.The average of duration of stay in OT among majority 90% (n=45) of subjects was varied greatly from 2 hrs 30 minutes to a maximum of up to 4hrs 40 minutes.52% (n=26) were stayed >2 hours in the PACU.

The amount of intravenous fluids used in perioperative period. Majority of subjects 70% (n=35) had received the average amount ie. 365 ml IV fluids in the holding area. (n=29) 58% & 70% (n=35) had IV fluid administration of 500ml to 2 liters intraoperatively and in PACU respectively.

Type of anesthesia among subjects Majority 92% (n=46) had general anesthesia, 6% (n=3) had regional anesthesia, 2% (n=1) had general and regional anesthesia.

Blood loss during surgery among subjects. 34% (n=17) had the blood loss below 100 ml, 36% (n=18) had the blood loss 100-200ml, 30% (n=15) had blood loss above 200 ml. Blood transfusion among subjects. 3 (6%) received blood transfusion during surgery, 2 (4%) received blood transfusion in the PACU.

SECTION C: Distribution of subjects based on presence of signs and symptoms of hypothermia

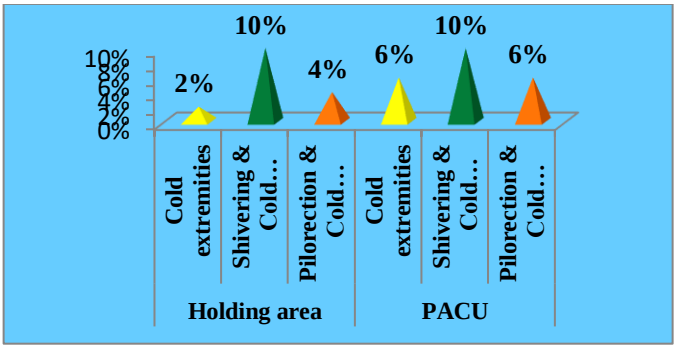


Figure2

Figure 2 explicates the frequency and percentage distribution on signs and symptoms of hypothermia among subjects in study and control group. Shivering was one of the important secondary outcomes studied because most of the ill effects of hypothermia are associated with shivering. About 10% (n=5) of subjects shivered and had Cold extremities in the Holding area and in PACU area respectively.

SECTION.D: Table.3 Distribution of vital parameters in perioperative period.

	Holding area		OT		PACU	
	No	%	No	%	No	%
1. Core body temperature						
a) Mild (35ºC-35.9ºC)	02	04	26	52	23	46
b) Moderate (34ºC-34.9ºC)	0	0	01	02	0	0
c) Severe (≤33.9ºC)	0	0	0	0	0	0
d) Normothermia (36 ºC-37ºC)	48	96	23	46	27	54

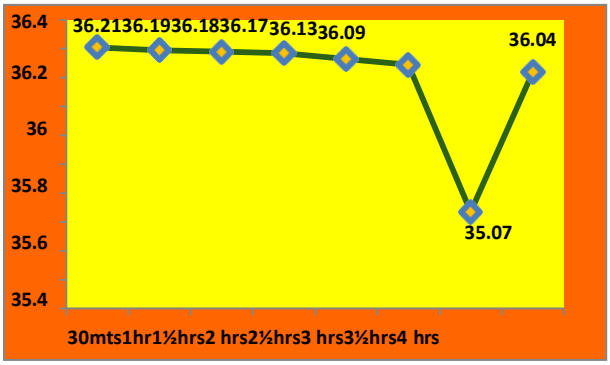
Table 3 demonstrates the distribution on core body temperature among subjects. The analysis shows that 4% (n=2) had mild hypothermia, 96% (n=48) had normothermia in the holding area. 52% (n=26) mild hypothermia. 2% (n=1) in had moderate hypothermia. 46% (n=23) had normothermia in the intraoperative period.46% (n=23) had mild hypothermia.54% (n=27) had normothermia in the PACU.

Table.4 Repeated Measures ANOVA of core body temperature at various time periods in perioperative period

Time periods	Holding area		ntraoperative		PACU		F value
	Mean	SD	Mean	SD	Mean	SD	
T1 (30 mts)	36.21	0.14	36.26	0.11	35.53	0.45	2.197*
T2 (1 hr)	36.19	0.11	36.18	0.30	35.32	0.39	
T3 (1½hrs)	36.18	0.09	35.78	0.45	35.05	0.48	
T4(2 hrs)	36.17	0.26	35.67	0.40	35.00	0.80	
T5 (2½ hrs)	36.13	0.11	35.59	0.47	35.25	0.42	
T6 (3 hrs)	36.09	0.13	35.53	0.45	36.41	0.20	
T7 (3½hrs)	35.07	0.11	35.08	0.46	36.48	0.14	
T8 (4	36.04	0.25	36.01	0.48	36.27	0.52	
T9 (4½hrs)			37.00	0.21			
T10 (5hrs)			36.05	0.08			

Table 4 presents the repeated measures ANOVA of core body temperature over a period of time in the perioperative period. There is a statistically significant difference in the mean scores of core body temperature measured at various time periods in holding area, intraoperative period and PACU at the level of p< .05

Figure 3: Mean score of core body temperature measurement at various time periods in holding area.



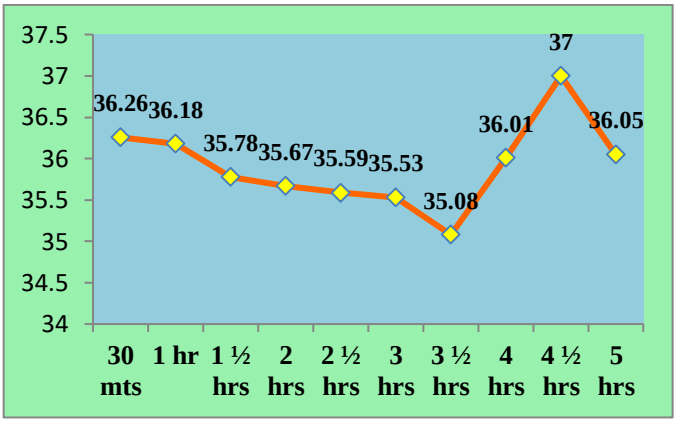


Figure 4: Mean core body temperature measurement at various time periods in intraoperative period.

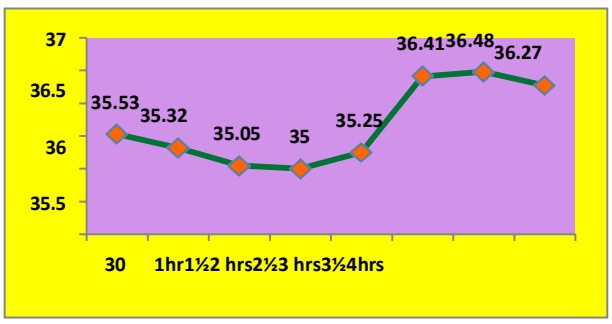


Figure 5: Mean score of core body temperature measurement at various time periods in PACU area

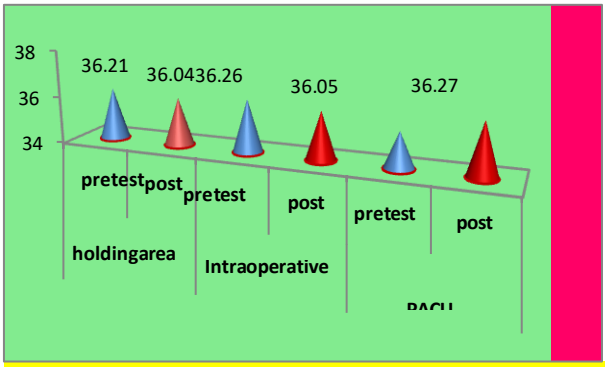


Figure 6: Comparison of pre-test & post mean score of core body temperature among subjects

Figure 6 interprets the comparison of mean score of core body temperature in the holding area in the study group during pre test & post test using paired t test. Comparison of the pre test and post test showed a statistically significant improvement in the post test mean score of core body temperature in the holding area intraoperative and the PACU than the pre test mean score of core body temperature in the holding area, intraoperative and the PACU. This is because of the fact, that the patients received a better and a quicker warming. And it is important to note that all patients remained above 36°C all throughout the surgery once they reached the cut off limit at p <0.001.

Table. 5 Distribution of Heart rate among subjects in perioperative period.

Vital parameters	Holding area		OT		PACU	
	No	%	No	%	No	%
1.Heartrate						
a) Normal	48	96	49	98	46	92
b) Bradycardia	01	02	01	02	02	04
c) Tachycardia	01	02	0	0	02	04

Table. 5 demonstrates the distribution of heart rate among subjects. The analysis shows that majority of subjects 96% (n=48), 98% (n=49) and 92% (n=46) had normal heart rate in the holding, intraoperative and PACU respectively.

Table. 6 Repeated Measures ANOVA of heart rate at various time periods in perioperative period

Time periods	Holding area		Intraoperative		PACU		F value
	Mean	SD	Mean	SD	Mean	SD	
T1 (30mts)	76.26	10.13	72.60	9.88	78.68	13.21	4.18*
T2 (1 hr)	61.82	29.93	72.46	14.76	79.92	11.78	
T3 (1½hrs)	71.28	8.20	73.56	10.32	77.71	11.68	
T4 (2 hrs)	69.25	5.50	72.41	10.27	78.22	11.08	
T5 (2½ hrs)	65.00	1.41	72.00	10.82	76.81	12.14	
T6 (3 hrs)	65.00	4.24	74.30	11.16	81.11	12.09	
T7 (3½ hrs)	63.00	1.41	76.16	11.82	82.00	12.98	
T8 (4 hrs)	64.00	2.19	76.44	11.18	75.37	17.90	
T9 (4½ hrs)			73.17	9.87			
T10 (5 hrs)			70.90	9.62			

Table 6 presents the repeated measures ANOVA of heart rate over a period of time in the perioperative period. There isa statistically significant difference in the mean scores of heart rate measured at various time periods in holding area, intraoperative period and PACU at the level of p< .05.

Table.7: Comparison Comparison of pre test and post test mean score of heart rate at various time periods in perioperative period.

Core body temperature	Duration of study	Mean	SD	Mean Difference	SD	't'value 'p'value
Holding Area	Pre test	76.26	10.13	12.26	7.01	4.32 0.0001***
	Post test	64.00	2.19			
Intra Operative	Pre test	72.60	9.88	1.70	1.01	2.47 0.004**
	Post test	70.90	9.62			
PACU	Pre test	78.68	13.21	3.31	4.10	5.59 0.0001***
	Post test	75.37	17.90			

- p<0.01,*- p<0.001

Table 7 interprets the comparison of mean score of heart rate in the holding area among subjects during pre test & post test using paired t test. Comparison of the pre test and post test showed a statistically significant improvement in the post test mean score of

heart rate in the holding area, intraoperative and the PACU than the pre test mean score of heart rate in the holding area, intraoperative and the PACU.

Table.8 Distribution of respiratory rate in perioperative period

Respiratory rate	Holding area		OT		PACU	
	No.	%	No.	%	No.	%
a) Normal	48	92	49	98	40	80
b) Bradypnea	02	04	0	0	0	0
c) Tachypnea	0	0	01	02	10	10

Table 8 demonstrates the distribution on respiratory rate among subjects. The analysis shows that majority of the subjects 92% (n=48), 98% (n=49) and 80% (n=40),had normal respiratory rate in the holding, intraoperative and PACU respectively.

Table 9 Repeated Measures ANOVA of respiratory rate at various time periods in perioperative period.

Time periods	Holding area		Intraoperative		PACU		F value
	Mean	SD	Mean	SD	Mean	SD	
T1 (30mts)	17.12	4.08	13.88	2.92	17.06	4.86	4.23*
T2 (1 hr)	15.44	7.78	13.20	2.82	18.68	6.01	
T3 (1 ½ hrs)	17.39	3.36	14.12	2.49	18.78	4.54	
T4 (2 hrs)	18.50	3.33	13.99	2.66	18.85	4.67	
T5 (2½ hrs)	18.00	0.000	13.59	1.79	18.44	4.31	
T6 (3 hrs)	21.00	1.41	13.24	1.84	19.39	5.26	
T7 (3 ½ hrs)	21.00	1.41	13.65	2.10	18.21	4.83	
T8 (4 hrs)	21.00	1.41	13.50	2.00	20.59	7.91	
T9 (4 ½ hrs)			14.22	2.36	20.00	6.92	
T10 (5 hrs)			14.10	2.68	22.00	0.000	

Table 9 presents the repeated measures ANOVA of respiratory rate over a period of time in the perioperative period. There is a statistically significant difference in the mean scores of respiratory rate measured at various time periods in holding area, intraoperative period and PACU at the level of p< .05.

Table 10: Comparison of pre-test and post-test mean score of respiratory rate among patients

Core body Temperature	Duration of study	Mean	SD	Mean Difference	SD	't' value 'p' value
Holdig Area	Pre test	17.12	4.08	3.88	1.23	3.97 0.0001***
	Post test	21.00	1.41			
Intra Operative	Pre test	13.88	2.92	0.22	0.04	6.83 .0001**
	Post test	14.10	2.68			
PACU	Pre test	17.06	4.86	4.94	2.11	11.52 0.0001***
	Postt est	22.00	0.000			

-p<0.01,*-p<0.001

Table 10 interprets the comparison of mean score of respiratory rate in the holding area in the study group during pre test & post test using paired t test. Comparison of the pre test and post test showed a statistically significant improvement in the post test mean score of respiratory rate in the holding area, intraoperative and the PACU than the pre test mean score of respiratory rate in the holding area, intraoperative and the PACU.

Table.11 Distribution of blood pressure among subjects in perioperative period

Blood pressure	Holding area		OT		PACU	
	No	%	NO	%	No	%
a) Normal	23	46	29	58	23	46
b) Pre HTN	13	26	17	34	16	32
c) I Stage	09	18	03	06	07	14
d) II Stage	04	08	0	0	03	06
e) Hypotension	01	02	01	02	01	02

Table 11 demonstrates the distribution on blood pressure among subjects. The analysis shows that majority 46% (n=23), 58% (n=29) and 46% (n=23), had normal blood pressure in the holding, intraoperative and PACU respectively.

Table.12 Repeated Measures ANOVA of blood pressure at various time periods in perioperative period

Timeperiods	Holding area		Intraoperative		PACU		F value (systolic)	F value (diastolic)
	Mean	SD	Mean	SD	Mean	SD		
T1 (30 mts)	126.50	21.56	117.04	19.72	123.58	25.2	7.185*	4.163*
	72.64	10.63	70.35	12.90	71.82	9.36		
T2 (1hr)	109.78	53.03	118.12	21.32	127.02	18.96		
	71.26	10.85	70.28	10.84	72.44	9.65		
T3 (1½ hrs)	130.06	23.83	116.56	16.26	125.59	25.10		
	72.18	8.08	70.14	9.51	71.11	9.90		
T4 (2hrs)	119.00	10.50	115.63	13.82	125.95	18.78		
	67.75	7.04	71.43	10.72	72.00	7.95		
T5 (2½ hrs)	119.50	2.12	114.30	13.71	126.34	17.04		
	71.00	1.41	70.50	9.31	70.03	7.48		
T6 (3hrs)	117.0	7.07	119.33	18.12	130.10	19.38		
	65.00	4.24	70.83	10.63	70.40	9.36		
T7 (3½ hrs)	117.0	7.07	116.73	18.52	131.07	18.04		
	69.00	1.41	70.30	10.74	70.56	11.16		
T8 (4hrs)	115.00	6.36	118.00	20.20	139.57	14.18		
	66.00	5.65	71.44	10.09	70.38	1.73		
T9 (4½ hrs)			124.56	13.63				
			71.47	8.26				
T10 (5hrs)			125.73	26.97				
			72.09	7.47				

Table 12 presents the repeated measures ANOVA of blood pressure over a period of time in the perioperative period. There is a statistically significant difference in the mean scores of systolic blood pressure and diastolic blood pressure measured at various time periods in holding area, intraoperative period and PACU at the level of p< .05.

Table.13 Comparison of pre-test and post-test mean score of blood pressure among patients

Core body Temperature	Duration	Mean	SD	Mean Difference	SD	't'value 'p'value
HoldingArea	Pretest	126.50	21.56	11.50	7.09	7.76 0.0001*
	Post test	115.00	6.36			
	Pretest	72.64	10.63	6.64	6.12	8.56 0.0001
	Post test	66.00	5.65			
Operative	Pre test	117.04	19.72	8.69	7.15	12.57 0.0001*
	Post test	125.73	26.97			
Intra	Pretest	70.35	12.90	1.74	5.78	6.52 0.0001*
	Post test	72.09	7.47			
PACU	Pretest	123.58	25.28	15.19	4.78	4.67 0.0001*
	Post test	139.57	14.18			
	Pretest	71.82	9.36	1.44	1.12	7.53 0.0001**
	Post test	70.38	1.73			

-p<0.01,*-p<0.001

Table 13 interprets the comparison of mean score of systolic and diastolic blood pressure in the holding area in the study group during pre test & post test using paired t test. Comparison of the pretest and post test showed a statistically significant improvement in the post test mean score of systolic and diastolic blood pressure in the holding area, intraoperative and the PACU than the pre test mean score of systolic and diastolic blood pressure in the holding area, intraoperative and the PACU.

SECTION E: Distribution of hypothermia prevention strategies among subjects in perioperative period

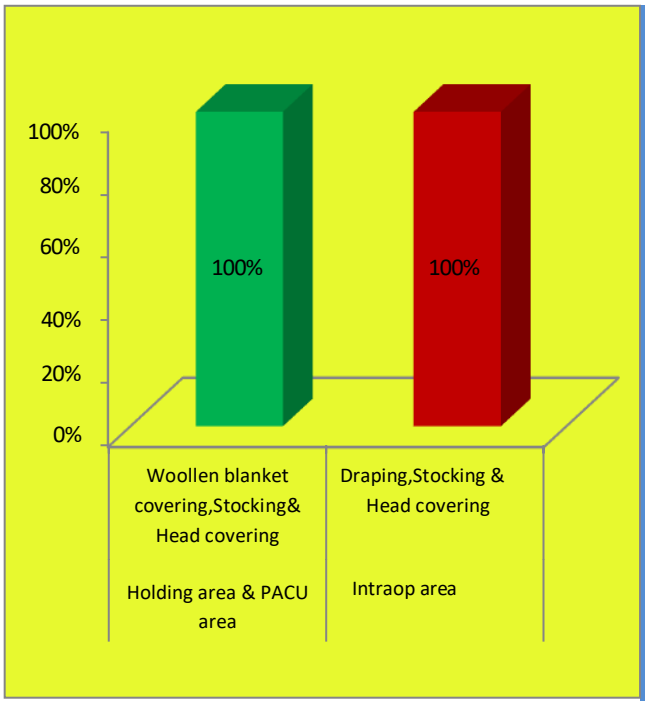


Figure 7: Distribution of passive warming devices used among subjects.

Figure 7 demonstrates the distribution of hypothermia prevention strategies among patients. In holding intraoperative area and PACU.100% (n=50) of subjects had received passive warming devices such as woolen blankets, stocking head, covering and draping (OT).

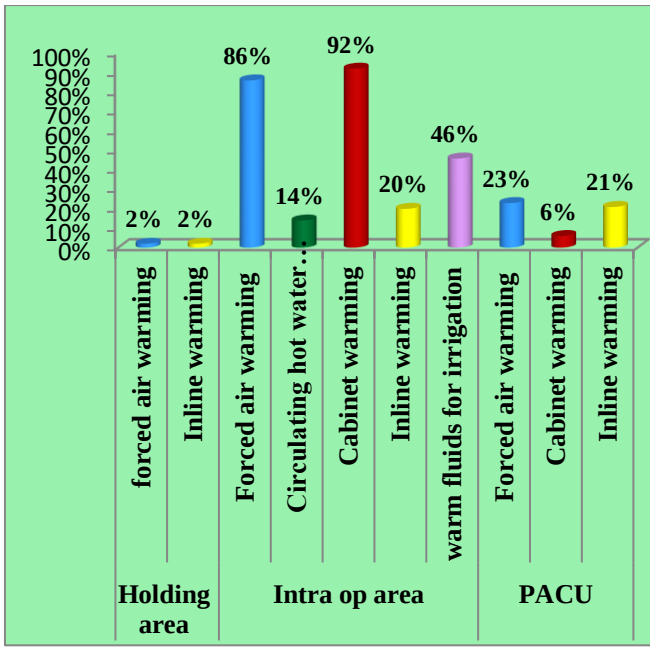


Figure 8: Distribution of active warming devices used among subjects.

Figure 8 shows that active warming devices 2% (n=1) of subject was on forced air and inline warming in holding area, 86% (n=43) were on forced air warming devices, 14% (n=7) were on circulating hot water mattress, 92% (n=46) were on cabinet warmingdevices,20%(n=10) were on inline warming devices, 46% (n=23) were on fluid warm irrigation in intraoperative area. In PACU, 46% (n=23) were on forced air warming devices, 12% (n=6) had received cabinet warming and 42% (n=21) inline warming devices.

SECTION F: Association between core body temperature with selected demographic variables, clinical variables and risk factors of hypothermia in perioperative period.

i. In holding area.

The results shows that there is a statistically significant association between core body temperature and duration of stay at $p<0.05$. There is no statistical significant association between core body temperature with selected demographic variables and clinical variables in holding area.

ii. In intraoperative period.

The results shows that there is a statistically significant association between core body temperature with duration of stay at ($p <0.05$) and surgical procedures ($p<0.001$). There is no statistically significant association between core body temperature with selected demographic variables and clinical variables in intraoperative period.

iii. In PACU

The results shows that there is a statistically significant association between core body temperature and age group at $p*<0.05$. There is no statistically significant association between core body temperature with selected demographic variables and clinical variables in PACU.

NURSING IMPLICATIONS

Nursing practice

- Preoperative nurse should intervene, depending on the patient's preoperative temperature, to normalize or maintain the patient's temperature before surgery.
- The nurse should provide passive warming measures before surgery (eg, head coverings, socks) to maintain the patient's temperature and plan for warming measures in the OR to prevent inadvertent hypothermia (eg, forced- air warming, warmed irrigation and IVfluids, reduced body exposure to room air, elevated OR

temperature).

- The nurse should plan to implement all methods of temperature maintenance and preservation available for these patients.
- Perioperative nurses should collaborate with the surgeon and anesthesia care provider to determine the advisability of increasing the OR temperature, using warm irrigationfluids, and instituting forced-air warming.

Nursing Education

- The perioperative educator ensures that the health care providers in the perioperative responsible need to be trained on tympanic membrane temperature monitoring.
- Nursing students should be taught about her risk factors for hypothermia in Operation theatre and its preventive strategies
- Nursing curriculum should include session on hypothermia prevention among patients posted for surgery.

Nursing Administration

- Standardized protocol Prevention hypothermia can be implemented. Policies and procedures should be made clear to the recovery room nurses in Operation Theatre about hypothermia prevention
- Nurse administrator should plan and organize continuing nursing education on prevention hypothermia or non –Maintenance of normal body temperature which includes maintaining the patient's temperature, providing pain control, and ensuring hydration. Increasing ambient room temperature, providing warm blankets, and minimizing skin exposure.
- Nurse administrators can organize educational programs such as short term course, refresher course, seminar, workshop and conferences in collaboration with Members of the multidisciplinary team to update the nurses in order to ensure effective patient care.

Nursing Research

- Nurses can use this study results for the implementation of protective actions against hypothermia may have a strong impact on patient safety and eliminate perioperative hypothermia.
- Better understanding of factors associated to the development of hypothermia provides evidences to support nurses' decision making to implement interventions for hypothermia prevention or treatment.

LIMITATIONS

- Study was limited to a small setting without randomization.
- The result cannot be generalized toother hospital OT's.
- As sample size are small, the results cannot be generalized.

RECOMMENDATION

- A study can be replicated involving large population and sample for a longer period. So that, the findings can be generalized.
- A similar study can bed one in other hospital settings.

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