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Perioperative Hypothermia and Predictors of Intra-Operative Hypothermia among Patients Operated at Gondar university Hospital from March to April 2015

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Abstract

Background: Humans maintain constant body temperature within a wide range of changes in external environment. Core body temperature is maintained within narrow range; Enzyme systems in the body have narrow temperature ranges in which they function optimally for caring out different activities in the body as metabolism, conduction of nervous function and skeletal muscle contraction. Perioperative hypothermia is one of the major problems during surgery that can affect operated patients. It has been shown by different researchers that Perioperative hypothermia will result in to various adverse events such as myocardial ischemia, coagulopathy, delayed awakening and wound infections.

Objective: The objective of this study was to determine incidence of perioperative hypothermia and determinant factors among patients operated in Gondar university hospital from March to April, 2015.

Methods: A prospective observational study was conducted to determine incidence of perioperative hypothermia and associated risk factors among patients that underwent surgery in Gondar university hospital. All consecutive patients from both elective and emergency surgery were included in this study.

Result: A total of 312 patients were participated in this study. The incidence of Pre, Intra and post-operative hypothermia were 23.4%, 49.7% and 50.6% respectively. Use of general anesthesia (AOR=2.3), co-morbidity (AOR=2.1), low body temperature before the start of anesthesia (AOR=4.7) and elective procedures (AOR=2.1) were found to be independent predictors of intra-operative hypothermia.

Conclusion and Recommendation: The incidence of perioperative hypothermia is high in Gondar University Hospital. Passive and active warming techniques should be implemented in the hospital.

Keywords: Hypothermia; Gondar; Ethiopia

Background

Humans maintain constant body temperature despite of changes in external environment [1]. Core body temperature is maintained within narrow range; because enzyme systems in the body have narrow temperature ranges in which they function optimally for caring out different activities in the body as metabolism, conduction of nervous function and skeletal muscle contraction [2].

Hypothermia is defined as core body temperature of <36°C. It could be classified in to three as mild (35-35.9°C), moderate (34-34.9°C) and severe when core body temperature is ≤ 33°C [3].

Patients under Anesthesia and surgery can have altered thermoregulation due to different reasons. These mechanisms include loss of normal response to heat loss (lack of shivering), increased heat loss to environment when body cavity is opened to cold operation room environment, cooling effect of cold anesthetic gases and reduced body heat production due to reduced metabolic rate [4].

Heat can be lost during surgery by different mechanisms. There are four means of heat loss. The dominant one is heat loss by radiation which accounts for 60% of heat loss. Any objects with temperature above absolute zero degree can lose heat to objects surrounding it [5]. The second means of heat loss is heat loss by convection which is facilitated by temperature difference between the patient and objects. This type of heat loss constitute for 20% of heat loss during surgery [6].

Heat loss by conduction is another means of heat loss which occurs due to direct contact of the patient with objects. Cold operation room table and cold OR attires facilitate this type of heat loss [7].

Evaporative and respiratory tract heat losses are other means of heat loss which are heat loss that occur via skin and respiratory tract. Evaporative heat loss mainly occurs by use of cold skin preparation solutions, while heat loss via respiratory system is facilitated by use of cold and dry anesthetic gases [8].

Mild intentional hypothermia is sometimes induced in an attempt to reduce cerebral and myocardial ischemia, but there are ample evidences that showed that hypothermia will have many adverse consequences on surgical patients [9].

Hypothermia is one of common events during perioperative time and can have different consequences that increase perioperative morbidity and mortality. A core temperature of less than 34°C is highly associated with mortality due to coagulopathy, metabolic acidosis, multiple organ failure, hemodynamic instability and infections [10].

Data on magnitude and local risk factors for perioperative hypothermia is lacking in our Hospital, hence the objective of this study was to determine incidences of pre, intra-operative and post-operative hypothermia, and predictors of intra operative hypothermia.

Methods

A prospective observational study was conducted after obtaining ethical approval letter from University of Gondar ethical review committee.

Sample size was calculated using single population formula. P was taken from previous study that showed proportion of hypothermic patients in the post anesthesia care unit as 30.7%, taking 95% confidence level and margin of error of 5% the minimum sample size was determined to be 328 patients.

All consecutive patients on both elective list and emergency cases of non-cardiac surgery during the data collection period (March to April, 2015) were included in the study except those patients with fever and short procedures under local anesthesia. Body temperature was measured using tympanic thermometer. Temperature was taken on arrival, immediately after induction, then after every hour till the procedure is finished. The post-operative temperature was taken every hour up to 2 hours considering that patients stay on average in the post Anesthesia care unit for 1-2 hours. This measurement was done using tympanic thermometer. Tympanic membrane temperature monitoring is often the preferred method in the preoperative and perioperative areas. The tympanic membrane is close to the carotid artery and hypothalamus and is a noninvasive and accurate measure of core temperature [11] With regard to accuracy of tympanic thermometer there are few data available, but one study conducted on 51 critically ill patients by comparing tympanic thermometer and thermistor of right heart catheters and rectal mercury thermometers showed that tympanic thermometer measurement is very accurate when used properly [12].

Data entry and analysis was done using SPSS version 20 and micro soft excel 2007. Tables and figures were used to describe descriptive results. Binary Logistic regression was used to test each factor with the dependent variable, and variables with P value of <0.2 were carried to multi variant analysis. 95% C.I. and P value of <0.05 was used as a cutoff point to test for significance of associations.

Result

Data was collected from 328 surgical patients, but only 312 questionnaires were taken for analysis. 6 patients were excluded because they had elevated body temperature on arrival to OR and the rest 10 participants were excluded because anesthetic duration was less than an hour. The mean age of participants was 31.7 years with standard deviation of 15.8. The proportion of female participants was 60%. Majority of participants were American society of Anesthesiologists' class I (ASAI) (85%). Forty four (15%) of participants had co morbidity. The leading co morbidity was HIV (34%). The mean BMI of participants was 21.2 with median of 21. The mean operation room temperature was 24°C with standard deviation of 1.9 (Table 1).

Variables	Number	Percentage
Age (years)		
Birth to 12 months	5	1.6
Preschool	5	1.6
School age	14	4.5
Adolescent	28	8.9
Adult	251	80.4
Geriatrics	9	2.9
Sex		
Male Female	126 186	40.4 59.6
Residence		
Rural Urban	148 164	47.4 52.6
BMI(kg/m^2)		
<18.5	47	15.1
18.5-24.5	229	73.4
25-30	27	8.7
>30	5	1.6
Co-existing illness		
Yes No	44 268	14 86
Procedures		
Head and neck	47	15
Upper abdominal	13	4.2
Lower abdominal	170	54.5
Thoracic	6	1.9
Extremity	42	13.5
Perianal	12	3.9
Others	22	7

Table 1: Socio demographic characteristics of surgical patients operated in Gondar University Hospital, March 1, to April 30, 2015 (n=312).

Anesthetic and surgical characteristics of study participants

Abdominal procedures, both lower and upper abdominal are the most commonly performed procedures in our Hospital, which accounted for 193 (61.8%), followed by extremity procedures which accounted 15%. With regard to invasiveness of the procedures, major

procedures constituted 44.5%, moderate and minor procedures constituted 46.8 and 8.6% respectively (Figure 1 and Table 2).

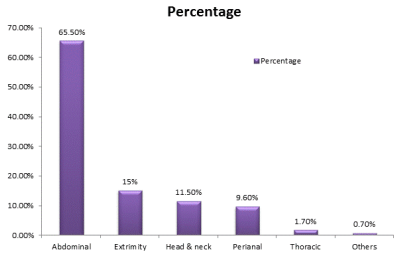

Figure 1: Common procedures performed in Gondar University Hospital from March 1 to April 30, 2015 (n=312).

With regard to Anesthetic type 52.2% were given general anesthesia and the rest were operated under Spinal anesthesia. From the general anesthesia group, 22.1% were given ketamine as induction. Thiopentone and propofol were used for 12.2 and 18.6% of participants respectively. The mean anesthetic duration was 102 minutes with standard deviation of 63 minutes and the median anesthetic duration was 80 minutes. The longest surgical and anesthetic duration were 340 and 800 minutes respectively.

Incidence of perioperative hypothermia

On arrival to operation room, over all patients had normal body temperature. The mean temperature on arrival was 36.3 with standard deviation of 0.7. Incidence of hypothermia before induction was 23.4%, of which majority (79.5%) was mild hypothermia. The incidence after induction of anesthesia was 30.5%. Most procedures were completed within 1-2 hours. There were 90 patients whose procedure time was between 2-3 hours and the incidence of hypothermia during this time was 72%. From the total patients enrolled to this study, there were only 24 procedures whose procedure time reached 3-4 hours. The incidence of hypothermia during this time was 87.5%.

The overall incidence of intra operative hypothermia was 49.7%. Of which; mild hypothermia was seen among 37.5%, moderate and severe hypothermia were seen among 10.3 and 1.9% respectively.

The overall incidence of post-operative hypothermia during this study was 50.6%, of this, mild hypothermia constituted 57.7%. Moderate and severe hypothermia were seen among 36.9 and 5.4% of patients respectively.

Factors associated with intra-operative hypothermia

When adjusted for other variables, type of anesthesia used, presence of co-existing illness, pre-operative temperature and urgency of surgery were found to be factors associated with intra-operative hypothermia. Accordingly the use of General anesthesia increased incidence of intra-operative hypothermia by more twice as compared to use of spinal anesthesia (AOR=2.3).

Variables	Numbers	Percentage
ASA Status		
ASA I	265	84.9
ASA II	45	14.4
ASA III	2	0.6
Anesthetic type		
GA	162	52
SA	150	48
Induction agent		
Ketamine	59	22.1
Thiopentone	38	12.2
Propofol	58	18.6
Post-operative analgesia		
Yes	186	60
No	126	40
Post-operative shivering		
Yes	55	17.6
No	257	82.4
Urgency of procedure		
Elective	143	45.8
Emergency	169	54.2
Duration of Surgery		
≤ 1 hour	119	38
>1hour	193	62
Intra operative blood loss		86.2
≤ 500 ml	269	13.8
>500 ml	43	
Time of operation		
Morning	119	38
Afternoon	78	25
Night	115	37

Table 2: Anesthetic and surgical characteristics among patients operated at GUH from March 1 to April 30, 2015; (n=312).

Those participants who had medical problems in addition to the surgical procedure were 2 times at risk to have intra operative hypothermia as compared to those with no medical problem (AOR=2.1). Low body temperature before induction has increased risk of hypothermia almost 5 times as compared to those with normal base

line temperature (AOR=4.7) elective procedures increased incidence of intra operative hypothermia by 2.1 times (AOR=2.1) (Figure 2 and Table 3).

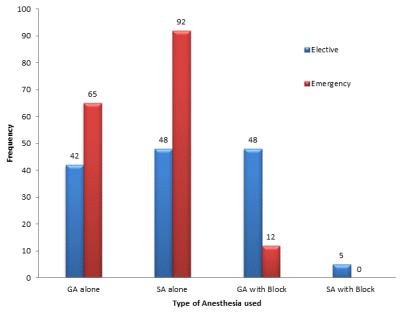

Figure 2: Comparison of Anesthetic modes used for elective vs. emergency procedures among patients operated in GUH, from March to April 30, 2015.

Discussion

With regard to socio demographic aspect participation of female patients was higher (54.5% vs 45.5%), but gender doesn't show any difference on incidence of hypothermia.

The incidence of pre, intra and post-operative hypothermia in this study was 23.4%, 49.7% and 50.6% respectively. Intra-operative hypothermia was observed in 155 (49.7%) patients with temperature ranging from 33 to 35.9°C. This incidence is higher when compared with study conducted by Arshad et al. in Pakistan, where incidence of intra operative was 25%, but lower than the incidence of intra operative hypothermia in study conducted by Ojas et al. in Australia where the incidence was 74% [13,14], but it is within the expected incidence range of perioperative hypothermia which is 50-90%.

Post-operative hypothermia was observed in 158 patients with a temperature ranging from 32.5 to 35.9°C. This incidence is higher when compared with studies done by Tadesse et al. and Luis et al. which were 30.7% and 32.4% respectively [15,16]

Out of the variables considered in this study only urgency of the procedure, co-morbidity; anesthetic type and preoperative temperatures were found to be independent predictors for intra-operative inadvertent hypothermia. Previous studies have shown that age is an independent risk factor for perioperative hypothermia, particularly neonates and older people were identified as those at higher risk, but in our study age doesn't show any association with intra-operative hypothermia which may be because of low proportion of these age groups in our sample [17].

Previous studies also have claimed that ASA class and amount of intra venous fluids used are risk factors of perioperative hypothermia, but in our study, we did not found a relation between these variables [18].

In this study general anesthesia showed association with intra-operative hypothermia. This can be discussed in different ways.

Variables	Intra operative hypothermia		COR (95% CI)	AOR (95% CI)	P value
	Yes	NO			
Anesthesia type					
GA	96 (62%)	67 (42%)	2.26 (1.39; 3.43)	1.84 (1.12; 3.01)	0.01
SA	59 (38%)	90 (60%)	1.00	1.00	
Co morbidity					
Yes	29 (18.7%)	15 (9.5%)	2.2 (1.12; 4.35)	2.1 (1.02; 4.4)	0.04
NO	126 (81.3%)	142 (90.5%)	1.00	1.00	
Type of Surgery					
Elective	93 (60%)	50 (31.8%)	3.21 (2.02; 5)	2.1 (1.25; 3.4)	0.005
Emergency	62 (40%)	107 (68.2%)	1.00	1.00	
Pre-operative temperature					
Normal Temperature	97 (62.6%)	142 (90.4%)	1.00	1.00	<0.001
Hypothermic	58 (37.4%)	15 (9.6%)	5.7 (3.03; 10.5)	4.7 (2.5;9.1)	

Table 3: Factors associated with post-operative hypothermia among patients operated in GUH, from March to April 30, 2015.

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 vaso dilatation 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 vaso constriction [19] The rapid redistribution phase causes heat to be redistributed from core to periphery that can decrease core temperature by 0.5-1.5°C [20]. This is particularly risky in a set ups where there are no warming devices, because the patient can further lose heat from relatively warm periphery to the OR. General anesthetics also decrease the triggering core temperatures for vasoconstriction and shivering by 2°C to 3°C [4].

The use of regional anesthesia can also predispose to hypothermia by causing redistribution and increasing threshold to thermo regulatory responses as shivering, but the degree of redistribution is less or limited to lower limbs, general anesthetics, particularly propofol, Thiopentone and opioids decreases metabolic heat production, whereas spinal anesthetics have relatively neutral effect on metabolic heat production [21].

Presence of medical problem is one of predictors of intra-operative hypothermia in our study. This is inconsistent with previous study

conducted by Sumer et al. [21] where presence of co-morbidity didn't correlate with perioperative hypothermia [22].

Patients with low temperature before the start of anesthesia were found to be more hypothermic compared with those with normal baseline temperature. This finding is also supported with evidence based guidelines which pointed that pre warming of patients at waiting areas at least for 30 minutes using active warmers prevents inadvertent perioperative hypothermia [23].

Operation room temperature was one of explanatory variables this study considered, but it doesn't show any association with intra operative hypothermia.

In our study elective procedures were associated with intra operative hypothermia, this is consistent with study conducted in the same department by Tadesse et al. [16], but previous studies claimed that emergency procedures were associated with perioperative hypothermia, the possible explanation could be the use of combined anesthetic technique (GA with regional nerve blocks) four times more often for elective cases compared to emergency cases. This combination was identified as a risk factor for perioperative hypothermia by a study conducted by Macario and Franklin [24]. The explanation for the increased incidence of hypothermia among patients that received combined anesthetic could be the combined effect of low heat production and increased threshold for shivering caused by general anesthesia and peripheral vasodilatation in the blocked limbs that increases heat loss to the environment.

Longer anesthetic and surgical times were claimed to increase incidence of perioperative hypothermia. We had patients who were normothermic at the beginning of the procedure, but became hypothermic as the duration of the procedure prolonged (but not supported by data). This could be due to exposure of body cavity to cold operation room air particularly in our set up where there is no warming facility.

Conclusions

The incidence of perioperative hypothermia is high in Gondar University Hospital. Use of General anesthesia, co-morbidity, low temperature before induction and elective procedures were associated with intra-operative hypothermia in Gondar University Hospital. Active warming devices should be used during perioperative time particularly when combined techniques are used. Appropriate waiting areas with warming facility should be prepared for all elective cases.

Competing Interests

The authors declare that they have no competing interests.

Authors' contributions

Zewditu Abdissa Denu initiated the research idea, designed the study, performed the statistical analysis and drafted the manuscript. Peter Semple, Hailu Yimer, and Adugna Aregawi participated in the study design, implementation of the study, statistical analysis and contributed to the draft manuscript. All authors contributed to the data analysis, read and approved the final manuscript.

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References

1. Leslie K, Sessler DI (2003) Perioperative hypothermia in the high-risk surgical patient. Best Pract Res Clin Anaesthesiol 17: 485-498.
2. Stoelting RK (1999) Pharmacology and physiology in anesthetic practice (3rdedn.) Lippincott, Williams & Wilkins, Philadelphia.
3. Kurz A (2008) Physiology of thermoregulation. Best Pract Res Clin Anaesthesiol 22: 627-644.
4. Sessler DI (2010) Temperature regulation and monitoring. In: Miller RD, Eriksson LI, Fleisher LA, Wiener-Kronish JP (eds.) Miller's Anesthesia. (7thedn.) Churchill Livingstone/Elsevier, Philadelphia.
5. American Association of Blood Banks (2006) Guidelines for the Use of Blood Warming Devices.
6. Welch TC (2002) AANA journal course. Update for nurse anesthetists. A common sense approach to hypothermia. AANA J 70: 227-231.
7. Bickler PE, Sessler DI (1990) Efficiency of airway heat and moisture exchangers in anesthetized humans. Anesth Analg 71: 415-418.
8. CLARK RE, ORKIN LR, ROVENSTINE EA (1954) Body temperature studies in anesthetized man: effect of environmental temperature, humidity, and anesthesia system. J Am Med Assoc 154: 311-319.
9. Bernard SA, Gray TW, Buist MD, Jones BM, Silvester W, et al. (2002) Treatment of comatose survivors of out-of-hospital cardiac arrest with induced hypothermia. N Engl J Med 346: 557-563.
10. Bondok RS (2009) Hypothermia in trauma: fluid and blood warming. Ain Shams Journal of Anesthesiology 2: 45-47.
11. Lenhardt R (2003) Monitoring and thermal management. Best Pract Res Clin Anaesthesiol 17: 569-581.
12. Amoateng-Adjepong Y, Del Mundo J, Manthous CA (1999) Accuracy of an infrared tympanic thermometer. Chest 115: 1002-1005.
13. Arshad M, Qureshi WA, Ali A, Haider SZ (2011) Frequency of Hypothermia during General Anesthesia. Pakistan Journal of Medical and Health Sciences 5(3).
14. Mehta OH, Barclay KL (2014) Perioperative hypothermia in patients undergoing major colorectal surgery. ANZ J Surg 84: 550-555.
15. Luís C, Moreno C, Silva A, Páscoa A, Abelha F (2012) Inadvertent Postoperative Hypothermia at Post-Anesthesia Care Unit: Incidence, Predictors and Outcome. Open Journal of Anesthesiology 2: 205-213.
16. Belayneh T, Gebeyehu A, Abdissa Z (2014) Post-operative Hypothermia in Surgical Patients at University of Gondar Hospital, Ethiopia. J Anesth Clin Res 5: 461.
17. Roberts S, Bolton DM, Stoller ML (1994) Hypothermia Associated with Percutaneous Nephrolithotomy. Urology 44: 832-835.
18. Sessler DI, Olofsson CI, Rubinstein EH (1988) The thermoregulatory threshold in humans during nitrous oxide-fentanyl anesthesia. Anesthesiology 69: 357-364.
19. Davis AJ, Bissonnette B (1999) Thermal regulation and mild intraoperative hypothermia. Curr Opin Anaesthesiol 12: 303-309.
20. Lehtinen SJ, Onicescu G, Kuhn KM, Cole DJ, Esnaola NF (2010) Normothermia to prevent surgical site infections after gastrointestinal surgery: holy grail or false idol? Ann Surg 252: 696-704.
21. Sumer BD, Myers LL, Leach J, Truelson JM (2009) Correlation between intraoperative hypothermia and perioperative morbidity in patients with head and neck cancer. Arch Otolaryngol Head Neck Surg 135: 682-686.
22. National Institute for Health and Clinical Evidence. Clinical practice guideline: The management of inadvertent perioperative hypothermia in adults.
23. Radauceanu DS, Dragnea D, Craig J (2009) NICE guidelines for inadvertent peri-operative hypothermia. Anaesthesia 64: 1381-1382.

24. Macario A, Dexter F (2002) What are the most important risk factors for a patient's developing intraoperative hypothermia? Anesth Analg 94: 215-220.