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Predictors of Intraoperative Hypothermia among Patients Undergoing Major Abdominal Surgeries

[1]Wafaa Ibrahim Mahmoud, [2]Amel.Gomaa.Abd El-Naby, [3]Hala Ibrahim Abo Deif, [4] Hany.M.EL-Hadia

[1]Clinical Instructor of Medical Surgical Nursing,

[2]AssistantProfessor of Medical Surgical Nursing,

[3]Lecturer of Medical Surgical Nursing,Faculty of Nursing, Cairo University, Egypt

[4]Lecture of anesthesia,Faculty of Medicine, Cairo University, Egypt.

Corresponding author email: wafaa.ibrahim2014@yahoo.com

Phone number: 01207080559

Abstract: **Thermal imbalances are very common during surgery. Hypothermia exposes the patient to post-operative shivering, cardiac dysfunction, coagulopathy, bleeding, wound infection, delayed anesthesia recovery, prolonged hospital stay and increased hospitalization cost. Aim: The aim of this study was two folds: first to assess the predictors of intra-operative hypothermia (IH) second to estimate it's incidence among patients undergoing major abdominal surgeries. Design: Descriptive/predictive research design was used. Setting: This study was conducted in general surgery operating rooms, at Kaser EL-Aini Hospital-affiliated to Cairo University Hospitals. Subjects: A convenient sample of 100 adult male and female patients who had undergone major abdominal surgeries. Tools: Three tools were utilized to gather data (a) Demographic data tool, (b) Predictors of intra-operative hypothermia assessment tool and (c) Intra-operative hypothermia severity measuring tool. Results: the findings of this study revealed that the mean age and SD of the studied sample were (42.3 ± 7.15) years. Most common predictors of IH among the studied sample were preoperative fasting time, duration of anesthesia, operating room temperature, intra-operative blood loss, type of operation & pre operative temperature as indicated by linear regression analysis. Conclusion: The current study concluded that prolonging preoperative fasting time, duration of anesthesia, decreased preoperative patient's temperature, operation room temperature and increase intra-operative blood loss were the predominant predictors for the occurrences of (IH). Recommendation: Replication of the study on larger probability sample selected from different geographical areas in Egypt is recommended to obtain more generalizable data**

Keywords: **predictors - intraoperative hypothermia –-abdominal surgery.**

1. INTRODUCTION

Intraoperative hypothermia (core temperature < 36 °C) remains a threat to all surgical patients undergoing general anesthesia. It's a frequently preventable complication with several adverse consequences. The prevalence of perioperative hypothermia affecting up to 90% of surgical patients per years**. (**Torossian et al., 2015). Recent studies in Malaysia and china which carried out by lai et al., (2019) and Yi et al., (2017) displayed that incidence of intra-operative hypothermia

was as high as (53.2% and 44.3%) respectively. Intra-operative hypothermia transpires due to disruption of thermoregulation by anesthesia coupled with cold exposure to procedural surroundings and cleansing agents (Swain, Yared, Doty& Wilson, 2015).

Body temperature management is one of homeostasis mechanisms, human body maintain core temperature within certain limits by keeping balance between heat production and heat loss. Body produces heat by increasing metabolic rate, physical activity and thermogenesis which mainly occur by shivering. Heat loss in the intra-operative period occurs by different routes such as radiation which represent about 40% to 60%, convection account for 25% to 50%, conduction stand for 10% and evaporation up to 25% (Abdeltwab et al. 2017).

During general anesthesia; there are three phases of heat loss; the first phase is the quick sharp fall in core body temperature which is seen during the first 40-60 minutes of anesthesia; where there is re-distribution of heat from core to periphery which is caused by vasodilatation caused by anesthetics, the second phase is a linear decrease in core body temperature caused by difference between heat production and loss and the last phase is the plateau phase caused by vasoconstriction ,The rapid redistribution phase causes heat to be redistributed from core to periphery that can decrease core temperature by 0.5-1.5°C. General anesthetics also decrease the triggering core temperatures for vasoconstriction and shivering by 2°C to 3°C (Pereira & De Mattia, 2019).

There are many predictors may contribute to an increased the occurrences of IH such as major surgery with large open surface, duration of surgery or anesthesia for more than two hours, epidural anesthesia combined with general anesthesia, and over four liters of applied intravenous fluid (Bandic et al., 2015). In addition; predictors of IH are numerous such as cold theatre, wearing a theatre gown, exposure to cool temperatures on transfer to theatre, the use of cool skin preparation fluids, administering unwarmed intravenous fluids or blood products, pre-medications such as muscle relaxants (Alparslan, et al .,2018).

Intra-operative hypothermia may result in serious complications affecting the surgical outcome of the patients in terms of morbidity and mortality such as cardiac abnormalities, coagulopathies, impaired wound healing and susceptibility to surgical site infection, slowed drug metabolism that causes prolonged drug action that delays recovery and other metabolic disorders (Association of surgical technology, 2015).In addition,a study conducted by (Bilgin, 2017) pointed out that intra-operative hypothermia can lead to immediate postoperative complications such as blood loss, hypoxia and prolonged recovery time.

A comprehensive nursing assessment is the first step in providing high quality of care, the nurse should assess predictors, observe the signs and symptoms of IH, such as cool skin, tachypenia, and low body temperature also, inspect the skin color and any abnormalities during operation. (Conway, Ersotelos, Sutherland & Duff, 2018). Nurses must have adequate knowledge about the predictors, clinical manifestations and complications of intra-operative hypothermia. It is crucial that nursing continuously measure temperatures, and take precautions to maintain a stable body temperature throughout surgical procedures. Therefore, the purpose of the current study was to provide nurses as well as health care professionals with information about predictors and incidence of intra-operative hypothermia among patients undergoing major abdominal surgeries. Also, these research findings will be utilized by health care professionals through identifying patients at risk for IH and implementing warming measures to prevent IH and its complications.

Significance of the Study

Patients who had undergone major abdominal surgeries were prone to the development of IH than other surgeries. In Egypt, recent study carried out by Abdeltwab et al., (2017) investigate the "Impact of Induced Normothermia on Occurrence of Post Anesthetic Shivering and Wound Infection among Patients Undergoing Abdominal Surgeries" found that 70% of the control group developed IH.

During the clinical experience the investigator observed that a large number of patients suffered from sudden drop in temperature especially after general anesthesia, there were not any warming measures had taken to decrease incidences of IH. Review of literature showed that there were few studies about intra-operative hypothermia. Also, scanty Egyptian studies exist in the literature. Furthermore, few published studies emphasized on the intra-operative temperature pattern. Rather most publication had focused on postoperative temperature and outcomes.

In fact, perioperative nursing seeks the high quality of care and safety of the surgical patients Hence, nurse should determine patients at risk for development of IH by assessing predictors, classifying patients into no, low, moderate and high risk for IH as well as monitoring patients' body temperature during surgery to detect and deal with signs and symptoms of IH. Also, it's necessary to develop effective intervention plans and implement preventive measures for intra-operative hypothermia among surgical patients in order to avoid IH complications and enhance surgical patient's outcomes.

Therefore, this study could be beneficial in providing health care providers; especially nurses with data base regarding IH. Also, it utilized by health care professional in the provision of care for such group of patients. Furthermore, this research finding could be helpful in maintaining cost effectiveness, patient's care, as it might protect patients against complications; also it was hoped that this effort will generate attention and motivation for further researches in this area.

2. MATERIAL & METHODS

Aims of the study:

- Assess the predictors of intra-operative hypothermia among patients undergoing major abdominal surgeries.
- Estimate the incidence of intra-operative hypothermia among patients undergoing major abdominal surgeries

Research Questions:

To fulfill the aims of this study the following research questions are formulated:

-What are the predictors of intra-operative hypothermia among patients undergoing major abdominal surgeries?

- What is the incidence of patients who develop intra-operative hypothermia?

Research Design:

Descriptive/predictive research design was utilized in the current study. Descriptive research helps researchers, plan and carry out descriptive studies that describe, observe, and document aspects of a situation, process, event, outcome and other phenomena. While predictive research was designed to predict the variance of one or more variables based on the variance of another variable, the study variables are classified as independent (predictors) and dependent (intraoperative hypothermia). However, these variables are not manipulated, but occur naturally (Polit& Beck, 2014 ; Sousa,Driessnack& Mendes, 2015)

Setting:

This study was carried out in general surgery operating rooms, at Kaser EL-Aini Hospital-affiliated to Cairo University Hospitals.

Subjects:

A convenient sample of 100 male and female adult patients through consecutive 6 months from July 2018 to January2019, patients age >18 years. The following selection criteria were established: patients undergoing major abdominal surgeries receive general anesthesia and/or epidural anesthesia, and length of operation time is not less than two hours. On the other hand, patients with any of the following conditions excluded from the study: high central fever caused by cerebrovascular disease, cerebral trauma, cerebral operations, epilepsy, or acute hydrocephalus, infectious fever with core temperature one week before operation higher than 38.5°C, thermoregulation abnormalities (e.g., malignant hyperthermia, neuroleptic malignant syndrome) and patients who received any warming methods

Tools:

Data pertinent to the study were collected by using the following three tools:-

Tool (a): Demographic data tool: This tool covering data related to age, gender, and level of education, occupation and marital status…..etc.

Tool (b): Predictors of Intra-operative Hypothermia Assessment Tool: was developed by the investigator, it consisted of two parts: the first part covered predictors related to patient such as active smoking ,obesity …….etc and the second part included predictors related to operation such as type of operation, Length of operation ,Type of anesthesia, Operation room temperature and duration of anesthesia…….etc

As regard the scoring system "zero" indicate no predictor; while (score 1) indicates presence of weak predictor; the (score 2) indicate presence of strong predictors with total score of (14). The interpretation of this tool's score described as the following: no risk (0-3), mild risk (4-7), moderate risk (8-11), high risk more than12.

Tool (3): Intra-operative Hypothermia Severity Measuring Tool: was developed by the investigator through extensive review of literature. It covered data related to the severity level of patient's temperature and signs and symptoms of mild, moderate and severe intra-operative hypothermia where the investigator measured patient' body temperature during operation after 30 minutes from induction of operation until the end of operation. .

Validity and reliability

Content validity of the developed tools was established to identify the degree to which the developed tools measures what it is supposed to be measured. It is tested by subjecting the tools to a panel of three experts, one expert in the field of medical surgical nursing and two experts in the field of anesthesia medicine. Each expert was asked to examine the tools for content coverage, clarity, and whether the included items are suitable to achieve the aim of the current study. Reliability was assessed using Cronbach's Alpha which showed satisfactory level = (0.91).

Ethical consideration:

In order to protect the human rights an official permission was taken from the ethical committee. Also, approval was obtained from hospital/clinic administrators. Each participant in the study was informed about the nature and purpose of the study. The researcher give emphasis to participation in the study is entirely voluntary as they can withdraw at any time; anonymity and confidentiality are assured though coding the data. After that oral and written informed consent was obtained from all participants.

Procedure:

The current study was conducted in two phases: preparation phase and implementation phase. **Preparation phase:** This phase achieved thorough review of the pertinent literature regarding intra-operative hypothermia and its predictors, reviewing other studies, searching for the available tools and seeking expert's advice. In addition to, obtaining the official permission to proceed with the proposed study.

Implementation phase:

At this point the investigator obtained names of potential subjects who met the criteria for possible inclusion in the study daily from the head nurse of the selected general surgery. At that time; in the waiting room, the purpose and the nature of the study explained to each potential patient individually, as well as all other ethical considerations mentioned previously also assured. Subjects who choose to participate in the study, then, were asked to sign the consent form. Demographic data tool completed firstly. Then data of this study including predictors related to patient such as preoperative fasting hours, preoperative temperature and BMI by using predictors of intra-operative hypothermia assessment tool collected and measuring patient's temperature before induction of anesthesia by using tympanic thermometer. In operating room, predictors related to operating room such intravenous fluid replacement and blood loss and the intra-operative hypothermia Severity measuring tool was completed, after 30 minutes from the induction of anesthesia for every patient, the body temperature is monitored using tympanic thermometer and it was measured every 30 minutes till the end of operation. At the same time the investigator continue to observe signs and symptoms of IH and measuring the temperature of operating room by using electronic thermometer. Data tabulated and subjected to statistical analysis to answer the formulated research questions**.**

Statistical analysis:

Upon completion of data collection, obtained data was tabulated, computed and analyzed using statistical package for the social sciences (SPSS) program version 20. Descriptive and Inferential statistics were utilized to analyze

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data pertinent to the study. Descriptive statistics included frequency, percentage distribution, mean and standard deviation. While, inferential statistics included *t*- test to explore if there was significant difference between intra-operative hypothermia and predictors of intra- operative hypothermia. Moreover, *t*- test to explore if there was significant correlation between intra-operative hypothermia and demographic data. A probability level of 0.05 was adopted as the level of significance.

3. RESULTS

Statistical findings of the current study divided into two sections: **Section (I):** described the demographic characteristics and medical related data (Tables 1) **Section II: answer the formulated research questions**; (table 2) represented the predictors of intra-operative hypothermia, **(**table 3) showed the risky level of IH and regression analysis of IH (table 4)

Section I:

Table (1) Frequency and Percentage Distribution of demographic Data among Study sample (N = 100).

Variables	Values	No.	%
Age	20-29	4	4
	30-39	24	24
	40-49	57	57
	50-60	15	15
	Mean± SD 42.3 ± 7.15		
Gender	Male	40	40
	female	60	60
Occupation	employee	55	55
	not working	45	45
Education	Cannot read or write	9	9
	Read & write	34	34
	Primary	1	1
	Preparatory	6	6
	secondary	28	28
	collage	22	22
Residence	Rural	34	34
	Urban	66	66
Marital status	single	13	13
	married	82	82
	widow	3	3
	divorced	2	2

As shown in table (1), the study sample consisted of 100 adult patients, their mean age & SD was 42.3 ± 7.15 years, and the common age group was 40-50 years with a percentage of (57%). In relation to gender, studies were predominantly female (60%). Regarding the marital status, the overwhelming majority were married (82%). In relation to education, about (34%) of the studied sample read and write, and fifty-five percent were employed. Concerning place of residence, nearly two thirds of the studied subjects (66%) came from urban areas.

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Section II:

Table (2) Frequency and Percentage Distribution of Predictors of Intra-operative Hypothermia (N:100)

Variables	Values	No.	%
Preoperative fasting hrs	from6-8hours	12	12.0
	from 9-11 hours	47	47.0
	from 12-14 hours	41	41.0
Pre anesthetic medications	antibiotic,antiacide	28	28.0
	antiacide	1	1.0
	no	69	69.0
	anti biotic,antiemtic	2	2.0
BMI	underweight	6	6.0
	normal	33	33.0
	over weight	32	32.0
	Class I obese	21	21.0
	Class II obese	5	5.0
	mean &SD=26.5± 4.4		
Intravenous fluid replacement	<1000ml	24	24.0
	>1000ml	76	76.0
Intraoperative irrigation	no	37	37.0
	<500ml	20	20.0
	>500ml	43	43.0
Duration of anesthesia	2 hours	48	48.0
	>2hours	52	52.0
Operational room temperature	21	35	35.0
	22	18	18.0
	23	22	22.0
	24	23	23.0
	25	2	2.0
Blood loss	<5ooml	45	45.0
	> 500ml	55	55.0
Blood transfusion	> 500 ml	30	30.0
	< 500 ml	70	70.0
Smoking	no	68	68.0
	yes	32	32.0
History of previous surgical operation	no	31	31.0
	yes	69	69.0
Preoperative temperature	35-<36	32	32.0
	36-<37	68	68.0
Oxygen flow	3	8	8.0
	4	5	5.0
	6	86	86.0
	12	1	1.0
Type of operation	mesh hernioplasty	39	39.0
	open exploration	27	27.0
	open cholecystectomy	8	8.0
	spleenectomy	5	5.0
	abdominoplasty	7	7.0
	colostomy	6	6.0
	closure colostomy	8	8.0

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Table (2) revealed that, the mean BMI of the studied sample were 26.5 ± 4.4, about (33%) of them had normal BMI, and only (3%) had morbid obesity. In relation to preoperative fasting hours nearly half of the studied sample (47%) were fasting from 9 to 11 hours and (12%) of them were fasting from 6 to 8 hours, as regard type of operation about (39%), (27%), (8%), (7%), (6%) and (5%) of the study sample had mesh herinoplasty, open exploration, open cholecystectomy, closure colostomy, abdominoplasty, colostomy and spleenectomy respectively. Considering fluid replacement more than two third (76%) of the studied sample had intravenous fluid replacement more than 1000 ml, and (43%) were having intravenous fluid irrigation. In relation to duration of operation about half of the studied samples (52%) were more than two hours, pertinent to room temperature bout (75%), ranging between 20° C to less than 23 ° C presents. Considering blood loss more than half of the studied subjects (55%) were losing more than 500 ml blood. As regard blood transfusion about (70%) of they were receiving less than 500 ml blood. As regard preoperative temperature bout (32%) of the studied sample their temperature ranging between 35.0° C to more than 36 ° C.

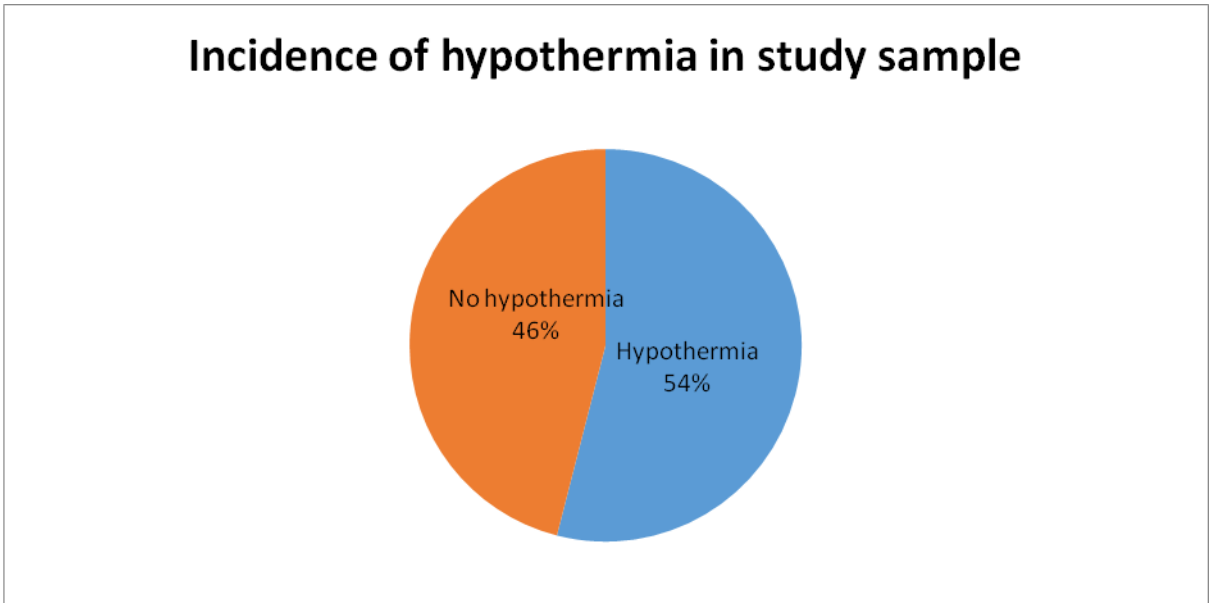
Table (3) Frequency and Percentage Distribution of patients at risk for intra-operative hypothermia according to Predictors of Intra-Operative Hypothermia Assessment Tool (N: 100)

Risk level	N	%
No risk	5	5
Low risk	37	37
Moderate risk	45	45
High risk	13	13
Total	100	100

Table (3) revealed that, more than half of the study sample (58%) is more risky for the development of intra-operative hypothermia.

Note: Total sore (14), no risk = (0-3), mild= (4-7), moderate= (8-11), high risk more than12.

Figure (1) Pie chart represents the incidence of intraoperative hypothermia among the study sample (**N: 100)**



This figure showed that 54% of the sample study had intraoperative hypothermia

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Table (4): Results of linear regression analysis for predictors of intra-operative hypothermia sample study (N: 100)

Predictors	r	Unstandardized coefficients		t-test	p	ANOVA test	p
		β	S.E				
Age	-0.021	-.002-	.009	-.237	.813	0.04	0.83
Gender	0.010	.085	.164	.514	.609	0.01	0.91
Preoperative fasting hrs	-0.235	-.221-	.093	-2.367	.020*	5.6	0.02*
Preanethetic Medications	0.098	.12	.13	0.96	.33	0.93	0.33
BMI	0.076	.062	.054	1.145	.256	0.55	0.45
Intravenaus fluid replacement	-0.007	-.213-	.163	-1.310	.194	0.004	0.94
Intraoperative irrigation	0.044	.281	.098	2.852	.006*	0.18	0.66
Duration of anesthesia	-0.04	-1.633	.812	-2.012	.047*	4.10	.047*
Type of operation	-0.31	-0.39	0.12	-3.25	0.002*	10.5	0.002*
Operating room temperature	0.285	.115	.049	2.355	.021*	8.46	0.005*
Intraoperative blood loss	-0.210	-.268-	.12	-2.1	.03*	4.41	0.03*
Blood transfusion	0.058	.060	.177	.337	.737	0.32	0.57
Smoking	0.102	.160	.176	.910	.366	0.99	0.31
CO-morbid diseases	-0.158	-.150-	.159	-.942	.349	2.44	0.12
History of previous surgical	0.086	.142	.131	1.083	.282	0.71	0.4
Pre – operative temprature	0.450	.691	.193	3.588	.001*	24.4	0.0001*

Table (4): represented the liner regression of the predictors of intra-operative hypothermia, it in which preoperative fasting hours, duration of anesthesia, operating room temperature, intra-operative blood loss, type of operation and pre operative temperature were the most predominant predictors of intra-operative hypothermia among the study sample.

4. DISCUSSION

Intra-operative hypothermia (IH) during a surgical procedure leads to various postoperative complications. Maintaining homeostasis during surgery is vital to promoting health and preventing this complication. this research supported predicting the factors that leads to intra-operative hypothermia for better postoperative outcome.

The study sample consisted of 100 adult patients; the common age group was 40-50 years. In relation to the gender, the majority of them married and being females. In relation to education, thirty four of the study samples can read and write and fifty five percent were employed. Concerning place of residence, less than two thirds of the study sample came from urban areas.

The current study revealed that, the mean age of the study sample was 42.3 ± 7.15, that reflect the majority of patients were in middle-aged adult. This finding is consistent with study carried out by Yi et al., (2015) entitled as "Establishment and Validation of a Prediction Equation to Estimate Risk of Intra-operative Hypothermia in Patients Receiving General Anesthesia". They reported that that risk of hypothermia is particularly high in patients over 60 years of age. Pertinent to age the literature explained that elderly patients had both more pronounced and more prolonged hypothermia than younger patients, in addition elderly patients had lower average temperatures than younger patients. Also, Elderly patients appear to have delayed ability to compensate for hypothermia (Slagle, 2015).

In relation to gender in the current study, overwhelming majority of the study sample were females. This result was in agreement with the studies conducted by Denu, et al., (2015), Warttig et al., (2016), Yi et al., (2017), Abdeltwab et al., (2017) and Carter (2018) as they mentioned that, the majority of their studied samples were females. Studies by Pereira, and De Matti (2019) indicated that females are more likely to develop hypothermia because women have less muscle mass and higher body surface index, leading to greater heat loss to the environment. Pertinent to gender the literature explained that gender doesn't show a difference on incidence of intra-operative hypothermia. Denu, et al., (2015)

As regard predictors of IH, preoperatively the study sample fasting hours were from 9 to 11hr (47%) & from 12 to 14hr (41%) The possible explanations for this result could be that, the more the fasting hours the more the occurrences of intra-operative hypothermia. Furthermore, that finding was supported by Healy, O'Sullivan, and McCarthy (2019) in studying a nurse-led audit on the incidence and management of inadvertent hypothermia in an operating theatre department of an Irish hospital; they reported that the extended period of fasting more than10 hour, may contribute to a reduction in core body temperature.

In the current study operating room temperature, about more than two third of the study sample had gone abdominal surgery patients are exposed to cold operating room ranged between 20° C to less than 23 ° C, this finding was supported by Denu,et al., (2015) ,Yang et al., (2015) ,Torossian et al .,(2015) , Carter (2018) and Sessler (2014) in which they reported that one major factor in the occurrence of lowered body temperature is a patient's exposure to the operating room cold environment, which can range from 18-23 degrees Celsius in addition, they revealed that the higher operating room (OR) temperature the higher patient body temperature also, they indicated that operation room temperature was 24°C relation with the occurrences of intra-operative hypothermia. Also, they added that The surgical center is an environment conducive to the development of IH due to the association between the low temperature of the OR, the performance of antisepsis of the skin of the patient with the body discovered, the infusion of cold solutions during the procedure, inhalation of cold gases, open cavities or wounds, and the use of anesthetic drugs that alter the mechanism of thermoregulation, inhibit tremors and produce peripheral vasodilatation.

Pertinent to duration of operation nearly half of the study sample lasted more than two hours in the operating room developing IH, this finding was supported by Denu,et al., (2015) & Bandic et al., (2015) ,Yang et al., 2015) , Yi et al., (2017) and Carter (2018) as they concluded that longest surgical and anesthetic duration >2 hr significantly contributed to intra-operative hypothermia . It is known that heat loss is higher and hypothermia is more frequent in long-lasting surgical procedures.

As regard fluid replacement the current study revealed that more than two third of the studied sample received intravenous fluid replacement more than 1000 ml, without warming measures. This finding is consistent with a study conducted by Yi et al., (2017) & Yanaral and Ertugrul (2019) , (Slagle, 2015) and Carter (2018) revealed that un-warmed intra-operative fluids greater than 1000 ml may contribute to intra-operative hypothermia development.

The present study revealed that, the majority of the study sample had intra-operative hypothermia (54%). This result was similar to lai, et al., (2019) and Morozumi, el at., (2019) as they reported that, more than half of their studied sample had intra-operative hypothermia (53.2%) and (54.8%) respectively. Also, These findings are congruent with lohsiriwat & Jaturanon (2019) and Zangmo,Chatmongkolchart& Sangsupawanich (2019), yi et al., (2017) and Abdeltwab et al., (2017) who reported that, majority of their studied sample had intraoperative hypothermia (77%), (61.5), (44.3%) and (70%) respectively.

In the current study, there were cumulative factors contribute mostly to the increased incidence of patients developing IH such as pre operative fasting time , duration of anesthesia, operating room temperature, intra-operative blood loss, type of operation and pre operative temperature as indicated by linear regression analysis, these finding was congruent with Carter (2018) in Evaluating Risk Factors and Postoperative Outcomes in Surgical Laryngectomies with Intra-operative Hypothermia as the author denoted that, preoperative core body temperature less than 36 degrees Celsius, general anesthesia, surgery time greater than two hours, un-warmed intra-operative fluids greater than 1000 ml, surgeries cold intra-operative setting considered the most risk factors associated with IH.

5. CONCLUSION

The current study concluded that prolonged preoperative fasting hours, duration of anesthesia, decrease pre operative patient's temperature, operation room temperature, type of operation and increase intra-operative blood loss were the predominant predictors for the development of intra-operative hypothermia.

6. RECOMMENDATIONS AND IMPLICATIONS

1-Replication of the study using a larger probability sample selected from different geographical areas in Egypt.

2- Carry out studies related to perioperative hypothermia complications.

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