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Nurses' Knowledge, Practice, and their Associated Factors regarding Perioperative Hypothermia Prevention at Northwest Amhara Regional State Referral Hospitals, Northwest Ethiopia

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Abstract

Introduction: Hypothermia is a health problem that is characterized as a body temperature below 36 °c (96.8°F) and it is a common problem associated with perioperative patients, which can cause decelerates all physiologic roles. Therefore, nurses must strive to ensure normothermia for all patients.

Objectives: To assess nurses' knowledge, practices, and associated factors toward perioperative hypothermia prevention at Northwest Amhara Regional State Referral Hospitals, Northwest Ethiopia.

Method: Institution-based cross-sectional study was conducted to collect data from 423 nurses working in perioperative units by using stratified sampling technique. The collected data were checked for any inconsistency, coded and entered by using EPI INFO version 7, and analyzed by using SPSS version 25. To identify factors for dependent variables, bivariate and multivariate logistic regression models were fitted. Model fitness was checked using the Hosmer Lemeshow goodness of fit test**.**

Results: A total of 244 (59.1%) of the respondents had good knowledge and 208 (50.4%) had good practice in perioperative hypothermia prevention. Factors affecting nurses' knowledge on prevention of perioperative hypothermia were being male [AOR = 1.61,95% CI (1.02-2.53)], having a bachelor, and master's degree [AOR = 2.50; 95% CI (1.25-5.00), and 4.39; (1.45-13.20)] respectively, and took training [AOR = 3.68; 95% CI (2.14-6.33)]. Whereas nurses who were working in recovery and intensive care units [AOR = 2.87; 95% CI (1.08-7.58), and 2.39; 95% CI (1.09-5.22)] respectively, took training [AOR = 2.64; 95% CI (1.53-4.57)], had a Job satisfaction [AOR 2.15; 95% CI (1.34-3.43)], and knowledgeable nurses [AOR 2.64; 95% CI (1.63-4.27)] were factors affecting nurse's practice on perioperative hypothermia prevention.

Conclusion and recommendation: Nurses' knowledge and practice regarding prevention of perioperative hypothermia were found to be inadequate. So, it is better to strengthen training, educational opportunity, equip wards with standardized guidelines and materials, and motivate and create a safe working environment.

Keywords: Perioperative hypothermia, Ethiopia, Knowledge, Practice, Nurses.

Limitations and Strength of the study

- Due to the time constraint, observational data collection method was not done.
- Furthermore, this study was not triangulated with the qualitative method
- Due to the limited availability of literature, I have used unpublished sources.

✓ Despite these limitations, this study clearly showed nurses' knowledge, practice, and associated factors toward perioperative hypothermia prevention for the first time in Ethiopia.

Background

Hypothermia is a common health problem in patients having surgery, that is characterized as a body temperature below 36 °c (96.8°F) and it is usually caused by too much heat loss from cold weather exposure, anesthetic effect, and administration of cold intravenous, or irrigation fluids (1-3). Hypothermia decelerates all physiologic roles including metabolic rate, mental awareness, nerve conduction, neuromuscular reaction times, and both the cardiovascular and respiratory systems, consequently disturbing patients' comfort and leading to longer hospitalizations, higher costs, and increased mortality (1, 4).

Different studies conducted in different areas revealed that the incidence of perioperative hypothermia in Germany, about 25%–90% (5), in brazil 69.8% (6), and in china ranged from 44.3% to 72.7% (7, 8). And also in Ethiopia, the study conducted in Tikur Anbessa Specialized Hospital the overall magnitude of preoperative, intraoperative, and postoperative hypothermia were 16.2%, 53.2%, and 31.3%, respectively (9) while, in UoGCSRH the incidence of Pre, Intra, and post-operative hypothermia were 23.4%, 49.7%, and 50.6% respectively (10).

According to the Association of Perioperative Register Nurses (AORN) Guideline, nurses need to have knowledge and skill on hypothermia prevention at the perioperative phase. This includes measuring the patient's body temperature, selecting methods for prevention of unintended hypothermia, and implementing the selected insulation and warming interventions (11). Warming intervention measures include warming the patient before surgery ("pre-warming"), during surgery, and after surgery by using passive insulation methods include warmed cotton blankets, surgical draping and thermal garments, and by using active warming techniques include forced-air warming devices, electric warming blankets, and warmed fluids including blood products and using irrigation solutions and gases (12, 13).

Preventing heat loss and maintaining normothermia are important nursing care in an early phase of resuscitation as metabolic changes accompanied by injury cannot be corrected when patients are in hypothermic status (14). Nurses need to be cognizant of the risks associated with each perioperative phase of the patient in the prevention of hypothermia(15). Preserving a normal body temperature during the surgical experience enhances the patient's chance of preventing postoperative complications (16).

Different evidence reported that the maintenance of normothermia decreases the length of hospitalization by approximately up to 40%, risk of surgical site infection by 64%, may prevent the costs of potential stay in the intensive care unit by $1,000 and a prolonged hospital stay by $465 per day, and also decreasing mortality rate by four folds (17-19). But available literature shows that nurses' knowledge and practice towards perioperative hypothermia prevention is low despite the high incidence, serious consequences, and availability of effective interventions to prevent and treat this frequent surgical complication (2, 20).

If nurses had not adequate knowledge and skill on the prevention of perioperative hypothermia, its occurrence is inevitable. Even if nurses knowledge and practice are important in prevention of perioperative hypothermia and its complication, available literature revealed that nurses had significant knowledge and practice gaps (30). Different socio-demographic and institutional factors which include age, marital status, educational level, work experience, presence of guidelines and risk assessment protocol, taking training, reading updated evidence, and job satisfaction affect nurses' knowledge and practice (2, 20-22).

In Ethiopia, there are no studies is available regarding nurses' knowledge and practice on perioperative hypothermia prevention. Therefore, the purpose of this study is to assess nurses' knowledge, practice, and their determinant factors of perioperative hypothermia prevention in Northwest Amhara Regional State Referral Hospitals, Northwest Ethiopia.

Methods

Study design and period

Institutional based cross-sectional study was conducted in perioperative units/wards of five referral hospitals from March 25-May 20/2021.

Study area

The study was conducted in Northwest Amhara Regional State Referral Hospitals, Northwest Ethiopia. Northwest Amhara is found in the northwestern part of Ethiopia. There are five government referral hospitals in Northwest Amhara regional state such as University of Gondar Comprehensive Specialized Referral Hospital (UoGCSRH), Felegehiwot Referral Hospital (FHRH), Tibebegion Specialized Referral Hospital (TGSRH), Debre Markos Referral Hospital (DMRH), and Debre Tabor Comprehensive Referral Hospital (DTCRH). All hospitals provide outpatient and inpatient services for more than 22,000,000 million people living in their catchment area. According to information obtained from the administrative offices of these hospitals, there are 1682 nurses, who provide services. Among those 725 nurses are working in an emergency ward including trauma unit, operation room, recovery ward, surgical ward, orthopedics ward, and surgical ICU (42-46).

UoGCSRH is a teaching hospital, which is located in Gondar town. Gondar is the capital city of the central Gondar zone and is the famous historical town in northwest Ethiopia with latitude and longitude locations of 120 3'N and 370 28'E respectively. It is 748 km away from Addis Abeba and 173 km from Bahir Dar. Gondar town has one governmental hospital, eight health centers, and other private health facilities which provide health care service to the community. UoGCSRH was established in 1954 and provide serves approximately 7 million people. According to the hospital human resource administration report in 2021, the hospital has 595 nurse staff among those 153 nurses who are working in a surgical emergency (including trauma), operation room, recovery ward, surgical ward, orthopedics ward, and also surgical ICU (42).

DMRH is located 299km from Addis Abeba and 265km from Bahir Dar. Its geographical location is 10^{o} 11, N latitude and 37^{o} 43, E longitude. The town has one governmental hospital and four health centers. DMRH potentially serves more than 5,000,000 people of the East Gojjam zone. According to the hospital human resource administration report in 2021, the hospital has 221 nurse staff among those 127 nurses who are working in emergency, operation room, recovery ward, surgical ward, orthopedics ward, and also surgical ICU (43).

DTCRH is located in the Debre Tabor town of the South Gondar zone of the Amhara region, 654km far from the Northcentral of Addis Abeba, which is the capital city of Ethiopia, and 108km to the east of Bahir Dar. The town has a latitude and longitude of 11^{o}51' N38^{o}1'E with an elevation

of 2,706m above sea level. Debre Tabor referral hospital provides health care services for more than 2 million populations. According to the hospital human resource administration report in 2021, the hospital has 156 nurses staff among those 81 nurses who are working in emergency, operation room, recovery ward, surgical ward, orthopedics ward, and also ICU ward (44).

FHRH is located in Bahir Dar the capital city of Amhara region. The city is located approximately 565km northwest of Addis Abeba having a latitude of 11° 38' North, a longitude of 37°15'east, and elevation 1840 above sea level. Bahir Dar city has three governmental hospitals and nine health centers. In addition, there are also private health facilities (including hospitals and higher clinics) that provide health care services to the community. According to the hospital human resource administration report in 2021, Felegehiwot referral hospital has 430 nurse staffs among those 220 nurses who are working in emergency, operation room, recovery ward, surgical ward, orthopedics ward, and also surgical ICU ward (45).

TGSRH is a new hospital and located on the outskirt of the vibrant Bahir Dar city (one of the ten most beautiful cities in Africa and one of the twelve UNESCO Learning Cities Awardees of 2015). It also far about 10km south of the city center and about 7 km from the new bus station (Addisu Meneharia) on the way to Adet district and about 23 km from the Blue Nile Falls. According to the hospital human resource administration report in 2021, the hospital has 280 nurse staff among those 144 nurses who are working in emergency, operation room, recovery ward, surgical ward, orthopedics ward, and also surgical ICU ward (46).

Source population

Source populations were all nurses who were working in emergency, operation room, recovery ward, surgical ward, orthopedics ward, and surgical ICU ward of Northwest Amhara Regional State Referral Hospitals, Northwest Ethiopia.

Study population

The study population included nurses who were working in emergency ward including trauma unit, operation room, recovery ward, surgical ward, orthopedics ward, and surgical ICU wards of UoGCSRH, DTCRH, DMRH, TGRH, and FHRH during the data collection period.

Sample size and sampling procedure

Sample size

The sample size of the study was calculated using the formula for the estimation of a single population proportion and the assumptions were the proportion of knowledge and practice of nurses regarding hypothermia prevention was 50% (since there was no study conducted in our country), with 95% level of confidence and 5% margin of error. By using a z-value of 1.96 at 95% CI the minimum sample size for this study was:

As: $n= Z\alpha/2^2 * P (1-P)/ d^2$

n = sample size

p = proportion of knowledge & practice of nurses on hypothermia prevention =0.5

d = maximum allowable error (margin of error) = 0.05

Z = value of standard normal distribution at 95% confidence level *(z=1.96)*.

n = *(1.96) (1.96) *(0.5) (1-0.5)/ (0.05) (0.05)* =384 subjects;

⇨ By adding 10% allowance for non-response rate the total sample size were 384+10%=423

Sampling procedure

The study was performed on nurses who were working at the emergency surgical (including trauma unit), operating theatre room, recovery ward, surgical ward, orthopedics ward, and surgical ICU ward of Northwest Amhara Regional State Referral Hospitals, Northwest Ethiopia. A stratified sampling technique was employed to recruit the required participant for the study. First, the study participants are stratified from each hospital and working ward/unit and allocated the required sample for each stratum proportionally. According to all hospitals of human resources, administration reports the total number of nurses who were working in these units or wards was 725. Based on the number of nurses working in each hospital, 423 samples were proportionally allocated from 725 (from 153 - 89 in UoGCSRH, from 144 - 84 in TGRH, from 220 -128 in FHRH, from 81 - 48 in DTRH, and 127 - 74 in DMRH). Finally, those participants were taken by lottery method of simple random sampling technique from each sampling frame (Figure 1).

Eligibility criteria

Inclusion Criteria

All nurses who were working in the surgical emergency, operating theatre room, recovery ward, surgical ICU, surgical & orthopedic ward of Northwest Amhara Regional State Referral Hospitals, Northwest Ethiopia during the time of data collection.

Exclusion Criteria

Matron and ward coordinator nurses were excluded because those nurses are primarily responsible is coordinating, monitoring, and evaluating the staff nurses rather they doing routine activities.

Operational definitions

Knowledge: Is theoretical or practical understanding of hypothermia and its prevention method through education or experience. Based on this research the percentage scores were graded as 'poor', and 'good to determine the knowledge level.

Good knowledge: If the study participants answer the knowledge questions above or equal to the computed median were considered as having good knowledge.

Poor knowledge: If the study participants answer, the knowledge questions below the computed median were considered as having poor knowledge.

Practice: Activities acting by nurses to prevent hypothermia. Items in this category of the Likert scale were intended to determine the frequency of performing certain interventions to prevent hypothermia and to increase patient comfort. The response categories were coded as 0 to 2 for: never, sometimes, and always.

Good practice: The study participants who answer above or equal to the computed median of practice questions were considered as having good practice.

Poor practice: The study participants who answer below the computed median of practice questions were considered as having poor practice.

Job satisfaction: is a positive or pleasurable emotional state resulting from the appraisal of one's job or job experience. Job satisfaction of nurses was measured using the questionnaire adopted by the principal investigator with a 27-item scale. This instrument had 5-point Likert scales in which five denotes strongly Agree and one denotes strongly disagree. When the total score for the job satisfaction questionnaire was greater than or equal to the computed median, we said they were

satisfied, and less than the computed median, we said they were dissatisfied with the overall aspect of their work.

Data collection instruments and procedure

Data was collected by using a self-administered questionnaire which was adapted from guidelines of AORN and NICE perioperative hypothermia prevention, and other literature (which involves 27 questions for knowledge and 14 questions for practice (20, 34, 47, 48), and 15 questions for Socio-demographic, institutional and other characteristics (2, 4, 20-22, 34, 39). The questioners were prepared in the English language based on the study objectives, focusing on the background information of hypothermia and its prevention. Five BSc nurse staff who were working other than the study ward were recruited for data collection and two MSc holder nurses were recruited as a supervisor. Overall, the data collection process was coordinate and supervise by the principal investigator.

Data quality control

To ensure the quality of data one-day training was given to data collectors and supervisors regarding the objective of the study and data collection process. Moreover, the questionnaire was pretested among 5% of the sample size (21 nurses) at Woldia Referral Hospital. Regular supervision was done to check the consistency and completeness of the filled-out questionnaires, by the supervisors and principal investigator. The reliability of the tool for each outcome variable and job satisfaction questionnaires were checked by using SPSS version 25, Cronbach's alpha reliability test. The tests were shows 0.81, 0.77, and 0.91 for knowledge, practice, and job satisfaction respectively, which is greater than the minimum standard (0.7). This shows that the tool was reliable in terms of internal consistency. To adhere to confidentiality, the names in the questionnaires were replaced by codes, and the participants were informed about these so that they had a record of their codes to facilitate tracking of the completeness of their respective questionnaires. The supervisors and the principal investigator were responsible for checking on the completeness of the data on-site. Incomplete questionnaires were put in offices arranged for this purpose so that participants completed their questionnaires. Furthermore, the supervisors and principal investigators throughout the data collection period did intensive supervision.

Data processing and analysis

After the data was checked for its consistency and completeness, data were entered into Epi Info version 7 and exported into SPSS version 25 for analysis. Descriptive analysis was done for each variable in the study by running frequencies, percentages, and median with IQR. Tables were used for presenting results to give a clear picture of the magnitude and relationships of various study variables. Binary logistic regression was used to determine the significant association between the independent and dependent variables. Those independent variables, which are less than 0.2 in bivariate analysis, were entered into multivariable logistic regressions. Association between the independent variable and dependent variable was considered significant if P-value was less than 0.05 from multivariate logistic regression analysis. Multicollinearity was cheeked by using the variance inflation factor and its values were between 1 and 10. Model adequacy was check by using Hosmer and Lemeshow so the model indicates a good fit which indicates .856 and .993 for knowledge and practice respectively.

Patient and public involvement

The questionnaires used for this study were developed or adapted from different literature and guidelines. The study focused on nurses' knowledge, practice, and determinant factors regarding perioperative hypothermia prevention at Northwest Amhara regional state referral hospitals. Because nurses are primarily responsible body to prevent the occurrence of hypothermia in surgical patients. So that nurses were actively involved, no patients or member of the public were involved in the design or planning of this research study. The result of the study will disseminate to hospital managers, regional health bureau, policymakers, and researchers in preparing plans, adopting practical guidelines, budget allocation for fulfilling materials and training, design proper strategies, and serve as baseline information's.

Results

Socio-demographic characteristics of the respondents

A total of 423, with a response rate of 97.6% of study participants were involved in this study. The median age (IQR) of the study participants was 29 (27, 32) years, ranging from 20-58 years and almost half of the participants were under the age category between 26 to 30 years. Two hundred

thirteen (51.6%) of the participants were male, and 235(56.9%) were married. Out of 413 nurses, three-fourth of the respondents had a bachelor's degree, and one hundred eighty-one (43.8%) of the respondents had 6-10 years of work experience. One hundred seventy-two (41.6%) of participants' monthly salary were range from 7001-9000 and the median salary of the respondents was 7071 with an interquartile range of (5644, 8017) Ethiopian birr (Table1).

Table 1: Sociodemographic characteristics of the study participants on hypothermia prevention among perioperative patients in Amhara Regional State Referral Hospitals, Northwest Ethiopia, 2021(N=413).

Variable	Response	Frequency (N=413)	Percentage (%)
Sex	Male	213	51.6
	Female	200	48.4
Age	≤ 25 years	53	12.8
	26-30	224	54.2
	31-35	86	20.8
	≥ 35	50	12.1
Marital status	Single	163	39.5
	Married	235	56.9
	Divorced	12	2.9
	Widowed	3	.7
Educational status	Diploma	59	14.3
	Degree	311	75.3
	Master	43	10.4
Work experience	≤ 5 years	157	38
	6-10	181	43.8

Variable	Response	Frequency (N=413)	Percentage (%)
	11-15	57	13.8
	≥ 16	18	4.4
Monthly salary(ETB)	≤ 5000	42	10.2
	5001-7000	158	38.3
	7001-9000	172	41.6
	≥ 9001	41	9.9

ETB- Ethiopian Birr

Institutional and job-related factors of the respondents

From 413, 268(64.9%) of nurses did not take training about perioperative hypothermia prevention. half of the respondents reports that they were reading or reviewing updated evidence, and only 121(29.3%) of participants have notified the presence of guidelines or protocols in their working area. Out of the study participants, 268 (64.9%) and 342 (82.8%) were having a shortage of thermometers and warming materials respectively. From 413 study participants near half of 217 (52.5%) participants were satisfied with their jobs (Table 2).

Table 2: Institutional and other related factors of the respondents on perioperative hypothermia prevention in Amhara Regional State Referral Hospitals, Northwest Ethiopia, 2021. (N=413).

Variable	Response	Frequency (N=413)	Percentage (%)
Working place (hospital)	TGSRH	84	20.3
	UoGCSRH	83	20.1
	DMCRH	73	17.7
	DTCRH	47	11.4
	FHRH	126	30.5

Variable	Response	Frequency (N=413)	Percentage (%)
Ward:	Emergency	103	24.9
	Recovery	39	9.4
	OR	102	24.7
	ICU	53	12.8
	Orthopedics ward	46	11.1
	Surgical ward	70	16.9
Daily working hours	≤ 8 hrs	354	85.7
	≥9 hrs	59	14.3
Training on hypothermia prevention	Yes	145	35.1
	No	268	64.9
Presence of protocol/guideline	Yes	121	29.3
	No	292	70.7
Reading updated evidence on hypothermia prevention	Yes	206	49.9
	No	207	50.1
Availability of thermometer	Yes	145	35.1
	No	268	64.9
Constraints of warming material	Yes	342	82.8
	No	71	17.2
Shortage of blanket	Yes	166	40.2
	No	247	59.8
Shortage of linens	Yes	89	21.5
	No	324	78.5

Variable	Response	Frequency (N=413)	Percentage (%)
Shortage of fluid warmer	Yes	132	32.0
	No	281	68.0
Shortage of air warmer/heater	Yes	212	51.3
	No	201	48.7
Shortage of warmer blanket	Yes	217	52.5
	No	196	47.5
Job satisfaction	Satisfied	217	52.5
	Dissatisfied	196	47.5

Knowledge of nurses on hypothermia prevention

The overall median knowledge score of the study participants on perioperative hypothermia prevention was 18 with an IQR of (16, 21). In this study, 244 (59.1%) with 95% CI: (54.7, 63.7) of the participants had good knowledge while the rest were not knowledgeable. Among a total of knowledge assessment questions, 359(86.9%) and 288(69.7%) of participants have correctly answered the statement of the internal environment of humans can be maintained by thermoregulation, and perioperative hypothermia is characterized as a core body temperature of < 36 ° C respectively. Three-fourth of the participants gave the correct answer of anesthetic drugs increase heat loss while 250(60.5) of the participants correctly answered the complications of hypothermia in surgical patients. Only 83(20.1%) of the participants were correctly respond in the theatre room, the patient's temperature should be measured every 30 minutes while in the recovery room, every 15 minutes (Table 3).

317 Table 3. Nurse's responses on knowledge of perioperative hypothermia prevention (N=413)

Statements about perioperative hypothermia prevention	True/ False	Correct answer		Wrong answer /I don't know	
		N	%	N	%
The internal environment of humans can be maintained by thermoregulation.	T*	359	86.9	54	13.1
PH at any time during the perioperative cycle is characterized as a core body temperature < 36 ° C.	T*	288	69.7	125	30.3
Anesthetic drugs decrease heat loss in surgical patients.	F**	311	75.3	102	24.7
Cold IV fluids and blood products increase heat loss.	T*	288	69.5	126	30.5
PH is not associated with complications such as changes in drug metabolism, healing complications, shivering, clotting defects, cardiac morbidity, and prolonged post-anesthetic recovery.	F**	250	60.5	163	39.5
To minimize post-operative complications, nurses should advise patients to bring along additional clothing to help them stay warm before surgery	T*	339	82.1	74	17.9
The pulmonary artery catheter, distal esophagus, urinary bladder, rectum, zero heat-flux are some of the sites for temperature measurements.	T*	174	42.1	239	57.9
Nurses should be well trained and knowledgeable about the use of both temperature recording and warming devices	T*	346	83.8	67	16.2
Forced-air warming devices, warm water circulating and conductive devices are not some of the devices for warming surgical patients	F**	241	58.4	172	41.6
The method for temperature monitoring should not be chosen based on the criteria for a procedure	F**	281	68	132	32
To ensure accurate information, the team takes the patient's temperature at 15-minute intervals using different measuring devices at different sites.	F**	138	33.4	275	66.6
Patients with temperature < 36.0°C undergoing anesthesia & those having a high risk of cardiovascular complications are at higher risk for IPH	T*	293	70.9	120	29.1
It is not necessary to measure patients' temperature in the hour before departing the ward since it will be measured at the theatre.	F**	279	67.6	134	32.4

Except in urgent circumstances, preoperative patients with temperatures of < 36.0°C should be warmed for 30 minutes by using active warming method	T*	284	68.8	129	31.2
Special attention should be given to the comfort of surgical patients having difficulties expressing themselves	T*	335	81.1	78	18.9
The method for warming patients should be chosen based on planned procedure, patient position, IV access site, and warming equipment constraints.	T*	333	80.6	80	19.4
Critical incidence reporting is not necessary for patients coming into the theatre with a temperature of less than 36.0°C.	F**	259	62.7	154	37.3
Induction of anesthesia should not begin unless the patient's temperature is 36.0°C or above.	T*	203	49.2	210	50.8
The theatre's room temperature should be at least 21°C which can be adjusted to allow better working once active warming is initiated.	T*	273	66.1	140	33.9
All irrigation fluids used intraoperative should be warmed in a thermostatically controlled cabinet to a temperature of 38- 40°C.	T*	214	51.8	199	48.2
Fluid warming devices should be used to warm IV fluids (500mls or more) & blood products to 37°C	T*	260	63	153	37
Regardless of the temperatures of patients before leaving the ward, they should be warmed using active warming method once in the theatre	T*	256	62	157	38
The surgical patient should be well covered throughout surgery to conserve heat and only be exposed during surgical preparation.	T*	310	75.1	103	24.9
During the post-operative period, hypothermic patients should be warmed using AWM until they become warm before transferring them to the ward.	T*	348	84.3	65	15.7
Patients should be provided with at least 1 cotton sheet, 2 blankets, or a duvet during the postoperative phase	T*	319	77.2	94	22.8
Whiles in the OR, the patients' temperature should be measured every 15 minutes and every 30 minutes while in the RR.	F**	83	20.1	330	79.9
The temperature of post-operative patients should be recorded on arrival in the ward and be documented as part of a routine 4 hrs. observations.	T*	337	81.6	76	18.4

318 T*-True statement, F**- False statement, N- Number of participants.

Practice of nurses on hypothermia prevention

The overall median practice score of the study participants on perioperative hypothermia prevention was 18 with an IQR of (14, 21). In this study, 208 (50.4%) with 95% CI: (45.5, 55) of the participants had a good practice. Among practice assessment questions, 258(62.5%) of the respondents they measure temperature as soon as patient arrival and 224(54.2 %%) of the respondents were always assessing the sign and symptoms of hypothermia. Nearly half of the respondents 217(52.1%), 214(51.8%), and 213(51.6%) were sometimes developed and implemented care plans on perioperative hypothermia prevention, maintaining ambient room temperature according to guidelines, and also applying warm intravenous, blood products, and irrigation fluids respectively. Among 413 participants, 185(44.8%) of the respondents were reported never using forced-air warming devices, warm water circulating devices, and conductive devices for warming surgical patients (Table 4).

Table 4. Nurse's responses on the practice of perioperative hypothermia prevention in Northwest Amhara Regional State Referral Hospitals, Northwest, Ethiopia (N=413)

Hypothermia prevention practices	Never		Some times		Always	
	N	%	N	%	N	%
Do you measure temperature as soon as patient arrival?	21	5.1	134	32.4	258	62.5
Do you measure temperature regularly according to guidelines?	50	12.1	202	48.9	161	39
Do you warm intravenous, blood products, and irrigation fluids using warming devices before administering to patients?	112	27.1	213	51.6	88	21.3
Do you cover the mattress plastic sheet with dry linen before patient admission?	59	14.3	200	48.4	154	37.3

Hypothermia prevention practices	Never		Some times		Always	
	N	%	N	%	N	%
Do you use forced-air warming devices, warm water circulating devices, and conductive devices for warming patients?	185	44.8	170	41.2	58	14
Do you communicate your assessment findings on factors that could lead to hypothermia to all members of the perioperative team?	57	13.8	160	38.7	196	47.5
Do you advise patients to inform you when they feel cold during their hospitalization?	53	12.8	195	47.2	165	40
Do you develop and implement care plans for perioperative hypothermia prevention?	73	17.7	217	52.5	123	29.8
Do you document the site for temperature measurement in the patients' file?	63	15.3	156	37.8	194	47
Do you maintain ambient room temperature according to the guideline?	110	26.6	214	51.8	89	21.5
Do you assess patients for their risk for perioperative hypothermia?	41	9.9	202	48.9	170	41.2
Do you assess for signs and symptoms of hypothermia?	30	7.3	159	38.5	224	54.2
Do you advise patients to stay warm prior to surgery?	48	11.6	185	44.8	180	43.6

Hypothermia prevention practices	Never		Some times		Always	
	N	%	N	%	N	%
Do you include thermoregulation interventions and patient-related care to thermoregulation in your hand-over report	41	9.9	194	47	178	43.1

Factors associated with the level of knowledge on hypothermia prevention

In the binary logistic regression, ten from fifteen variables were found to have a significant association with participants' level of knowledge on hypothermia at a p-value of < 0.2. However, after controlling for the effects of potentially confounding variables using multivariate logistic regression only sex, educational status, and training were found to be significant predictors for knowledge on hypothermia prevention.

In this study, being male had 1.61 times more knowledge [AOR = 1.61,95% CI (1.02-2.53)]. Study participants who had an educational level of degree and masters were 2.5 and 4.39 times more likely to have good knowledge [AOR = 2.50; 95% CI (1.25-5.00), 4.39; (1.45-13.20)] respectively. In this study also nurses who took training on perioperative hypothermia prevention had 3.68 times more knowledge [AOR = 3.68; 95% CI (2.14-6.33)] (Table 5).

Table 5- Bi-variable and multivariable analysis of factors associated with knowledge of nurses on perioperative hypothermia prevention in Amhara Region Referral Hospitals, Northwest Ethiopia.

Variable	Knowledge of nurses		COR (95%CI)	P-value	AOR (95% CI)	P-value
	Good	**Poor**				
Sex						
Female	105	95	1		1	
Male	139	74	1.69(1.14-2.52)	.009	1.61(1.02-2.53)	.038**
Educational status						
Diploma	19	40	1		1	

Degree	191	120	3.35(1.85-6.05)	.000	2.50(1.25-5.00)	.010**
Master	34	9	7.95(3.18-19.8)	.000	4.39(1.45-13.2)	.008**
Hospital						
FHRH	67	59	1		1	
UoGCSRH	48	35	1.20(.69-2.11)	.314	1.18(.631-2.21)	.601
DMCRH	51	22	2.04(1.11-3.76	.056	1.74(.863-3.49)	.118
DTCRH	33	14	2.08(1.01-4.25)	.046	2.16(.933-4.94)	.068
TGSRH	45	39	1.01(.58-1.77)	.955	1.20(.627-2.29)	.581
Ward						
Emergency	52	51	1		1	
Recovery	31	8	3.8(1.59-9.05)	.003	2.24(.862-5.84)	.098
ICU	34	19	1.75(.88-3.46	.106	1.48(.696-3.16)	.307
OR	67	35	1.87(1.07-3.29)	.028	1.51(.799-2.86)	.203
Orthopedics	26	20	1.27(.63-2.56)	.496	1.35(.641-3.02)	.402
Surgical	34	36	.92(.50-1.70)	.805	.850(.431-.1.67)	.640
Monthly salary(ETB)						
≤ 5000	18	21	1		1	
5001-7000	90	74	1.41(.7-2.85)	.477	1.10 (.478-2.35)	.885
7001-9000	107	64	1.95(.96-3.93)	.075	.848(.492-2.49)	.802
≥ 9001	29	10	3.38(1.3-8.79)	.010	1.53(.507-4.67)	.447
Having guideline						
No	124	168	1		1	
Yes	75	46	1.37(.88-2.1)	.153	.848(.490-1.46)	.555
Took Training						

No	128	140	1		1	
Yes	116	29	4.37(2.72-7.01)	.000	3.68(2.14-6.33)	.000**
Reading updated evidence						
No	106	100	1		1	
Yes	138	69	1.88(1.26-2.80)	.002	1.32(.834-2.10)	.234
Shortage of thermometer						
Yes	148	120	1		1	
No	96	49	1.58(1.04-2.41)	.031	1.27(.776-2.08)	.325
Job satisfaction						
Unsatisfied	100	95	1		1	
Satisfied	144	74	1.84(1.24-2.74)	.002	1.38(.873-2.20)	.166

Variables which show significant association during multivariable logistic regression at **p-value <0.05, Hosmer and Lemeshow test P=.856, 1=Reference.

Factors associated with the level of practice on hypothermia prevention

In bivariate logistic regression analysis, eleven from sixteen variables were found to have significant predictors at a p-value < 0.2. But after controlling for the effects of potentially confounding variables using multivariate logistic regression only nurses working ward, took training, job satisfaction, and knowledge of nurses were found to be significant predictors for the practice of nurses on hypothermia prevention at (P<0.05).

Nurses who were working in recovery and intensive care units were 2.87 and 2.39 times more likely to have good practice [AOR = 2.87; 95% CI (1.08-7.58), and 2.39; 95% CI (1.09-5.22)] respectively. Nurses who took training in hypothermia prevention were 2.64 times more likely to have good practices for hypothermia prevention [AOR = 2.64; 95% CI (1.53-4.57)]. In this study, also nurses who are satisfied with their job were 2.15 times higher to have a good level of practice [AOR 2.15; 95% CI (1.34-3.43)]. The other significant variable is nurses who had knowledge of

hypothermia were 2.64 times higher to have a good level of practice [AOR 2.64; 95% CI (1.63-4.27)] (Table 6)

Table 6- Bi-variable and multivariable analysis of factors associated with the practice of nurses on perioperative hypothermia prevention in Amhara Region Referral Hospitals, Northwest Ethiopia.

Variable	Practice of nurses		COR (95%CI)	P-value	AOR (95% CI)	P-value
	Good	Poor				
Educational status						
Diploma	16	43	1		1	
Degree	159	152	2.81(1.51-5.20)	.000	1.94(.902-4.20)	.089
Master	24	19	3.39(1.47-7.79)	.002	1.28(.411-4.00)	.669
Working ward						
Emergency	41	62	1		1	
Recovery	30	9	5.04(2.1-11.71)	.000	2.87(1.08-7.58)	.033**
ICU	34	19	2.70(1.36-5.37)	.004	2.39(1.09-5.22)	.029**
OR	59	43	2.07(1.18-3.62)	.010	1.63(.856-3.12)	.136
Orthopedics	20	26	1.16(.575-2.35)	.674	1.17(.527-2.62)	.693
Surgical	24	46	.78(.419-1.48)	.467	.657(.321-1.34)	.250
Work experience						
≤ 5 years	69	88	1		1	
6-10	95	86	1.4(.917-2.16)	.118	1.26(.713-2.23)	.424
11-15	32	25	1.63(.886-3.00)	.116	1.68(.735-3.86)	.217
≥ 16	12	6	2.55(.911-7.14)	.075	3.26(.85-12.44)	.083

Monthly salary(ETB)						
≤ 5000	17	25	1		1	
5001-7000	67	91	1.08(.542-2.16)	.822	1.01(.436-2.35)	.976
7001-9000	98	74	1.94(.987-3.86)	.057	1.26(.517-3.10)	.604
≥ 9001	26	15	2.54(1.05-6.17)	.038	1.05(.310-3.58)	.933
Having guideline/ protocol						
No	131	161	1		1	
Yes	77	44	2.15(1.39-3.32)	.001	1.42(.824-2.47)	.205
Took training						
No	104	164	1		1	
Yes	104	41	4.00(2.58-6.19)	.000	2.64(1.53-4.57)	.001**
Reading updated evidence						
No	84	122	1		1	
Yes	124	83	2.17(1.46-3.21)	.000	1.37(.853-2.21)	.192
Constraint of thermometer						
Yes	123	145	1.67(1.11-2.51)	.014	1.10(.661-1.83)	.711
No	85	60	1		1	
Shortage of warming material						
Yes	166	176	1.53(.914-2.57)	.105	1.77(.923-3.39)	.086
No	42	29	1		1	
Job satisfaction						
Unsatisfied	71	124	1		1	
Satisfied	137	81	2.95(1.97-4.41)	.000	2.15(1.34-3.43)	.001**
Knowledge						

Good	157	87	4.17(2.74-6.35)	.000	2.64(1.63-4.27)	.000**
Poor	51	118	1		1	

Variables which show significant association during multivariable logistic regression at** p-value <0.05, Hosmer and Lemeshow test P=.993, 1=Reference.

Discussion

The result of this study showed that the overall knowledge of nurses on perioperative hypothermia prevention was 59.1% with 95%, CI (54.7, 63.7). This finding is higher than previous studies conducted AaBET hospital in Addis Abeba, Ethiopia(52.1%) (30). The possible reason might be due to sociodemographic differences, in the previous study most participants were having a degree and diploma level of educational status and the study area was a single setting of trauma center while in the current study greater than 10% of the participant had masters and study setting were multicenter. The other reason might be due to the difference in the time of the study because of the advancement of technology including updated evidence, educational programs were increased when the time is more and more recent. So, the participant might have to get more information regarding the topics. But this finding is much lower than those of studies conducted in Gambia (82%) (20), Turkey(77.5%) (4), Brazil (81.5%) (24), University of Iowa Hospitals and Clinics, America (71%) (25), Maryland, America (100%) (26), Ireland (28), and also as compare to NICE, AORN, and ASPAN guidelines of perioperative hypothermia prevention (3, 11, 23). The possible justification for this difference might be due to the level of staff training, adopted recommended guidelines, socioeconomic status, and sample size. According to training on hypothermia prevention in this study, only a few nurses (35.1%) have been trained while in the comparison group except in Gambia, almost all participants were taking training on perioperative hypothermia prevention. In terms of using guideline/protocol, the studies conducted in America participants always used recommended guidelines and protocols while in this study only 29.3% of nurses were report having guidelines/protocols. According to difference in socioeconomic status of the participants as well as study setting, we Ethiopians are under a low-income country compared to America, Brazil, Ireland. This is indirectly affects the quality of healthcare education as well as

healthcare setting. In terms of sample size in the present study has a larger sample size (n=413) as compare to all listed above (in Gambia (n=53), Turkey(n=200), Brazil(n=21), University of Iowa Hospitals and Clinics, America n=30, Maryland, America n=19, Ireland n=198).

In this study, the overall practice of nurses on perioperative hypothermia prevention was 50.4% with 95%, CI (45.5-55). This is consistent with the studies done in AaBET hospital Addis Abeba, Ethiopia (52.5%)(30), and Durban, South Africa (46%) (35). But this study is higher than the study done in Gambia (19%) (20). The possible reason might be the difference in socio-demographic characteristics like most of the participants in the Gambia were have less than five years' experience, and hadn't masters holder participants. On the other hand, the result of this study is much lower when from NICE, AORN, and ASPAN recommendations guidelines (3, 11, 23). This discrepancy could be due to the insufficient availability of warming material, measurement material, and guidelines or protocol. Might be also an inadequate opportunity for frequent training for nurses.

Regarding the determinants of the level of knowledge on hypothermia prevention, this study has found out that male nurses were found to have more knowledge with hypothermia prevention by1.6 times as compared to females. The reason might be females have an extra workload, most home activities such as bearing and taking care of children, cooking, washing e.t.c, are mostly done by females (49). So due to being overloaded by other additional home activities they might haven't enough time to scale up their knowledge.

Nurses who had degrees and masters were more likely to have good knowledge with hypothermia prevention by 2.5 and 4.4 times respectively as compared to those who had a diploma. This finding is supported by studies conducted in Iran(21), and Brazil, educational interventions are fundamental for nurses to guide their team and be the link of technical-scientific knowledge to improve the quality of patient care (24). The possible reason might be that more educated respondents have a higher opportunity of exposure to different courses directly or indirectly related to the prevention of hypothermia.

Those nurses who received training related to hypothermia prevention were 3.7 and 2.6 times more likely to have good knowledge and practice of hypothermia prevention as compared to counterparts. This finding is supported by studies in Maryland, America(26), Brazil (36), Iran (21),

Turkey(4). The possible reason might be because training plays an important role in improving the quality of patient care. The need to promote the effectiveness of in-site and off-site training of nurses is an invaluable criterion. Training is necessary to update theoretical and practical knowledge in every aspect of nursing education(49).

Another finding is nurses who were working in recovery and intensive care units were 2.9 and 2.4 times more likely to have good practice respectively as compared to the nurses who were working in the emergency ward. This finding is inconsistent with the study conducted in Turkey, ICU nurses had more knowledge than nurses who were working in other wards but their practice was not changing (4). The possible reason why Recovery and ICU nurses had better practice might be patients admitted in Recovery and ICU wards need close follow-up because of their physiological change/disturbance due to surgery or anesthesia effect. So working in two wards, the nurses perform more activities, which maintain thermoregulation. Another reason might be nurse to patient ratio is better than other wards, the standard is in recovery one to two, ICU one to one, emergency one to three, and for surgical and orthopedics wards is one to six in Ethiopia. The other reason might have better availability of resources like a thermometer, warming materials. And also might be most nurses who were working in those two wards took more training than other nurses.

In this study, also nurses who are satisfied with their job were 2.2 times more likely to have a good level of practice as compared to those who were not satisfied. Job satisfaction of the nurses is highly important in building up employee interest and efficiency, as higher job satisfaction determines better employee performance(50). Therefore, hospital administrators need to work on improving working environments, so that nurses become safe and comfortable to result in a positive feeling towards their job.

The other significant variable is nurses who had knowledge of hypothermia were 2.6 times more likely to have a good practice as compared to those who hadn't knowledge of hypothermia prevention. This study has supported studies conducted at the University of Calabar, Nigeria (37) and Textbook of Brunner & Suddarth (38), AORN, surgical team awareness, education, and understanding of the effects of hypothermia are necessary components to change how clinicians provide quality, cost-effective patient care (51).

Strength and Limitations of the study

A self-reported questionnaire measure of knowledge and practice of nurses on the prevention of perioperative hypothermia is prone to social desirability bias and recall bias. Furthermore, this study was not triangulated with a qualitative method. Despite these limitations, this study clearly showed the knowledge, practice, and associated factors of nurses toward perioperative hypothermia prevention among nurses working at comprehensive referral hospitals for the first time in Ethiopia.

Conclusion

This study revealed that nurses' knowledge and practice regarding the prevention of perioperative hypothermia was found to be inadequate as compared to the recommended guidelines. Having higher educational status, being male, and attending training showed a positive and significant association with good knowledge of perioperative hypothermia prevention. Whereas, factors contributing to practice were working ward, training, job satisfaction, and knowledge of nurses. Based on the findings of the study, we recommend to Amhara regional health bureau and hospital administrators including ward coordinators in collaboration with other stakeholders: Improve sponsored educational opportunities especially those nurses who have a diploma, promote and strengthen in-service training periodically and regularly, better to motivate those who have the knowledge and practiced well, should fulfill the availability of resources like warming materials, thermometers, and updated guidelines/protocols, better to improve working environments so that nurses become safe and comfortable to result in a positive feeling towards their job. Researchers also should do other research for a strong recommendation by adding observational data collection methods.

List of Abbreviation

AOR: Adjusted Odd Ratio; AORN:Association of perioperative Register Nurses; ASPAN: American Society of PeriAnesthesia Nurses; CI: Confidence Interval; DMRH: Debre Markos Referral Hospital; DTCRH: Debre Tabor Comprehensive Referral Hospital; EMS:Emergency

Medical Service; EPI INFO: Statistical Package for Epidemiological Information Analysis; FHRH: Felege Hiwot Referral Hospital; ICU: Intensive Care Unit; IPH: Inadvertent Perioperative Hypothermia; OR: Odds Ratio; OR: Operation Room; HP: Perioperative Hypothermia; PI: Principal Investigator; RR: Recovery Room; SPSS: Statistical Package of Social Science; T^{o} c: Temperature In Degree Centigrade; TGSRH: Tibebe Gion Specialized Referral Hospital; UK: United Kingdom; UoGCSRH: University of Gondar Comprehensive Specialized Referral Hospital; USA: United States of America

Declaration

Ethical Approval and informed consent to participate

The Institutional Ethical Review Board of the University of Gondar approved the study. Ethical clearance was obtained from the board on behalf of the School of Nursing (Ref. No. S/R/164/2/2021). Upon this clearance, additional written permission to conduct the study was obtained from the manager of all five referral hospitals when after explaining the purpose, the possible benefit of the study. Informed written consent was obtained from each respondent before fulfilling the questionnaire. It was explained for the respondents that participated in the study were voluntary and private information would be protected. The process no identify respondents by their name so; the process was done by keeping the privacy of the respondents.

Consent to publish

Not applicable

Availability of data and materials:

All the data were included in the study, and data will be available upon a responsible request from the corresponding author

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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Authors' contributions

Ashenafi Worku carried out the study starting from designing the study, analyzing, interpreting data, and reviewing the manuscript. Bezenaw Yimer Mekkonen, Netsanet Tsegaye, and Endalkachew Dellie participated in proposal writing, data analysis, interpretation, and commenting drafts of the paper and manuscript. All authors involved in writing, review and approving the final draft of the manuscript. All authors read and approved the manuscript before submitted to the journal for publication.

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Figure legend:

Figure 1: Schematic presentation of sampling procedure of nurses' knowledge and practice, and associated factors on hypothermia prevention among surgical patients.

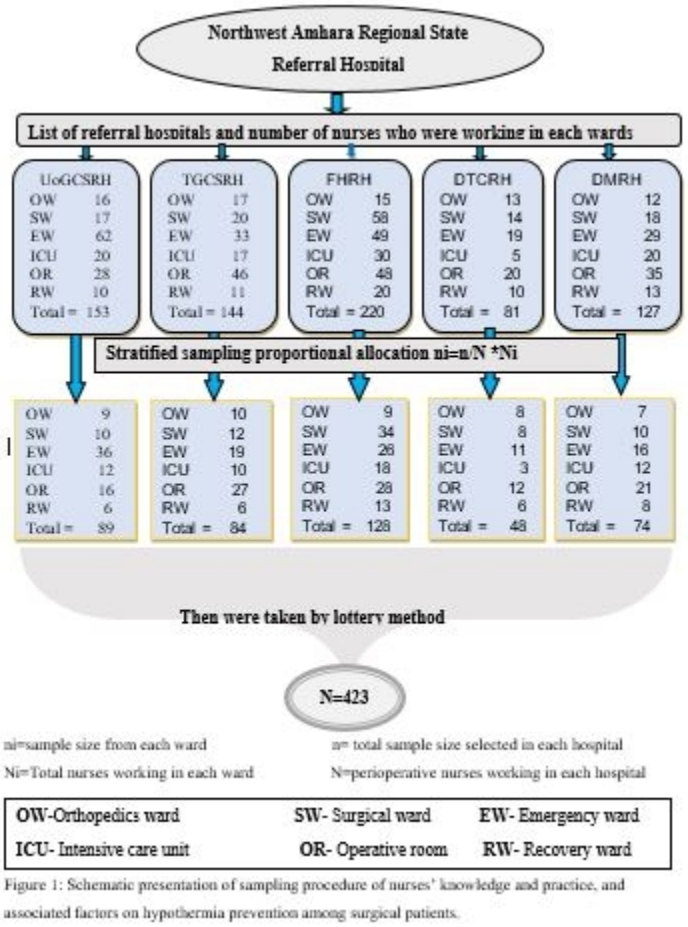

Figure 1: Schematic presentation of sampling procedure of nurses' knowledge and practice, and associated factors on hypothermia prevention among surgical patients.

92x123mm (96 x 96 DPI)

STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No.	Recommendation	Page No.	Relevant text from manuscript
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract	2	Line (36); An institution-based cross-sectional study was conducted among 423 nurses who are working in perioperative units/wards of five referral hospitals from March 25-May 20/2021.
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	2	Lines (28 – 54); Abstract
Introduction				
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	3 and 4	Lines (63 – 109); Introduction
Objectives	3	State-specific objectives, including any pre-specified hypotheses	4	Lines (107 – 109); This study aimed to assess nurses' knowledge, practice, and their determinant factors of perioperative hypothermia prevention in Northwest Amhara Regional State Referral Hospitals, Northwest Ethiopia.
Methods				
Study design	4	Present key elements of study design early in the paper	4	Lines (112 – 113); Institutional based cross-sectional study was conducted in perioperative units/wards of five referral hospitals from March 25-May 20/2021.

Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	4, 5, and 6	Lines (112 – 162); Study design, period, and setting
Participants	6	(a) Cohort study—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up Case-control study—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls Cross-sectional study—Give the eligibility criteria and the sources and methods of selection of participants	6, 7, and 8	Lines (163 – 170); Source and study population Lines (185 – 196); A total of 423 nurses were selected through a stratified random sampling technique, and data was collected from them. Lines (197 – 204); Inclusion and exclusion criteria (eligibility criteria)
		(b) Cohort study—For matched studies, give matching criteria and number of exposed and unexposed Case-control study—For matched studies, give matching criteria and the number of controls per case	N/A	This was a cross-sectional study
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	8 and 9	Lines (205 – 227); Operational definition of variables
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	9	Lines (228 – 237); Data collection tools and procedures
Bias	9	Describe any efforts to address potential sources of bias	9	Lines (238–253); To maintain data quality training was given to data collectors and supervisors. the questionnaire was pretested

				among 5% of the sample size. Quality is also maintained by close monitoring of the procedure, and checking on the completeness of the data on-site by the responsibility of supervisors and the principal investigator.
Study size	10	Explain how the study size was arrived at	7	Lines (172–184); The sample size was determined by using a formula to estimate a single population proportion with the assumption of a 95% level of confidence, 50% proportion, and a 5% marginal error.
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	10	Lines (259–263); Binary logistic regression was used to determine the significant association between the independent and dependent variables. Those independent variables, which are less than 0.2 in bivariate analysis, were entered into multivariable logistic regressions. Association between the independent variable and dependent variable was considered significant if P-value was less than 0.05 from multivariate logistic regression analysis
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	10	Lines (254–266); Statistical Analysis
		(b) Describe any methods used to examine subgroups and interactions	N/A	There were no subgroups
		(c) Explain how missing data were addressed	N/A	There was no missing data
		(d) Cohort study—If applicable, explain how loss to follow-up was addressed Case-control study—If applicable, explain how matching of cases and controls was addressed	N/A	Lines (186 – 196); A total of 423 nurses were selected through a stratified random sampling technique, and data was collected from them

		Cross-sectional study—If applicable, describe analytical methods taking account of sampling strategy		
		(e) Describe any sensitivity analyses	N/A	
Results				
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	N/A	This was a cross-sectional study with only one stage.
		(b) Give reasons for non-participation at each stage	N/A	
		(c) Consider use of a flow diagram	N/A	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, institutional, other) and information on exposures and potential confounders	11, 12, and 13	Line (287-289); Table 1: Sociodemographic characteristics of the study participants on hypothermia prevention among perioperative patients in Amhara Regional State Referral Hospitals, Northwest Ethiopia, 2021(N=413). Line (298-299); Table 2: Institutional and other related factors of the respondents on perioperative hypothermia prevention in Amhara Regional State Referral Hospitals, Northwest Ethiopia, 2021. (N=413).
		(b) Indicate number of participants with missing data for each variable of interest	N/A	There was no missing data
		(c) Cohort study—Summarise follow-up time (eg, average and total amount)	N/A	This was a cross-sectional study

Outcome data	15*	Cohort study—Report numbers of outcome events or summary measures over time	N/A	This was cross-sectional study
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	N/A	This was a cross-sectional study
		Cross-sectional study—Report numbers of outcome events or summary measures	14 and 17	Lines (292–293); In this study, 244 (59.1%) with 95% CI: (54.7, 63.7) of the participants had good knowledge while the rest were not knowledgeable. Lines (292–293); In this study, 208 (50.4%) with 95% CI: (45.5, 55) of the participants had good practice.
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	14, 17, 19, and 21	Lines (302-303); In this study, 244 (59.1%) with 95% CI: (54.7, 63.7) of the participants had good knowledge while the rest were not knowledgeable. Lines (321-322); In this study, 208 (50.4%) with 95% CI: (45.5, 55) of the participants had a good practice. Lines (344-345); Table 3- Bi-variable and multivariable analysis of factors associated with knowledge of nurses on perioperative hypothermia prevention in Amhara Region Referral Hospitals, Northwest Ethiopia. Lines (362-363); Table 4- Bi-variable and multivariable analysis of factors associated with the practice of nurses on perioperative hypothermia prevention in Amhara Region Referral Hospitals, Northwest Ethiopia.

		(b) Report category boundaries when continuous variables were categorized	N/A	There was no continuous variable.
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	N/A	There was no estimates of relative risk.
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	N/A	There was no sub groups and sensitivity analysis.
Discussion				
Key results	18	Summarise key results with reference to study objectives	24-26	Lines (370–449); Discussion
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	26	Lines (450–453); A self-reported questionnaire measure of knowledge and practice of nurses on the prevention of perioperative hypothermia is prone to social desirability bias and recall bias. Furthermore, this study was not triangulated with a qualitative method.
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	24-26	Lines (370-449); Discussion
Generalizability	21	Discuss the generalizability (external validity) of the study results	27	Lines (458-463); This study revealed that nurses' knowledge and practice regarding the prevention of perioperative hypothermia was found to be inadequate as compared to the recommended guidelines. Having higher educational status, being male, and attending training showed a positive and significant association with good knowledge of perioperative hypothermia prevention. Whereas, factors contributing to practice were working ward, training, job satisfaction, and knowledge of nurses.

Other information				
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	28	This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

BMJ Open

Knowledge and Practice of nurses regarding Perioperative Hypothermia Prevention at Northwest Amhara Regional State Referral Hospitals, Northwest Ethiopia: a cross-sectional study

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Knowledge and Practice of nurses regarding Perioperative Hypothermia Prevention at Northwest Amhara Regional State Referral Hospitals, Northwest Ethiopia: a cross-sectional study

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Word count: 3,988 (Introduction to conclusion; excluding tables and figure).

Abstract

Objectives Nurses are the primary responsible body to prevent the occurrence of hypothermia among surgical patients, as it has been reported that maintenance of normothermia decreases the length of hospitalization by approximately up to 40%, risk of surgical site infection by 64%, and also mortality rate by four folds. Therefore, the aim of this study was to assess nurses' knowledge, practices, and associated factors toward perioperative hypothermia prevention.

Design Cross-sectional study design.

Setting Northwest Amhara Regional State Referral Hospitals, Northwest Ethiopia.

Participants 413 nurses.

Main outcome measures Perioperative hypothermia prevention knowledge and practices among nurses

Results A total of 244 (59.1%) of the respondents had good knowledge and 208 (50.4%) had good practice in perioperative hypothermia prevention. Factors affecting nurses' knowledge on prevention of perioperative hypothermia were being male [AOR = 1.61, 95% CI (1.02-2.53)], having a bachelor, and master's degree [AOR = 2.50; 95% CI (1.25-5.00), and 4.39; (1.45-13.20)] respectively, and took training [AOR = 3.68; 95% CI (2.14-6.33)]. Whereas nurses who were working in recovery and intensive care units [AOR = 2.87; 95% CI (1.08-7.58), and 2.39; 95% CI (1.09-5.22)] respectively, took training [AOR = 2.64; 95% CI (1.53-4.57)], had a Job satisfaction [AOR 2.15; 95% CI (1.34-3.43)], and knowledgeable nurses [AOR 2.64; 95% CI (1.63-4.27)] were factors affecting nurse's practice on perioperative hypothermia prevention.

Conclusion Nurses' knowledge and practice regarding prevention of perioperative hypothermia were found to be inadequate. So, it is better to strengthen training, educational opportunity, equip wards with standardized guidelines and materials, and motivate and create a safe working environment.

Keywords: Perioperative hypothermia, Ethiopia, Knowledge, Practice, Nurses.

Limitations and Strength of the study

- Due to the time constraint, observational data collection method was not done.
- Furthermore, this study was not triangulated with the qualitative method
- Due to the limited availability of literature, I have used unpublished sources.
- Despite these limitations, this study covers large setting area.

Background

Hypothermia is a common health problem in patients having surgery, that is characterized as a body temperature below 36 °c (96.8°F) and it is usually caused by too much heat loss from cold weather exposure, anesthetic effect, and administration of cold intravenous, or irrigation fluids (1-3). Hypothermia decelerates all physiologic roles including metabolic rate, mental awareness, nerve conduction, neuromuscular reaction times, and both the cardiovascular and respiratory systems, consequently disturbing patients' comfort and leading to longer hospitalizations, higher costs, and increased mortality (1, 4).

Different studies conducted in different areas revealed that the magnitude of perioperative hypothermia in Brazil 56.7%(5), in Australia 74% (6), in Turkey research hospital in Ankara, and Trakya University Hospital were 78.6% and 63.3% respectively (7, 8). Another studies conducted in Ethiopia, Tikur Anbessa Specialized Hospital the overall magnitude of preoperative, intraoperative, and postoperative hypothermia were 16.2%, 53.2%, and 31.3%, respectively (9) while, in University of Gondar Comprehensive Specialized Hospital (UoGCSRH) the incidence of Pre, Intra, and post-operative hypothermia were 23.4%, 49.7%, and 50.6% respectively (10). But available literature shows that nurses' knowledge and practice towards perioperative hypothermia prevention is low despite the high incidence, serious consequences, and availability of effective interventions to prevent and treat this frequent surgical complication (2, 11). Interventional studies conducted on perioperative hypothermia prevention in Brazil and Turkey, 55.9% and 61.77% of nurses had good knowledge respectively before they were taken the training (4, 12). Other cross-sectional study done in Ethiopia regarding perioperative hypothermia prevention on trauma patients, only 52.1% of nurses were had good knowledge (13). While studies conducted in south Africa and Gambia, 46% and 19% of nurses had good practice respectively on perioperative hypothermia prevention (11, 14).

According to the Association of Perioperative Register Nurses (AORN) Guideline, nurses need to have knowledge and skill on hypothermia prevention at the perioperative phase. This includes measuring the patient's body temperature, selecting methods for prevention of unintended hypothermia, and implementing the selected insulation and warming interventions (15). Warming intervention measures include warming patients before surgery, during surgery, and

after surgery by using passive insulation and active warming methods such as warmed cotton blankets, surgical draping, thermal garments, forced-air warming devices, electric warming blankets, and warmed fluids (16, 17).

Preventing heat loss and maintaining normothermia are important nursing care in an early phase of resuscitation as metabolic changes accompanied by injury cannot be corrected when patients are in hypothermic status (18). Nurses need to be cognizant of the risks associated with each perioperative phase of the patient in the prevention of hypothermia(19). Preserving a normal body temperature during the surgical experience enhances the patient's chance of preventing postoperative complications (20). Different evidence reported that the maintenance of normothermia decreases the length of hospitalization by approximately up to 40%, risk of surgical site infection by 64%, may prevent the costs of potential stay in the intensive care unit by $1,000 and a prolonged hospital stay by $465 per day, and also decreasing mortality rate by four folds (21-23).

If nurses had not adequate knowledge and skill on the prevention of perioperative hypothermia, its occurrence is inevitable. Even if nurses knowledge and practice are important in prevention of perioperative hypothermia and its complication, available literature revealed that nurses had significant knowledge and practice gaps (13). Different socio-demographic and institutional factors which include age, marital status, educational level, work experience, presence of guidelines and risk assessment protocol, taking training, reading updated evidence, and job satisfaction affect nurses' knowledge and practice (2, 11, 24, 25).

In Ethiopia, there are no studies is available regarding nurses' knowledge and practice on perioperative hypothermia prevention. Therefore, the purpose of this study is to assess nurses' knowledge, practice, and their determinant factors of perioperative hypothermia prevention in Northwest Amhara Regional State Referral Hospitals, Northwest Ethiopia.

Methods

Study design and period

Institutional based cross-sectional study was conducted in perioperative units/wards of five referral hospitals from March 25-May 20/2021.

Study area

The study was conducted in Northwest Amhara Regional State Referral Hospitals, Northwest Ethiopia. Northwest Amhara is found in the northwestern part of Ethiopia. There are five government referral hospitals in Northwest Amhara regional state such as University of Gondar Comprehensive Specialized Referral Hospital (UoGCSRH), Felege Hiwot Referral Hospital (FHRH), Tibebe Gion Specialized Referral Hospital (TGSRH), Debre Markos Referral Hospital (DMRH), and Debre Tabor Comprehensive Referral Hospital (DTCRH). All hospitals provide outpatient and inpatient services for more than 22,000,000 million people living in their catchment area. Surgical department is one of the actively serving departments giving emergency and elective surgery among the service given by the hospitals. All five hospitals have different surgical units in their surgical department such as surgical emergency ward, operation room, recovery ward, surgical ward, orthopedics ward, and surgical intensive care unit (ICU). According to information obtained from the administrative offices of these hospitals, there are 1682 nurses, who provide services. Among those 725 nurses (153 in UoGCSRH, 220 in FHRH, 144 in TGSRH, 127 in DMRH, and 81 in DTCRH) are working in our study unit (26-30). Nurses who are working in perioperative unit provide different hypothermia preventive activities like covering of patients by linens and blanket, measure patients' temperature, warming of intravenous fluids; adjust room temperature and so on. Because preventing perioperative hypothermia is a crucial role for nurses.

Source population

Source populations were all nurses who were working in emergency, operation room, recovery ward, surgical ward, orthopedics ward, and surgical ICU ward of Northwest Amhara Regional State Referral Hospitals, Northwest Ethiopia.

Study population

The study population included nurses who were working in emergency ward, operation room, recovery ward, surgical ward, orthopedics ward, and surgical ICU wards of UoGCSRH, DTCRH, DMRH, TGRH, and FHRH during the data collection period.

Sample size and sampling procedure

Sample size

The sample size of the study was calculated using the formula for the estimation of a single population proportion and the assumptions were the proportion of knowledge and practice of nurses regarding hypothermia prevention was 50% (since there was no study conducted in our country), with 95% level of confidence and 5% margin of error. By using a z-value of 1.96 at 95% CI the minimum sample size for this study was:

As: $n= Z\alpha/2^2 * P (1-P)/ d^2$

n = sample size

p = proportion of knowledge & practice of nurses on hypothermia prevention =0.5

d = maximum allowable error (margin of error) = 0.05

Z = value of standard normal distribution at 95% confidence level *(z=1.96)*.

n = *(1.96) (1.96) *(0.5) (1-0.5)/ (0.05) (0.05)* =384 subjects;

⇨ By adding 10% allowance for non-response rate the total sample size were 384+10%=423

Sampling procedure

The study was performed on nurses who were working at the emergency surgical (including trauma unit), operation room, recovery ward, surgical ward, orthopedics ward, and surgical ICU ward of Northwest Amhara Regional State Referral Hospitals, Northwest Ethiopia. A stratified sampling technique was employed to recruit the required participant for the study. First, the study participants are stratified from each hospital and working ward/unit and allocated the required sample for each stratum proportionally. According to all hospitals of human resources, administration reports the total number of nurses who were working in these units or wards was 725. Based on the number of nurses working in each hospital, 423 samples were proportionally allocated from 725 (from 153 - 89 in UoGCSRH, from 144 - 84 in TGRH, from 220 -128 in FHRH, from 81 - 48 in DTRH, and 127 - 74 in DMRH). Finally, those participants were taken by lottery method of simple random sampling technique from each sampling frame (Supplemental Figure)

Inclusion and exclusion criteria

All nurses who were working in the surgical emergency, operation room, recovery ward, surgical ICU, surgical & orthopedic ward of Northwest Amhara Regional State Referral Hospitals, Northwest Ethiopia during the time of data collection were included in this study.

Matron and ward coordinator nurses were excluded because those nurses are primarily responsible is coordinating, monitoring, and evaluating the staff nurses rather they doing routine activities.

Operational definitions

Knowledge: Is theoretical or practical understanding of hypothermia and its prevention method through education or experience. Based on this research the percentage scores were graded as 'poor', and 'good to determine the knowledge level.

Good knowledge: If the study participants answer the knowledge questions above or equal to the computed median were considered as having good knowledge.

Poor knowledge: If the study participants answer, the knowledge questions below the computed median were considered as having poor knowledge.

Practice: Activities acting by nurses to prevent hypothermia. Items in this category of the Likert scale were coded as 0 to 2 for: never, sometimes, and always.

Good practice: The study participants who answer above or equal to the computed median of practice questions were considered as having good practice.

Poor practice: The study participants who answer below the computed median of practice questions were considered as having poor practice.

Job satisfaction: When the total score for the job satisfaction questionnaire was greater than or equal to the computed median, we said they were satisfied, and less than the computed median, we said they were dissatisfied with the overall aspect of their work.

Data collection instruments and procedure

Data was collected by using a self-administered questionnaire which was adapted from guidelines of AORN and NICE perioperative hypothermia prevention, and other literature which involves 27 questions for knowledge and 14 questions for practice (11, 31-33), and 15 questions for Socio-demographic, institutional and other characteristics (2, 4, 11, 24, 25, 31, 34). The questioners were prepared in the English language based on the study objectives, focusing on the background information of hypothermia and its prevention. Five BSc nurse staff who was

working other than the study wards were recruited for data collection and two MSc holder nurses were recruited as a supervisor. Overall, the data collection process was coordinate and supervises by the principal investigator.

Data quality control

In order to ensure the quality of the collected data, data collectors and supervisors underwent one-day training on the purpose of the study and the data collection procedure. The questionnaire was additionally pretested at Woldia Comprehensive Referral Hospital with 5% of the sample size. Internal consistency was checked by computing Cronbach's α for both dependent variable and job satisfaction questionnaires. The tests were shows 0.81, 0.77, and 0.91 for knowledge, practice, and job satisfaction respectively. Supervisors and primary investigator conducted routine supervision to verify the consistency and completeness of the questionnaires that were filled out. Incomplete questionnaires were put in offices arranged for this purpose so that participants completed their questionnaires.

Data processing and analysis

After the data was checked for its consistency and completeness, data were entered into Epi Info version 7 and exported into SPSS version 25 for analysis. A frequency table was used to describe the participant characteristics knowledge and practice scores. Multicollinearity was cheeked by using the variance inflation factor and its values were between 1 and 10. Model adequacy was checked by using Hosmer-Lemeshow goodness of fit test and the model was fitted well which indicates .856 and .993 for knowledge and practice respectively. Binary logistic regression was used to determine the significant association between the independent and dependent variables. Those independent variables, which are less than 0.2 in bivariate analysis, were entered into multivariable logistic regressions. Association between the independent variable and dependent variable was considered significant if P-value was less than 0.05 from multivariate logistic regression analysis.

Patient and public involvement

It was not appropriate or possible to involve patients or public in the design, conduct, report or dissemination plans of our research because this study was done on Nurses.

Results

Socio-demographic characteristics of the respondents

A total of 423, with a response rate of 97.6% of study participants were involved in this study. The median age (IQR) of the study participants was 29 (27, 32) years, ranging from 20-58 years and almost half of the participants were under the age category between 26 to 30 years. Two hundred thirteen (51.6%) of the participants were male, and 235(56.9%) were married. Out of 413 nurses, three-fourth of the respondents had a bachelor's degree (Table1).

Table 1: Socio-demographic characteristics of the study participants on perioperative hypothermia prevention in Amhara Regional State Referral Hospitals, Northwest Ethiopia, 2021(N=413).

Variable	Response	Frequency (N=413)	Percentage (%)
Sex	Male	213	51.6
	Female	200	48.4
Age	≤ 25 years	53	12.8
	26-30	224	54.2
	31-35	86	20.8
	≥ 35	50	12.1
Marital status	Single	163	39.5
	Married	235	56.9
	Divorced	12	2.9
	Widowed	3	.7
Educational status	Diploma	59	14.3
	Degree	311	75.3
	Master	43	10.4

Work experience	≤ 5 years	157	38
	6-10	181	43.8
	11-15	57	13.8
	≥ 16	18	4.4
Monthly salary(ETB)	≤ 5000	42	10.2
	5001-7000	158	38.3
	7001-9000	172	41.6
	≥ 9001	41	9.9

ETB- Ethiopian Birr

Institutional and job-related factors of the respondents

From 413, 268(64.9%) of nurses did not take training about perioperative hypothermia prevention. half of the respondents reports that they were reading or reviewing updated evidence, and only 121(29.3%) of participants have notified the presence of guidelines or protocols in their working area. Out of the study participants 268 (64.9%) and 342 (82.8%) were having a shortage of thermometers and warming materials respectively. From 413 study participants near half of 217 (52.5%) participants were satisfied with their jobs (Supplemental Table).

Knowledge of nurses on hypothermia prevention

The overall median knowledge score of the study participants on perioperative hypothermia prevention was 18 with an IQR of (16, 21). In this study, 244 (59.1%) with 95% CI: (54.7, 63.7) of the participants had good knowledge. Among a total of knowledge assessment questions, 359(86.9%) and 288(69.7%) of participants have correctly answered the statement about the definition of thermoregulation and perioperative hypothermia respectively. Three-fourth of the participants gave the correct answer of anesthetic drugs increase heat loss while 250(60.5) of the participants correctly answered the complications of hypothermia in surgical patients. Only 83(20.1%) of the participants were correctly respond in the theatre room, the patient's

temperature should be measured every 30 minutes while in the recovery room, every 15 minutes (Table 2).

Table 2. Nurse's responses on knowledge of perioperative hypothermia prevention (N=413)

Statements about perioperative hypothermia prevention	True/ False	Correct answer		Wrong answer /I don't know	
		N	%	N	%
The internal environment of humans can be maintained by thermoregulation.	T*	359	86.9	54	13.1
PH at any time during the perioperative cycle is characterized as a core body temperature < 36 ° C.	T*	288	69.7	125	30.3
Anesthetic drugs decrease heat loss in surgical patients.	F**	311	75.3	102	24.7
Cold IV fluids and blood products increase heat loss.	T*	288	69.5	126	30.5
PH is not associated with complications such as changes in drug metabolism, healing complications, shivering, clotting defects, cardiac morbidity, and prolonged post-anesthetic recovery.	F**	250	60.5	163	39.5
To minimize post-operative complications, nurses should advise patients to bring along additional clothing to help them stay warm before surgery	T*	339	82.1	74	17.9
The pulmonary artery catheter, distal esophagus, urinary bladder, rectum, zero heat-flux are some of the sites for temperature measurements.	T*	174	42.1	239	57.9
Nurses should be well trained and knowledgeable about the use of both temperature recording and warming devices	T*	346	83.8	67	16.2
Forced-air warming devices, warm water circulating and conductive devices are not some of the devices for warming surgical patients	F**	241	58.4	172	41.6
The method for temperature monitoring should not be chosen based on the criteria for a procedure	F**	281	68	132	32
To ensure accurate information, the team takes the patient's temperature at 15- minute intervals using different measuring devices at different sites.	F**	138	33.4	275	66.6
Patients with temperature < 36.0°C undergoing anesthesia & those having a high risk of cardiovascular complications are at higher risk for IPH	T*	293	70.9	120	29.1
It is not necessary to measure patients' temperature in the hour before departing the ward since it will be measured at the theatre.	F**	279	67.6	134	32.4

Except in urgent circumstances, preoperative patients with temperatures of < 36.0°C should be warmed for 30' by using active warming method	T*	284	68.8	129	31.2
Special attention should be given to the comfort of surgical patients having difficulties expressing themselves	T*	335	81.1	78	18.9
The method for warming patients should be chosen based on planned procedure, patient position, IV access site, and warming equipment constraints.	T*	333	80.6	80	19.4
Critical incidence reporting is not necessary for patients coming into the theatre with a temperature of less than 36.0°C.	F**	259	62.7	154	37.3
Induction of anesthesia should not begin unless the patient's temperature is 36.0°C or above.	T*	203	49.2	210	50.8
The theatre's room temperature should be at least 21°C which can be adjusted to allow better working once active warming is initiated.	T*	273	66.1	140	33.9
All irrigation fluids used intraoperative should be warmed in a thermostatically controlled cabinet to a temperature of 38- 40°C.	T*	214	51.8	199	48.2
Fluid warming devices should be used to warm IV fluids (500mls or more) & blood products to 37°C	T*	260	63	153	37
Regardless of the temperatures of patients before leaving the ward, they should be warmed using active warming method once in the theatre	T*	256	62	157	38
The surgical patient should be well covered throughout surgery to conserve heat and only be exposed during surgical preparation.	T*	310	75.1	103	24.9
During the post-operative period, hypothermic patients should be warmed using AWM until they become warm before transferring them to the ward.	T*	348	84.3	65	15.7
Patients should be provided with at least 1 cotton sheet, 2 blankets, or a duvet during the postoperative phase	T*	319	77.2	94	22.8
Whiles in the OR, the patients' temperature should be measured every 15 minutes and every 30 minutes while in the RR.	F**	83	20.1	330	79.9
The temperature of post-operative patients should be recorded on arrival in the ward and be documented as part of a routine 4 hrs observations.	T*	337	81.6	76	18.4

T*-True statement, F**- False statement, N- Number of participants.

Practice of nurses on hypothermia prevention

The overall median practice score of the study participants on perioperative hypothermia prevention was 18 with an IQR of (14, 21). In this study, 208 (50.4%) with 95% CI: (45.5, 55) of

the participants had a good practice. Among practice assessment questions, 258(62.5%) of the respondents they measure temperature as soon as patient arrival and 224(54.2 %%) of the respondents were always assessing the sign and symptoms of hypothermia. Nearly half of the respondents 214(51.8%) and 213(51.6%) were sometimes maintaining ambient room temperature according to guidelines and also applying warm intravenous, blood products, and irrigation fluids respectively. Among 413 participants, 185(44.8%) of the respondents were reported never using forced-air warming devices, warm water circulating devices, and conductive devices for warming surgical patients (Table 3).

Table 3. Nurse's responses on the practice of perioperative hypothermia prevention in Northwest Amhara Regional State Referral Hospitals, Northwest, Ethiopia (N=413)

Hypothermia prevention practices	**Never**		**Some times**		**Always**	
	N	%	N	%	N	%
Do you measure temperature as soon as patient arrival?	21	5.1	134	32.4	258	62.5
Do you measure temperature regularly according to guidelines?	50	12.1	202	48.9	161	39
Do you warm intravenous, blood products, and irrigation fluids using warming devices before administering to patients?	112	27.1	213	51.6	88	21.3
Do you cover the mattress plastic sheet with dry linen before patient admission?	59	14.3	200	48.4	154	37.3
Do you use forced-air warming devices, warm water circulating devices, and conductive devices for warming patients?	185	44.8	170	41.2	58	14
Do you communicate your assessment findings on factors that could lead to hypothermia to all members of the perioperative team?	57	13.8	160	38.7	196	47.5
Do you advise patients to inform you when they feel cold during their hospitalization?	53	12.8	195	47.2	165	40

Do you develop and implement care plans for perioperative hypothermia prevention?	73	17.7	217	52.5	123	29.8
Do you document the site for temperature measurement in the patients' file?	63	15.3	156	37.8	194	47
Do you maintain ambient room temperature according to the guideline?	110	26.6	214	51.8	89	21.5
Do you assess patients for their risk for perioperative hypothermia?	41	9.9	202	48.9	170	41.2
Do you assess for signs and symptoms of hypothermia?	30	7.3	159	38.5	224	54.2
Do you advise patients to stay warm prior to surgery?	48	11.6	185	44.8	180	43.6
Do you include thermoregulation interventions and patient-related care to thermoregulation in your hand-over report	41	9.9	194	47	178	43.1

Factors associated with the level of knowledge on hypothermia prevention

In the binary logistic regression, ten from fifteen variables were found to have a significant association with participants' level of knowledge on hypothermia at a p-value of < 0.2. However, after adjusting for the effects of potentially confounding variables using multivariate logistic regression, only gender, educational status, and training were found to be significant predictors of knowledge about how to prevent hypothermia.

In this study, being male had 1.61 times more knowledge [AOR = 1.61, 95% CI (1.02-2.53)]. Study participants who had an educational level of degree and masters were 2.5 and 4.39 times more likely to have good knowledge [AOR = 2.50; 95% CI (1.25-5.00), 4.39; (1.45-13.20)] respectively. In this study also nurses who took training on perioperative hypothermia prevention had 3.68 times more knowledge [AOR = 3.68; 95% CI (2.14-6.33)] (Table 4).

Table 4- Bi-variable and multivariable analysis of factors associated with knowledge of nurses on perioperative hypothermia prevention in Amhara Region Referral Hospitals, Northwest Ethiopia.

Variable	Knowledge of nurses		COR (95%CI)	P-value	AOR (95% CI)	P-value
	Good	**Poor**				
Sex						
Female	105	95	1		1	
Male	139	74	1.69(1.14-2.52)	.009	1.61(1.02-2.53)	.038**
Educational status						
Diploma	19	40	1		1	
Degree	191	120	3.35(1.85-6.05)	.000	2.50(1.25-5.00)	.010**
Master	34	9	7.95(3.18-19.8)	.000	4.39(1.45-13.2)	.008**
Hospital						
FHRH	67	59	1		1	
UoGCSRH	48	35	1.20(.69-2.11)	.314	1.18(.631-2.21)	.601
DMCRH	51	22	2.04(1.11-3.76	.056	1.74(.863-3.49)	.118
DTCRH	33	14	2.08(1.01-4.25)	.046	2.16(.933-4.94)	.068
TGSRH	45	39	1.01(.58-1.77)	.955	1.20(.627-2.29)	.581
Ward						
Emergency	52	51	1		1	
Recovery	31	8	3.8(1.59-9.05)	.003	2.24(.862-5.84)	.098
ICU	34	19	1.75(.88-3.46	.106	1.48(.696-3.16)	.307
OR	67	35	1.87(1.07-3.29)	.028	1.51(.799-2.86)	.203
Orthopedics	26	20	1.27(.63-2.56)	.496	1.35(.641-3.02)	.402
Surgical	34	36	.92(.50-1.70)	.805	.850(.431-.1.67)	.640
Monthly salary(ETB)						

≤ 5000	18	21	1		1	
5001-7000	90	74	1.41(.7-2.85)	.477	1.10 (.478-2.35)	.885
7001-9000	107	64	1.95(.96-3.93)	.075	.848(.492-2.49)	.802
≥ 9001	29	10	3.38(1.3-8.79)	.010	1.53(.507-4.67)	.447
Having guideline						
No	124	168	1		1	
Yes	75	46	1.37(.88-2.1)	.153	.848(.490-1.46)	.555
Took Training						
No	128	140	1		1	
Yes	116	29	4.37(2.72-7.01)	.000	3.68(2.14-6.33)	.000**
Reading updated evidence						
No	106	100	1		1	
Yes	138	69	1.88(1.26-2.80)	.002	1.32(.834-2.10)	.234
Shortage of thermometer						
Yes	148	120	1		1	
No	96	49	1.58(1.04-2.41)	.031	1.27(.776-2.08)	.325
Job satisfaction						
Unsatisfied	100	95	1		1	
Satisfied	144	74	1.84(1.24-2.74)	.002	1.38(.873-2.20)	.166

Variables which show significant association during multivariable logistic regression at **p-value <0.05, Hosmer and Lemeshow test P=.856, 1=Reference.

Factors associated with the level of practice on hypothermia prevention

In bivariate logistic regression analysis, eleven from sixteen variables were found to have significant predictors at a p-value < 0.2. But after controlling for the effects of potentially confounding variables using multivariate logistic regression only nurses working ward, took

training, job satisfaction, and knowledge of nurses were found to be significant predictors for the practice of nurses on hypothermia prevention at (P<0.05).

Nurses who were working in recovery and intensive care units were 2.87 and 2.39 times more likely to have good practice [AOR = 2.87; 95% CI (1.08-7.58), and 2.39; 95% CI (1.09-5.22)] respectively. Nurses who took training in hypothermia prevention were 2.64 times more likely to have good practices for hypothermia prevention [AOR = 2.64; 95% CI (1.53-4.57)]. In this study, also nurses who are satisfied with their job were 2.15 times higher to have a good level of practice [AOR 2.15; 95% CI (1.34-3.43)]. The other significant variable is nurses who had knowledge of hypothermia were 2.64 times higher to have a good level of practice [AOR 2.64; 95% CI (1.63-4.27)] (Table 5)

Table 5- Bi-variable and multivariable analysis of factors associated with the practice of nurses on perioperative hypothermia prevention in Amhara Region Referral Hospitals, Northwest Ethiopia.

Variable	Practice of nurses		COR (95%CI)	P-value	AOR (95% CI)	P-value
	Good	Poor				
Educational status						
Diploma	16	43	1		1	
Degree	159	152	2.81(1.51-5.20)	.000	1.94(.902-4.20)	.089
Master	24	19	3.39(1.47-7.79)	.002	1.28(.411-4.00)	.669
Working ward						
Emergency	41	62	1		1	
Recovery	30	9	5.04(2.1-11.71)	.000	2.87(1.08-7.58)	.033**
ICU	34	19	2.70(1.36-5.37)	.004	2.39(1.09-5.22)	.029**
OR	59	43	2.07(1.18-3.62)	.010	1.63(.856-3.12)	.136
Orthopedics	20	26	1.16(.575-2.35)	.674	1.17(.527-2.62)	.693

Surgical	24	46	.78(.419-1.48)	.467	.657(.321-1.34)	.250
Work experience						
≤ 5 years	69	88	1		1	
6-10	95	86	1.4(.917-2.16)	.118	1.26(.713-2.23)	.424
11-15	32	25	1.63(.886-3.00)	.116	1.68(.735-3.86)	.217
≥ 16	12	6	2.55(.911-7.14)	.075	3.26(.85-12.44)	.083
Monthly salary(ETB)						
≤ 5000	17	25	1		1	
5001-7000	67	91	1.08(.542-2.16)	.822	1.01(.436-2.35)	.976
7001-9000	98	74	1.94(.987-3.86)	.057	1.26(.517-3.10)	.604
≥ 9001	26	15	2.54(1.05-6.17)	.038	1.05(.310-3.58)	.933
Having guideline/ protocol						
No	131	161	1		1	
Yes	77	44	2.15(1.39-3.32)	.001	1.42(.824-2.47)	.205
Took training						
No	104	164	1		1	
Yes	104	41	4.00(2.58-6.19)	.000	2.64(1.53-4.57)	.001**
Reading updated evidence						
No	84	122	1		1	
Yes	124	83	2.17(1.46-3.21)	.000	1.37(.853-2.21)	.192
Constraint of thermometer						
Yes	123	145	1.67(1.11-2.51)	.014	1.10(.661-1.83)	.711
No	85	60	1		1	
Shortage of warming material						

Yes	166	176	1.53(.914-2.57)	.105	1.77(.923-3.39)	.086
No	42	29	1		1	
Job satisfaction						
Unsatisfied	71	124	1		1	
Satisfied	137	81	2.95(1.97-4.41)	.000	2.15(1.34-3.43)	.001**
Knowledge						
Good	157	87	4.17(2.74-6.35)	.000	2.64(1.63-4.27)	.000**
Poor	51	118	1		1	

Variables which show significant association during multivariable logistic regression at** p-value <0.05, Hosmer and Lemeshow test P=.993, 1=Reference.

Discussion

The result of this study showed that the overall knowledge of nurses on perioperative hypothermia prevention was 59.1% with 95%, CI (54.7, 63.7). This finding is higher than previous studies conducted Addis Ababa, Ethiopia(52.1%) (13). The possible reason might be due to socio-demographic differences, in the previous study most participants were having a degree and diploma level of educational status and the study area was a single setting of trauma center while in the current study greater than 10% of the participant had masters and study setting were multicenter. The other reason might be due to the difference in the time of the study because of the advancement of technology including updated evidence; educational programs were increased when the time is more and more recent. So, the participant might have to get more information regarding the topics. But this finding is much lower than those of studies conducted in Gambia (82%) (11), Turkey(77.5%) (4), Brazil (81.5%) (12), University of Iowa Hospitals and Clinics, America (71%) (35), Maryland, America (100%) (36), Ireland (37), and also as compare to NICE, AORN, and ASPAN guidelines of perioperative hypothermia prevention (3, 15, 38). The possible justification for this difference might be due to the level of staff training, adopted recommended guidelines, socioeconomic status, and sample size. According to training on hypothermia prevention in this study, only a few nurses (35.1%) have been trained while in the comparison group except in Gambia, almost all participants were taking

training on perioperative hypothermia prevention. In terms of using guideline/protocol, the studies conducted in America participants always used recommended guidelines and protocols while in this study only 29.3% of nurses were report having guidelines/protocols. According to difference in socioeconomic status of the participants as well as study setting, we Ethiopians are under a low-income country compared to America, Brazil, and Ireland. This is indirectly affects the quality of healthcare education as well as healthcare setting. In terms of sample size in the present study has a larger sample size (n=413) as compare to all listed above (in Gambia (n=53), Turkey (n=200), Brazil (n=21), University of Iowa Hospitals and Clinics, America n=30, Maryland, America n=19, Ireland n=198).

In this study, the overall practice of nurses on perioperative hypothermia prevention was 50.4% with 95%, CI (45.5-55). This is consistent with the studies done in Addis Ababa, Ethiopia (52.5%)(13), and Durban, South Africa (46%) (14). But this study is higher than the study done in Gambia (19%) (11). The possible reason might be the difference in socio-demographic characteristics like most of the participants in the Gambia were have less than five years' experience, and hadn't masters holder participants. On the other hand, the result of this study is much lower when from NICE, AORN, and ASPAN recommendations guidelines (3,15, 38). This discrepancy could be due to the insufficient availability of warming material, measurement material, and guidelines or protocol or it might be also an inadequate opportunity for frequent training for nurses.

Regarding the determinants of the level of knowledge on hypothermia prevention, this study has found out that male nurses were found to have more knowledge with hypothermia prevention by1.6 times as compared to females. The reason might be females have an extra workload, most home activities such as bearing and taking care of children, cooking, washing etc. are mostly done by females (39). So due to being overloaded by other additional home activities they might haven't enough time to scale up their knowledge.

Nurses who had degrees and masters were more likely to have good knowledge with hypothermia prevention by 2.5 and 4.4 times respectively as compared to those who had a diploma. This finding is supported by studies conducted in Iran(24), and Brazil, educational interventions are fundamental for nurses to guide their team and be the link of technical-

scientific knowledge to improve the quality of patient care (12). The possible reason might be that more educated respondents have a higher opportunity of exposure to different courses directly or indirectly related to the prevention of hypothermia.

Those nurses who received training related to hypothermia prevention were 3.7 and 2.6 times more likely to have good knowledge and practice of hypothermia prevention as compared to counterparts. This finding is supported by studies in Maryland, America(36), Brazil (40), Iran (24), Turkey(4). The possible reason might be because training plays an important role in improving the quality of patient care. The need to promote the effectiveness of in-site and off-site training of nurses is an invaluable criterion. Training is necessary to update theoretical and practical knowledge in every aspect of nursing education(39).

Another finding is nurses who were working in recovery and intensive care units were 2.9 and 2.4 times more likely to have good practice respectively as compared to the nurses who were working in the emergency ward. This finding is inconsistent with the study conducted in Turkey, ICU nurses had more knowledge than nurses who were working in other wards but their practice was not changing (4). The possible reason why Recovery and ICU nurses had better practice might be patients admitted in Recovery and ICU wards need close follow-up because of their physiological change/disturbance due to surgery or anesthesia effect. So working in two wards, the nurses perform more activities, which maintain thermoregulation. Another reason might be nurse to patient ratio is better than other wards, the standard is in recovery one to two, ICU one to one, emergency one to three, and for surgical and orthopedics wards is one to six in Ethiopia. The other reason might have better availability of resources like a thermometer, warming materials. And also might be most nurses who were working in those two wards took more training than other nurses.

In this study, also nurses who are satisfied with their job were 2.2 times more likely to have a good level of practice as compared to those who were not satisfied. Job satisfaction of the nurses is highly important in building up employee interest and efficiency, as higher job satisfaction determines better employee performance(41). Therefore, hospital administrators need to work on improving working environments, so that nurses become safe and comfortable to result in a positive feeling towards their job.

The other significant variable is nurses who had knowledge of hypothermia were 2.6 times more likely to have a good practice as compared to those who hadn't knowledge of hypothermia prevention. This study has supported studies conducted at the University of Calabar, Nigeria (42) and Textbook of Brunner & Suddarth (43), AORN, surgical team awareness, education, and understanding of the effects of hypothermia are necessary components to change how clinicians provide quality, cost-effective patient care (44).

Strength and Limitations of the study

A self-reported questionnaire measure of knowledge and practice of nurses on the prevention of perioperative hypothermia is prone to social desirability bias and recall bias. Furthermore, this study was not triangulated with a qualitative method. Despite these limitations, this study covers large setting (multicenter) area.

Conclusion

This study revealed that nurses' knowledge and practice regarding the prevention of perioperative hypothermia was found to be inadequate as compared to the recommended guidelines. Having higher educational status, being male and attending training showed a positive and significant association with good knowledge of perioperative hypothermia prevention. Whereas, factors contributing to practice were working ward, training, job satisfaction, and knowledge of nurses. Based on the findings of the study, we recommend to Amhara regional health bureau and hospital administrators including ward coordinators in collaboration with other stakeholders: Improve sponsored educational opportunities especially those nurses who have a diploma, promote and strengthen in-service training periodically and regularly, better to motivate those who have the knowledge and practiced well, should fulfill the availability of resources like warming materials, thermometers, and updated guidelines/protocols, better to improve working environments so that nurses become safe and comfortable to result in a positive feeling towards their job. Researchers also should do other research for a strong recommendation by adding observational data collection methods.

List of Abbreviation

AOR: Adjusted Odd Ratio; AORN:Association of perioperative Register Nurses; ASPAN: American Society of PeriAnesthesia Nurses; CI: Confidence Interval; DMRH: Debre Markos Referral Hospital; DTCRH: Debre Tabor Comprehensive Referral Hospital; EMS:Emergency Medical Service; EPI INFO: Statistical Package for Epidemiological Information Analysis; FHRH: Felege Hiwot Referral Hospital; ICU: Intensive Care Unit; IPH: Inadvertent Perioperative Hypothermia; OR: Odds Ratio; OR: Operation Room; HP: Perioperative Hypothermia; PI: Principal Investigator; RR: Recovery Room; SPSS: Statistical Package of Social Science; T^{o} c: Temperature In Degree Centigrade; TGSRH: Tibebe Gion Specialized Referral Hospital; UK: United Kingdom; UoGCSRH: University of Gondar Comprehensive Specialized Referral Hospital; USA: United States of America

Declaration

Ethical Approval and informed consent to participate

The Institutional Ethical Review Board of the University of Gondar approved the study. Ethical clearance was obtained from the board on behalf of the School of Nursing (Ref. No. S/R/164/2/2021). Upon this clearance, additional written permission to conduct the study was obtained from the manager of all five referral hospitals when after explaining the purpose, the possible benefit of the study. Informed written consent was obtained from each respondent before fulfilling the questionnaire. It was explained for the respondents that participated in the study were voluntary and private information would be protected. The processes no identify respondents by their name so; the process was done by keeping the privacy of the respondents.

Consent to publish

Not applicable

Availability of data and materials:

All data relevant to the study are included in the article or uploaded as supplementary information

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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Authors' contributions

Ashenafi Worku carried out the study starting from designing the study, analyzing, interpreting data, and reviewing the manuscript. Bezenaw Yimer Mekkonen, Netsanet Tsegaye, and Endalkachew Dellie participated in proposal writing, data analysis, interpretation, and commenting drafts of the paper and manuscript. All authors involved in writing, review and approving the final draft of the manuscript. All authors read and approved the manuscript before submitted to the journal for publication.

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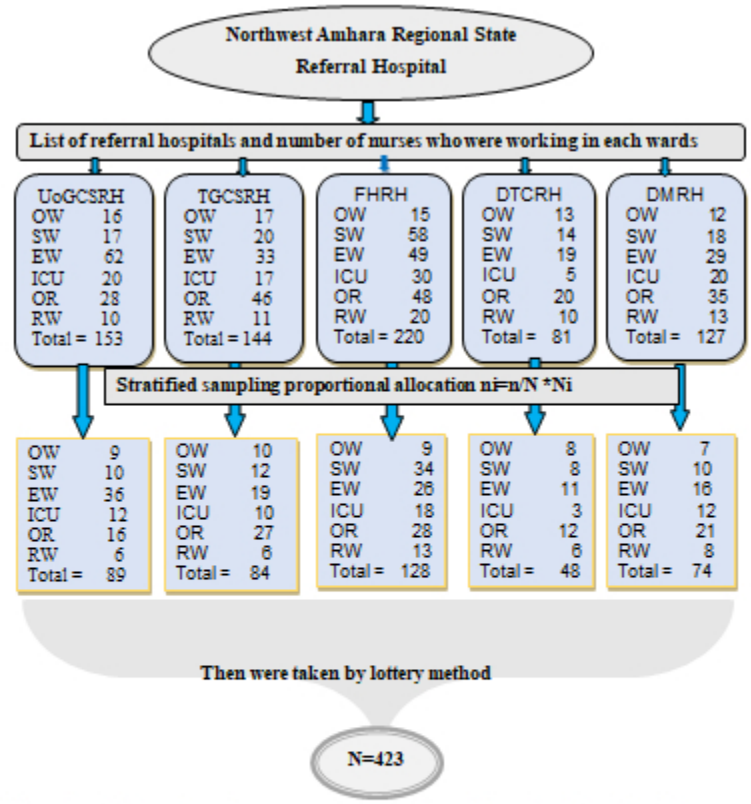
Table legend:

Supplemental Table: Institutional and other related factors of the respondents on perioperative hypothermia prevention in Amhara Regional State Referral Hospitals, Northwest Ethiopia, 2021 (N=413).

Figure legend:

Supplemental Figure: Schematic presentation of sampling procedure of nurses' knowledge and practice, and associated factors on hypothermia prevention among surgical patients.



Supplemental Figure: Schematic presentation of sampling procedure of nurses' knowledge and practice, and associated factors on hypothermia prevention among surgical patients.

315x352mm (38 x 38 DPI)

Supplemental Table: Institutional and other related factors of the respondents on perioperative hypothermia prevention in Amhara Regional State Referral Hospitals, Northwest Ethiopia, 2021 (N=413).

Variable	Response	Frequency (N=413)	Percentage (%)
Working place (hospital)	TGSRH	84	20.3
	UoGCSRH	83	20.1
	DMCRH	73	17.7
	DTCRH	47	11.4
	FHRH	126	30.5
Ward:	Emergency	103	24.9
	Recovery	39	9.4
	OR	102	24.7
	ICU	53	12.8
	Orthopedics ward	46	11.1
	Surgical ward	70	16.9
Daily working hours	≤ 8 hrs.	354	85.7
	≥9 hrs.	59	14.3
Training on hypothermia prevention	Yes	145	35.1
	No	268	64.9
Presence of protocol/guideline	Yes	121	29.3
	No	292	70.7
Reading updated evidence on hypothermia prevention	Yes	206	49.9
	No	207	50.1

Variable	Response	Frequency (N=413)	Percentage (%)
Availability of thermometer	Yes	145	35.1
	No	268	64.9
Constraints of warming material	Yes	342	82.8
	No	71	17.2
Shortage of blanket	Yes	166	40.2
	No	247	59.8
Shortage of linens	Yes	89	21.5
	No	324	78.5
Shortage of fluid warmer	Yes	132	32.0
	No	281	68.0
Shortage of air warmer/heater	Yes	212	51.3
	No	201	48.7
Shortage of warmer blanket	Yes	217	52.5
	No	196	47.5
Job satisfaction	Satisfied	217	52.5
	Dissatisfied	196	47.5

STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No.	Recommendation	Page No.	Relevant text from manuscript
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract	1	Line (1-3); An institution-based cross-sectional study was conducted for the title of Knowledge and Practice of nurses regarding Perioperative Hypothermia Prevention at Northwest Amhara Regional State Referral Hospitals, Northwest Ethiopia:
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	2	Lines (26 – 50); Abstract
Introduction				
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	3 and 4	Lines (56 – 108); Introduction
Objectives	3	State-specific objectives, including any pre-specified hypotheses	4	Lines (106 – 108); This study aimed to assess nurses' knowledge, practice, and their determinant factors of perioperative hypothermia prevention in Northwest Amhara Regional State Referral Hospitals, Northwest Ethiopia.
Methods				
Study design	4	Present key elements of study design early in the paper	4	Lines (110 – 112); Institutional based cross-sectional study was conducted in perioperative units/wards of five referral hospitals from March 25-May 20/2021.
Setting	5	Describe the setting, locations, and relevant dates,	5	Lines (113 – 131); Study setting

		including periods of recruitment, exposure, follow-up, and data collection		
Participants	6	(a) Cohort study—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up Case-control study—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls Cross-sectional study—Give the eligibility criteria and the sources and methods of selection of participants	5,6, and 7	Lines (132 – 139); Source and study population Lines (155 – 167); A total of 423 nurses were selected through a stratified random sampling technique, and data was collected from 413 nurses. Lines (168– 174); Inclusion and exclusion criteria (eligibility criteria)
		(b) Cohort study—For matched studies, give matching criteria and number of exposed and unexposed Case-control study—For matched studies, give matching criteria and the number of controls per case	N/A	This was a cross-sectional study
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	7	Lines (175 – 191); Operational definition of variables
Data sources/ measurement	8	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	7 and 8	Lines (192 – 201); Data collection tools and procedures
Bias	9	Describe any efforts to address potential sources of bias	8	Lines (202–211); To maintain data quality training was given to data collectors and supervisors. the questionnaire was pretested among 5% of the sample size. Quality was also maintained by

				close monitoring of the procedure, and checking on the completeness of the data on-site by the responsibility of supervisors and the principal investigator.
Study size	10	Explain how the study size was arrived at	5 and 6	Lines (140–154); The sample size was determined by using a formula to estimate a single population proportion with the assumption of a 95% level of confidence, 50% proportion, and a 5% marginal error.
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	9	Lines (218–223); Binary logistic regression was used to determine the significant association between the independent and dependent variables. Those independent variables, which are less than 0.2 in bivariate analysis, were entered into multivariable logistic regressions. Association between the independent variable and dependent variable was considered significant if P-value was less than 0.05 from multivariate logistic regression analysis
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	8	Lines (213–223); Statistical Analysis
		(b) Describe any methods used to examine subgroups and interactions	N/A	There were no subgroups
		(c) Explain how missing data were addressed	N/A	There was no missing data
		(d) Cohort study—If applicable, explain how loss to follow-up was addressed Case-control study—If applicable, explain how matching of cases and controls was addressed Cross-sectional study—If applicable, describe analytical methods taking account of sampling strategy	6	Lines (158 – 167); A total of 423 nurses were selected through a stratified random sampling technique, and data was collected from them

		(e) Describe any sensitivity analyses	N/A	
Results				
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	N/A	This was a cross-sectional study with only one stage.
		(b) Give reasons for non-participation at each stage	N/A	
		(c) Consider use of a flow diagram	N/A	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, institutional, other) and information on exposures and potential confounders	9 and 10	Line (234-236); Table 1: Socio-demographic characteristics of the study participants on hypothermia prevention among perioperative patients in Amhara Regional State Referral Hospitals, Northwest Ethiopia, 2021(N=413). Line (238-244); **Institutional and job-related factors of the respondents** of the study participants
		(b) Indicate number of participants with missing data for each variable of interest	N/A	There was no missing data
		(c) Cohort study—Summarise follow-up time (eg, average and total amount)	N/A	This was a cross-sectional study
Outcome data	15*	Cohort study—Report numbers of outcome events or summary measures over time	N/A	This was cross-sectional study
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	N/A	This was a cross-sectional study

		Cross-sectional study—Report numbers of outcome events or summary measures	10, 12,and 13	Lines (246–248); In this study, 244 (59.1%) with 95% CI: (54.7, 63.7) of the participants had good knowledge Lines (260–262); In this study, 208 (50.4%) with 95% CI: (45.5, 55) of the participants had good practice.
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	10, 12, 13, and 20	Lines (246-248); In this study, 244 (59.1%) with 95% CI: (54.7, 63.7) of the participants had good knowledge Lines (260-262); In this study, 208 (50.4%) with 95% CI: (45.5, 55) of the participants had a good practice. Lines (282-284); Table 4- Bi-variable and multivariable analysis of factors associated with knowledge of nurses on perioperative hypothermia prevention in Amhara Region Referral Hospitals, Northwest Ethiopia. Lines (301-303); Table 5- Bi-variable and multivariable analysis of factors associated with the practice of nurses on perioperative hypothermia prevention in Amhara Region Referral Hospitals, Northwest Ethiopia.
		(b) Report category boundaries when continuous variables were categorized	N/A	There was no continuous variable.
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	N/A	There was no estimate of relative risk.
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	N/A	There was no sub groups and sensitivity analysis.
Discussion				

Key results	18	Summarise key results with reference to study objectives	19-22	Lines (306–387); Discussion
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	22	Lines (389–392); A self-reported questionnaire measure of knowledge and practice of nurses on the prevention of perioperative hypothermia is prone to social desirability bias and recall bias. Furthermore, this study was not triangulated with a qualitative method.
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	19-22	Lines (306-392); Discussion and limitation and strength
Generalizability	21	Discuss the generalizability (external validity) of the study results	22	Lines (393-407); This study revealed that nurses' knowledge and practice regarding the prevention of perioperative hypothermia was found to be inadequate as compared to the recommended guidelines. Having higher educational status, being male, and attending training showed a positive and significant association with good knowledge of perioperative hypothermia prevention. Whereas, factors contributing to practice were working ward, training, job satisfaction, and knowledge of nurses.
Other information				
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	24	Lines (437)-This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

BMJ Open

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Knowledge and Practice of Nurses regarding Perioperative Hypothermia Prevention at Northwest Amhara Regional State Referral Hospitals, Northwest Ethiopia: A cross-sectional study

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Word count: 3,998 (Introduction to conclusion).

Abstract

Objectives Nurses are primarily responsible body to preventing the occurrence of hypothermia among surgical patients, as it has been reported that maintenance of normal body temperature decreases the length of hospitalization by approximately up to 40%, the risk of surgical site infection by 64%, and mortality rate by four folds. Therefore this study aimed to assess nurses' knowledge, practices, and associated factors toward perioperative hypothermia prevention.

Design Cross-sectional study design.

Setting Northwest Amhara Regional State Referral Hospitals, Northwest Ethiopia

Participants A total of 413 nurses were working in a perioperative unit of five referral hospitals.

Main outcome measures Perioperative hypothermia prevention knowledge and practices among nurses

Results A total of 244 (59.1%) of the respondents had good knowledge and 208 (50.4%) had good practice in perioperative hypothermia prevention. Factors affecting nurses' knowledge on prevention of perioperative hypothermia were being male [AOR = 1.61, 95% CI (1.02-2.53)], having a bachelor, and master's degree [AOR = 2.50; 95% CI (1.25-5.00), and 4.39; (1.45-13.20)] respectively, and took training [AOR = 3.68; 95% CI (2.14-6.33)]. Whereas nurses who were working in recovery and intensive care units [AOR = 2.87; 95% CI (1.08-7.58), and 2.39; 95% CI (1.09-5.22)] respectively, took training [AOR = 2.64; 95% CI (1.53-4.57)], had a Job satisfaction [AOR 2.15; 95% CI (1.34-3.43)], and knowledgeable nurses [AOR 2.64; 95% CI (1.63-4.27)] were factors affecting nurse's practice on perioperative hypothermia prevention.

Conclusion Nurses' knowledge and practice regarding the prevention of perioperative hypothermia were found to be inadequate. So, it is better to strengthen training, educational opportunities, equip wards with standardized guidelines and materials, and motivate and create a safe working environment.

Keywords: Perioperative hypothermia, Ethiopia, Knowledge, Practice, Nurses.

Limitations and Strengths of the Study

- Due to the time constraint, the observational data collection method was not done.
- Furthermore, this study was not triangulated with the qualitative method
- Due to the limited availability of literature, I have used unpublished sources.
- Despite these limitations, this study covers a large setting area.

Background

Hypothermia is a common health problem in patients having surgery, that is characterized as a body temperature below 36℃ (96.8°F) and it is usually caused by too much heat loss from cold weather exposure, anesthetic effect, and administration of cold intravenous, or irrigation fluids (1-3). Hypothermia decelerates all physiologic roles including metabolic rate, mental awareness, nerve conduction, neuromuscular reaction times, and both the cardiovascular and respiratory systems, consequently disturbing patients' comfort and leading to longer hospitalizations, higher costs, and increasing mortality (1, 4).

Different studies conducted in different areas revealed that the magnitude of perioperative hypothermia in Brazil was 56.7%(5), in Australia 74% (6), and in Turkey research hospital hospitals of Ankara, and Trakya University Hospital were 78.6% and 63.3% respectively (7, 8). In other studies conducted in Thailand, the incidence of preoperative, intraoperative, and postoperative hypothermia was 0.4%, 73.5%, and 11.9% respectively (9). While the study conducted in Deutschland to evaluate the hypothermia rates achieved with pre-warming and without pre-warming methods the result revealed patients subjected to pre-warming showed an intraoperative hypothermia rate of 15.8% and a postoperative hypothermia rate of 5.1% while patients without pre-warming showed an intraoperative hypothermia rate of 30.4% and a postoperative hypothermia rate of 12.4%. This means a 52% reduction in the intraoperative hypothermia rate and a 41% reduction in the postoperative hypothermia rate for patients who received pre-warming (10). Furthermore, studies conducted in Ethiopia, Tikur Anbessa Specialized Hospital the overall magnitude of preoperative, intraoperative, and postoperative hypothermia were 16.2%, 53.2%, and 31.3%, respectively (11) while, in the University of Gondar Comprehensive Specialized Referral Hospital (UoGCSRH) the incidence of pre, intra, and post-operative hypothermia were 23.4%, 49.7%, and 50.6% respectively (12). However available literature shows that nurses' knowledge and practice towards perioperative hypothermia prevention is low despite the high incidence, serious consequences, and availability of effective interventions to prevent and treat this frequent surgical complication (2, 13). In interventional studies conducted on perioperative hypothermia prevention in Brazil and Turkey, 55.9% and 61.77% of nurses had good knowledge respectively before they were taken the training (4, 14). Another cross-sectional study was done in Ethiopia regarding perioperative

hypothermia prevention in trauma patients, only 52.1% of nurses had good knowledge (15). In studies conducted in South Africa and Gambia, 46% and 19% of nurses had good practice respectively on perioperative hypothermia prevention (13, 16).

According to the Association of Perioperative Register Nurses (AORN) Guideline, nurses need to have knowledge and skills on hypothermia prevention during the perioperative phase. This includes measuring the patient's body temperature, selecting methods for the prevention of unintended hypothermia, and implementing the selected insulation and warming interventions (17). Warming intervention measures include warming patients before surgery, during surgery, and after surgery by using passive insulation and active warming methods such as warmed cotton blankets, surgical draping, thermal garments, forced-air warming devices, electric warming blankets, and warmed fluids (18, 19).

Preventing heat loss and maintaining normal body temperature are important nursing care in an early phase of resuscitation as metabolic changes accompanied by injury cannot be corrected when patients are in hypothermic status (20). Nurses need to be cognizant of the risks associated with each perioperative phase of the patient in the prevention of hypothermia(21). Preserving a normal body temperature during the surgical experience enhances the patient's chance of preventing postoperative complications (22). Different evidence reported that maintenance of normal body temperature decreases the length of hospitalization by approximately up to 40%, the risk of surgical site infection by 64%, may prevent the costs of potential stay in the intensive care unit by $1,000 and a prolonged hospital stay by $465 per day, and also decreasing mortality rate by four folds (23-25).

If nurses do not have adequate knowledge and skill in the prevention of perioperative hypothermia, its occurrence is inevitable. Even if nurses' knowledge and practice are important in the prevention of perioperative hypothermia and its complications, available literature revealed that nurses had significant knowledge and practice gaps (15). Different socio-demographic and institutional factors which include age, marital status, educational level, work experience, presence of guidelines and risk assessment protocol, taking training, reading updated evidence, and job satisfaction affect nurses' knowledge and practice (2, 13, 26, 27).

In Ethiopia, there are no studies available regarding nurses' knowledge and practice on perioperative hypothermia prevention. Therefore, the purpose of this study is to assess nurses' knowledge, practice, and their determinant factors of perioperative hypothermia prevention in Northwest Amhara Regional State Referral Hospitals, Northwest Ethiopia.

Methods

Study design and period

An institutional-based cross-sectional study was conducted in perioperative units/wards of five referral hospitals from March 25 to May 20/2021.

Study area

The study was conducted in Northwest Amhara Regional State Referral Hospitals, Northwest Ethiopia. Northwest Amhara is found in the northwestern part of Ethiopia. There are five governmental referral hospitals in Northwest Amhara regional state namely University of Gondar Comprehensive Specialized Referral Hospital (UoGCSRH), Felege Hiwot Referral Hospital (FHRH), Tibebe Gion Specialized Referral Hospital (TGSRH), Debre Markos Referral Hospital (DMRH), and Debre Tabor Comprehensive Referral Hospital (DTCRH). All hospitals provide outpatient and inpatient services. The surgical department is one of the actively serving departments giving emergency and elective surgery among the services given by the hospitals. All five hospitals have different surgical units in their surgical department such as surgical emergency, operation room, recovery ward, surgical ward, orthopedics ward, and surgical intensive care unit (ICU). According to information obtained from the administrative offices of these hospitals, there are 1682 nurses, who provide services. Among those 725 nurses (153 in UoGCSRH, 220 in FHRH, 144 in TGSRH, 127 in DMRH, and 81 in DTCRH) are working in our study unit (28-32). Nurses who are working in the perioperative unit provide different hypothermia preventive activities like covering patients with linens and blankets, measuring patients' temperature, warming intravenous fluids; adjusting room temperature, and so on. Because preventing perioperative hypothermia is a crucial role for nurses.

Source population

The source populations were all nurses who were working in the emergency, operation room, recovery ward, surgical ward, orthopedics ward, and surgical ICU of Northwest Amhara Regional State Referral Hospitals, Northwest Ethiopia.

Study population

The study population included nurses who were working in an emergency ward, operation room, recovery ward, surgical ward, orthopedics ward, and surgical ICU of UoGCSRH, DTCRH, DMRH, TGRH, and FHRH during the data collection period.

Sample size and sampling procedure

Sample size

The sample size of the study was calculated using the formula for the estimation of a single population proportion and the assumptions were the proportion of knowledge and practice of nurses regarding hypothermia prevention was 50% (since there was no study conducted in our country), with 95% level of confidence and 5% margin of error. By using a z-value of 1.96 at 95% CI the minimum sample size for this study was:

As: $n= Z\alpha/2^2 * P (1-P)/ d^2$

n = sample size

p = proportion of knowledge & practice of nurses on hypothermia prevention =0.5

d = maximum allowable error (margin of error) = 0.05

Z = value of standard normal distribution at 95% confidence level *(z=1.96)*.

n = *(1.96) (1.96) *(0.5) (1-0.5)/ (0.05) (0.05)* =384 subjects;

⇨ By adding a 10% allowance for non-response rate the total sample size was 384+10%=423

Sampling procedure

The study was performed on nurses who were working in the emergency surgical (including the trauma unit), operation room, recovery ward, surgical ward, orthopedics ward, and surgical ICU of Northwest Amhara Regional State Referral Hospitals, Northwest Ethiopia. A stratified sampling technique was employed to recruit the required participants for the study. First, the study participants are stratified from each hospital and working ward/unit and allocated the

required sample for each stratum proportionally. According to all hospitals human resources, and administration reports the total number of nurses who were working in these units or wards was 725. Based on the number of nurses working in each hospital, 423 samples were proportionally allocated from 725 (from 153 - 89 in UoGCSRH, 144 - 84 in TGRH, 220 -128 in FHRH, 81 - 48 in DTRH, and 127 - 74 in DMRH). Finally, those participants were taken by lottery method of simple random sampling technique from each sampling frame (Supplemental Figure)

Inclusion and exclusion criteria

All nurses who were working in the surgical emergency, operation room, recovery ward, surgical ICU, surgical ward, and orthopedic ward of Northwest Amhara Regional State Referral Hospitals, Northwest Ethiopia during the time of data collection were included in this study.

Matron and ward coordinator nurses were excluded because those nurses are primarily responsible is coordinating, monitoring, and evaluating the staff nurses rather they doing routine activities.

Operational definitions

Knowledge: Is theoretical or practical understanding of hypothermia and its prevention method through education or experience. Based on this research the percentage scores were graded as 'poor', and 'good to determine the knowledge level.

Good knowledge: If the study participants answer the knowledge questions above or equal to the computed median they are considered as having good knowledge.

Poor knowledge: If the study participants answered, the knowledge questions below the computed median were considered as having poor knowledge.

Practice: Activities acting by nurses to prevent hypothermia. Items in this category of the Likert scale were coded as 0 to 2 for: never, sometimes, and always.

Good practice: The study participants who answered above or equal to the computed median of practice questions were considered as having good practice.

Poor practice: The study participants who answered below the computed median of practice questions were considered to have poor practice.

Job satisfaction: When the total score for the job satisfaction questionnaire was greater than or equal to the computed median, we said they were satisfied, and less than the computed median, we said they were dissatisfied with the overall aspect of their work.

Data collection instruments and procedure

Data was collected by using a self-administered questionnaire which was adapted from guidelines of AORN and NICE perioperative hypothermia prevention, and other literature which involves 27 questions for knowledge and 14 questions for practice (13, 33-35), and 15 questions for Socio-demographic, institutional and other characteristics (2, 4, 13, 26, 27, 33, 36). Besides, three advisors who have experience in establishing through revision of content validity instruments were consulted to assess the questionnaire's validity. The questionnaires were prepared in the English language based on the study objectives, focusing on the background information of hypothermia and its prevention. Five BSc nurse staff who was working other than the study wards were recruited for data collection and two MSc holder nurses were recruited as a supervisor. Overall, the data collection process was coordinated and supervised by the principal investigator.

Data quality control

To ensure the quality of the collected data, data collectors and supervisors underwent one-day training on the purpose of the study and the data collection procedure. The questionnaire was additionally pretested at Woldia Comprehensive Referral Hospital with 5% of the sample size. Internal consistency was checked by computing Cronbach's α for both dependent variables and job satisfaction questionnaires. The tests showed 0.81, 0.77, and 0.91 for knowledge, practice, and job satisfaction respectively. Supervisors and primary investigator conducted routine supervision to verify the consistency and completeness of the questionnaires that were filled out. Incomplete questionnaires were put in offices arranged for this purpose so that participants completed their questionnaires.

Data processing and analysis

After the data was checked for its consistency and completeness, data were entered into Epi Info version 7 and exported into SPSS version 25 for analysis. A frequency table was used to describe

the participant characteristics knowledge and practice scores. Multicollinearity was cheeked by using the variance inflation factor and its values were between 1 and 10. Model adequacy was checked by using the Hosmer-Lemeshow goodness of fit test and the model was fitted well which indicates .856 and .993 for knowledge and practice respectively. Binary logistic regression was used to determine the significant association between the independent and dependent variables. Those independent variables, which are less than 0.2 in bivariate analysis, were entered into multivariable logistic regressions. The association between the independent variable and dependent variable was considered the significant if P-value was less than 0.05 from multivariate logistic regression analysis.

Patient and public involvement

It was not appropriate or possible to involve patients or the public in the design, conduct, report, or dissemination plans of our research because this study was done on Nurses.

Results

Socio-demographic characteristics of the respondents

A total of 423, with a response rate of 97.6% of study participants were involved in this study. The median age (IQR) of the study participants was 29 (27, 32) years, ranging from 20-58 years and almost half of the participants were under the age category between 26 to 30 years. Two hundred thirteen (51.6%) of the participants were male, and 235(56.9%) were married. Out of 413 nurses, three-fourths of the respondents had a bachelor's degree (Table 1).

Table 1: Socio-demographic characteristics of nurses on perioperative hypothermia prevention in Amhara Regional State Referral Hospitals, Northwest Ethiopia, 2021(N=413).

Variable	Response	Frequency (N=413)	Percentage (%)
Sex	Male	213	51.6
	Female	200	48.4
Age	≤ 25 years	53	12.8
	26-30	224	54.2
	31-35	86	20.8
	≥ 35	50	12.1

Marital status	Single	163	39.5
	Married	235	56.9
	Divorced	12	2.9
	Widowed	3	.7
Educational status	Diploma	59	14.3
	Degree	311	75.3
	Master	43	10.4
Work experience	≤ 5 years	157	38
	6-10	181	43.8
	11-15	57	13.8
	≥ 16	18	4.4
Monthly salary(ETB)	≤ 5000	42	10.2
	5001-7000	158	38.3
	7001-9000	172	41.6
	≥ 9001	41	9.9

ETB- Ethiopian Birr

Institutional and job-related factors of the respondents

From 413, 268(64.9%) of nurses did not take training about perioperative hypothermia prevention. half of the respondents reported that they were reading or reviewing updated evidence, and only 121(29.3%) of participants were notified of the presence of guidelines or protocols in their working area. Out of the study participants, 268 (64.9%) and 342 (82.8%) had a shortage of thermometers and warming materials respectively. From 413 study participants, nearly half of 217 (52.5%) participants were satisfied with their jobs (Supplemental Table).

Knowledge of nurses on hypothermia prevention

The overall median knowledge score of the study participants on perioperative hypothermia prevention was 18 with an IQR of (16, 21). In this study, 244 (59.1%) with 95% CI: (54.7, 63.7) of the participants had good knowledge. Among a total of knowledge assessment questions,

359(86.9%) participants have correctly answered the statement about thermoregulation. Three-fourths of the participants gave the correct answer of anesthetic drugs increase heat loss while 250(60.5) of the participants correctly answered the complications of hypothermia in surgical patients. Only 83(20.1%) of the participants were correctly respond in the theatre room, the patient's temperature should be measured every 30 minutes while in the recovery room, every 15 minutes (Table 2).

Table 2. Nurse's responses on knowledge of perioperative hypothermia prevention (N=413)

Statements about perioperative hypothermia prevention	**True / False**	**Correct answer**		**Wrong answer /don't know**	
		N	**%**	**N**	**%**
The internal environment of humans can be maintained by thermoregulation.	T*	359	86.9	54	13.1
PH at any time during the perioperative cycle is characterized as a core body temperature < 36 ° C.	T*	288	69.7	125	30.3
Anesthetic drugs decrease heat loss in surgical patients.	F**	311	75.3	102	24.7
Cold IV fluids and blood products increase heat loss.	T*	288	69.5	126	30.5
PH is not associated with complications such as changes in drug metabolism, healing complications, shivering, clotting defects, cardiac morbidity, and prolonged post-anesthetic recovery.	F**	250	60.5	163	39.5
To minimize post-operative complications, nurses should advise patients to bring along additional clothing to help them stay warm before surgery	T*	339	82.1	74	17.9
The pulmonary artery catheter, distal esophagus, urinary bladder, rectum, zero heat-flux are some of the sites for temperature measurements.	T*	174	42.1	239	57.9
Nurses should be well trained and knowledgeable about the use of both temperature recording and warming devices	T*	346	83.8	67	16.2
Forced-air warming devices, warm water circulating and conductive devices are not some of the devices for warming surgical patients	F**	241	58.4	172	41.6
The method for temperature monitoring should not be chosen based on the criteria for a procedure	F**	281	68	132	32
To ensure accurate information, the team takes the patient's temperature at 15- minute intervals using different measuring devices at different sites.	F**	138	33.4	275	66.6
Patients with temperature < 36.0°C undergoing anesthesia & those having a high risk of cardiovascular complications are at higher risk for IPH	T*	293	70.9	120	29.1
It is not necessary to measure patients' temperature in the hour before	F**	279	67.6	134	32.4

departing the ward since it will be measured at the theatre.

Except in urgent circumstances, preoperative patients with temperatures of < 36.0°C should be warmed for 30' by using active warming method	T*	284	68.8	129	31.2
Special attention should be given to the comfort of surgical patients having difficulties expressing themselves	T*	335	81.1	78	18.9
The method for warming patients should be chosen based on planned procedure, patient position, IV access site, and warming equipment constraints.	T*	333	80.6	80	19.4
Critical incidence reporting is not necessary for patients coming into the theatre with a temperature of less than 36.0°C.	F**	259	62.7	154	37.3
Induction of anesthesia should not begin unless the patient's temperature is 36.0°C or above.	T*	203	49.2	210	50.8
The theatre's room temperature should be at least 21°C which can be adjusted to allow better working once active warming is initiated.	T*	273	66.1	140	33.9
All irrigation fluids used intraoperative should be warmed in a thermostatically controlled cabinet to a temperature of 38- 40°C.	T*	214	51.8	199	48.2
Fluid warming devices should be used to warm IV fluids (500mls or more) & blood products to 37°C	T*	260	63	153	37
Regardless of the temperatures of patients before leaving the ward, they should be warmed using active warming method once in the theatre	T*	256	62	157	38
The surgical patient should be well covered throughout surgery to conserve heat and only be exposed during surgical preparation.	T*	310	75.1	103	24.9
During the postoperative period, hypothermic patients should be warmed using AWM until they become warm before transferring them to the ward.	T*	348	84.3	65	15.7
Patients should be provided with at least 1 cotton sheet, 2 blankets, or a duvet during the postoperative phase	T*	319	77.2	94	22.8
While in the OR, the patients' temperature should be measured every 15 minutes and every 30 minutes while in the RR.	F**	83	20.1	330	79.9
The temperature of post-operative patients should be recorded on arrival in the ward and be documented as part of a routine 4-hour observation.	T*	337	81.6	76	18.4

T*-True statement, F**-False statement, N- Number of participants.

Practice of nurses on hypothermia prevention

The overall median practice score of the study participants on perioperative hypothermia prevention was 18 with an IQR of (14, 21). In this study, 208 (50.4%) with 95% CI: (45.5, 55) of the participants had good practice. Among practice assessment questions, 258(62.5%) of the

respondents measured temperature as soon as the patient arrived, and 224(54.2%) of the respondents were always assessing the signs and symptoms of hypothermia. Nearly half of the respondents 214(51.8%) and 213(51.6%) were sometimes maintaining ambient room temperature according to guidelines and also applying warm intravenous, blood products, and irrigation fluids respectively. Among 413 participants, 185(44.8%) of the respondents were reported never using forced-air warming devices, warm water circulating devices, and conductive devices for warming surgical patients (Table 3).

Table 3. Nurse's responses on practice of perioperative hypothermia prevention (N=413)

Hypothermia prevention practices	**Never**		**Some times**		**Always**	
	N	%	N	%	N	%
Do you measure temperature as soon as the patient arrival?	21	5.1	134	32.4	258	62.5
Do you measure temperature regularly according to guidelines?	50	12.1	202	48.9	161	39
Do you warm intravenous, blood products, and irrigation fluids using warming devices before administering to patients?	112	27.1	213	51.6	88	21.3
Do you cover the mattress plastic sheet with dry linen before patient admission?	59	14.3	200	48.4	154	37.3
Do you use forced-air warming devices, warm water circulating devices, and conductive devices for warming patients?	185	44.8	170	41.2	58	14
Do you communicate your assessment findings on factors that could lead to hypothermia to all members of the perioperative team?	57	13.8	160	38.7	196	47.5
Do you advise patients to inform you when they feel cold during their hospitalization?	53	12.8	195	47.2	165	40
Do you develop and implement care plans for perioperative hypothermia prevention?	73	17.7	217	52.5	123	29.8
Do you document the site for temperature measurement in the patients' file?	63	15.3	156	37.8	194	47
Do you maintain ambient room temperature according to the guideline?	110	26.6	214	51.8	89	21.5
Do you assess patients for their risk for perioperative hypothermia?	41	9.9	202	48.9	170	41.2
Do you assess for signs and symptoms of hypothermia?	30	7.3	159	38.5	224	54.2
Do you advise patients to stay warm prior to surgery?	48	11.6	185	44.8	180	43.6
Do you include thermoregulation interventions and patient-related care to thermoregulation in your hand-over report	41	9.9	194	47	178	43.1

Factors associated with the level of knowledge on hypothermia prevention

In the binary logistic regression, ten of fifteen variables p-value of < 0.2 and were candidates for multiple logistic regression. In multiple logistic regression, only three variables were significantly associated with knowledge of perioperative hypothermia prevention. In this study, being male [AOR = 1.61, 95% CI (1.02-2.53)], an educational level of degree and masters [AOR = 2.50; 95% CI (1.25-5.00), 4.39; (1.45-13.20)] respectively, and took training on perioperative hypothermia prevention [AOR = 3.68; 95% CI (2.14-6.33)] were significantly associated with their knowledge (Table 4).

Table 4- Bi-variable and multivariable analysis of factors associated with knowledge of nurses on perioperative hypothermia prevention in Amhara Region Referral Hospitals, Northwest Ethiopia.

Variable	Knowledge of nurses		COR (95%CI)	P-value	AOR (95% CI)	P-value
	Good	Poor				
Sex						
Female	105	95	1		1	
Male	139	74	1.69(1.14-2.52)	.009	1.61(1.02-2.53)	.038**
Educational status						
Diploma	19	40	1		1	
Degree	191	120	3.35(1.85-6.05)	.000	2.50(1.25-5.00)	.010**
Master	34	9	7.95(3.18-19.8)	.000	4.39(1.45-13.2)	.008**
Hospital						
FHRH	67	59	1		1	
UoGCSRH	48	35	1.20(.69-2.11)	.314	1.18(.631-2.21)	.601
DMCRH	51	22	2.04(1.11-3.76	.056	1.74(.863-3.49)	.118
DTCRH	33	14	2.08(1.01-4.25)	.046	2.16(.933-4.94)	.068
TGSRH	45	39	1.01(.58-1.77)	.955	1.20(.627-2.29)	.581

Ward						
Emergency	52	51	1		1	
Recovery	31	8	3.8(1.59-9.05)	.003	2.24(.862-5.84)	.098
ICU	34	19	1.75(.88-3.46	.106	1.48(.696-3.16)	.307
OR	67	35	1.87(1.07-3.29)	.028	1.51(.799-2.86)	.203
Orthopedics	26	20	1.27(.63-2.56)	.496	1.35(.641-3.02)	.402
Surgical	34	36	.92(.50-1.70)	.805	.850(.431-.1.67)	.640
Monthly salary(ETB)						
≤ 5000	18	21	1		1	
5001-7000	90	74	1.41(.7-2.85)	.477	1.10 (.478-2.35)	.885
7001-9000	107	64	1.95(.96-3.93)	.075	.848(.492-2.49)	.802
≥ 9001	29	10	3.38(1.3-8.79)	.010	1.53(.507-4.67)	.447
Having guideline						
No	124	168	1		1	
Yes	75	46	1.37(.88-2.1)	.153	.848(.490-1.46)	.555
Took Training						
No	128	140	1		1	
Yes	116	29	4.37(2.72-7.01)	.000	3.68(2.14-6.33)	.000**
Reading updated evidence						
No	106	100	1		1	
Yes	138	69	1.88(1.26-2.80)	.002	1.32(.834-2.10)	.234
Shortage of thermometer						
Yes	148	120	1		1	
No	96	49	1.58(1.04-2.41)	.031	1.27(.776-2.08)	.325
Job satisfaction						
Unsatisfied	100	95	1		1	
Satisfied	144	74	1.84(1.24-2.74)	.002	1.38(.873-2.20)	.166

Variables that show significant association during multivariable logistic regression at **p-value <0.05, Hosmer and Lemeshow test P=.856, 1=Reference.

Factors associated with the level of practice on hypothermia prevention

In bivariate logistic regression analysis, eleven of sixteen variables were found to have significant predictors at a p-value < 0.2 and were candidates for multiple logistic regression. In multiple logistic regression only four variables were nurses' significant predictors for the practice of nurses on hypothermia prevention at (P<0.05).

Nurses who were working in recovery and intensive care units [AOR = 2.87; 95% CI (1.08-7.58), and 2.39; 95% CI (1.09-5.22)] respectively, having training related to hypothermia prevention [AOR = 2.64; 95% CI (1.53-4.57)],satisfied with their job [AOR 2.15; 95% CI (1.34-3.43)], and to have good knowledge of hypothermia [AOR 2.64; 95% CI (1.63-4.27)] were significantly associated with their practice (Table 5)

Table 5- Bi-variable and multivariable analysis of factors associated with the practice of nurses on perioperative hypothermia prevention in Amhara Region Referral Hospitals, Northwest Ethiopia.

Variable	Practice of nurses		COR (95%CI)	P-value	AOR (95% CI)	P-value
	Good	Poor				
Educational status						
Diploma	16	43	1		1	
Degree	159	152	2.81(1.51-5.20)	.000	1.94(.902-4.20)	.089
Master	24	19	3.39(1.47-7.79)	.002	1.28(.411-4.00)	.669
Working ward						
Emergency	41	62	1		1	
Recovery	30	9	5.04(2.1-11.71)	.000	2.87(1.08-7.58)	.033**
ICU	34	19	2.70(1.36-5.37)	.004	2.39(1.09-5.22)	.029**
OR	59	43	2.07(1.18-3.62)	.010	1.63(.856-3.12)	.136
Orthopedics	20	26	1.16(.575-2.35)	.674	1.17(.527-2.62)	.693
Surgical	24	46	.78(.419-1.48)	.467	.657(.321-1.34)	.250
Work experience						
≤ 5 years	69	88	1		1	

6-10	95	86	1.4(.917-2.16)	.118	1.26(.713-2.23)	.424
11-15	32	25	1.63(.886-3.00)	.116	1.68(.735-3.86)	.217
≥ 16	12	6	2.55(.911-7.14)	.075	3.26(.85-12.44)	.083
Monthly salary(ETB)						
≤ 5000	17	25	1		1	
5001-7000	67	91	1.08(.542-2.16)	.822	1.01(.436-2.35)	.976
7001-9000	98	74	1.94(.987-3.86)	.057	1.26(.517-3.10)	.604
≥ 9001	26	15	2.54(1.05-6.17)	.038	1.05(.310-3.58)	.933
Having guidelines/ protocol						
No	131	161	1		1	
Yes	77	44	2.15(1.39-3.32)	.001	1.42(.824-2.47)	.205
Took training						
No	104	164	1		1	
Yes	104	41	4.00(2.58-6.19)	.000	2.64(1.53-4.57)	.001**
Reading updated evidence						
No	84	122	1		1	
Yes	124	83	2.17(1.46-3.21)	.000	1.37(.853-2.21)	.192
Constraint of thermometer						
Yes	123	145	1.67(1.11-2.51)	.014	1.10(.661-1.83)	.711
No	85	60	1		1	
Shortage of warming material						
Yes	166	176	1.53(.914-2.57)	.105	1.77(.923-3.39)	.086
No	42	29	1		1	
Job satisfaction						
Unsatisfied	71	124	1		1	
Satisfied	137	81	2.95(1.97-4.41)	.000	2.15(1.34-3.43)	.001**
Knowledge						
Good	157	87	4.17(2.74-6.35)	.000	2.64(1.63-4.27)	.000**
Poor	51	118	1		1	

Variables that show significant association during multivariable logistic regression at** p-value <0.05, Hosmer and Lemeshow test P=.993, 1=Reference.

Discussion

The result of this study showed that the overall knowledge of nurses on perioperative hypothermia prevention was 59.1% with 95%, CI (54.7, 63.7). This finding is higher than previous study conducted in Addis Ababa, Ethiopia(52.1%) (15). The possible reason might be due to socio-demographic differences, in the previous study most participants had a degree and diploma level of educational status and the study area was a single setting of trauma center while in the current study, greater than 10% of the participant had masters and study setting was multicenter. The other reason might be due to the difference in the time of the study because of the advancement of technology including updated evidence; educational programs were increased when the time is more and more recent. So, the participant might have to get more information regarding the topics. But this finding is much lower than those of studies conducted in Gambia (82%) (13), Turkey(77.5%) (4), Brazil (81.5%) (14), University of Iowa Hospitals and Clinics, America (71%) (37), Maryland, America (100%) (38), Ireland (39), and also as compare to NICE, AORN, and ASPAN guidelines of perioperative hypothermia prevention (3, 17, 40). The possible justification for this difference might be due to the level of staff training, adopted recommended guidelines, socioeconomic status, and sample size. According to training on hypothermia prevention in this study, only a few nurses (35.1%) have been trained while in the comparison group except in Gambia, almost all participants were taking training on perioperative hypothermia prevention. In terms of using guidelines/protocol, in the studies conducted in America participants always used recommended guidelines and protocols while in this study only 29.3% of nurses were report as having guidelines/protocols. According to a difference in socioeconomic status of the participants as well as the study setting, we Ethiopians are in a low-income country compared to America, Brazil, and Ireland. This indirectly affects the quality of healthcare education as well as the healthcare setting. In terms of sample size the present study has a larger sample size (n=413) as compared to all listed above (in Gambia (n=53), Turkey (n=200), Brazil (n=21), University of Iowa Hospitals and Clinics, America n=30, Maryland, America n=19, Ireland n=198).

In this study, the overall practice of nurses on perioperative hypothermia prevention was 50.4% with 95%, CI (45.5-55). This is consistent with the studies done in Addis Ababa, Ethiopia (52.5%) and Durban, South Africa (46%) (15, 16). But this study is higher than the study done in Gambia (19%) (13). The possible reason might be the difference in socio-demographic characteristics like most of the participants in the Gambia had less than five years of experience, and hadn't master's holder participants. On the other hand, the result of this study is much lower when from NICE, AORN, and ASPAN recommendations guidelines (3, 17, 40). This discrepancy could be due to the insufficient availability of warming material, measurement material, and guidelines or protocol or it might be also an inadequate opportunity for frequent training for nurses.

Regarding the determinants of the level of knowledge on hypothermia prevention, this study has found out that male nurses were found to have more knowledge of hypothermia prevention by 1.6 times as compared to females. The reason might be females have an extra workload, most home activities such as bearing and taking care of children, cooking, washing, etc. are mostly done by females (41). So due to being overloaded by other additional home activities, they might not have enough time to scale up their knowledge.

Nurses who had degrees and masters were more likely to have good knowledge of hypothermia prevention by 2.5 and 4.4 times respectively as compared to those who had a diploma. This finding is supported by studies conducted in Iran(26), and Brazil, educational interventions are fundamental for nurses to guide their team and be the link of technical-scientific knowledge to improve the quality of patient care (14). The possible reason might be that more educated respondents have a higher opportunity of exposure to different courses directly or indirectly related to the prevention of hypothermia.

Those nurses who received training related to hypothermia prevention were 3.7 and 2.6 times more likely to have good knowledge and practice of hypothermia prevention as compared to their counterparts. This finding is supported by studies in Maryland, America(38), Brazil (42), Iran (26), Turkey(4). The possible reason might be that training plays an important role in improving the quality of patient care. The need to promote the effectiveness of in-site and off-site training of nurses is an invaluable criterion. Training is necessary to update theoretical and practical knowledge in every aspect of nursing education(41).

Another finding is nurses who were working in recovery and intensive care units were 2.9 and 2.4 times more likely to have good practice respectively as compared to the nurses who were working in the emergency ward. This finding is inconsistent with the study conducted in Turkey, ICU nurses had more knowledge than nurses who were working in other wards but their practice was not changing (4). The possible reason why Recovery and ICU nurses had better practice might be patients admitted to Recovery and ICU wards need close follow-up because of their physiological change/disturbance due to surgery or anesthesia effect. So working in two wards, the nurses perform more activities, which maintain thermoregulation. Another reason might be that the nurse-to-patient ratio is better than other wards, the standard is in recovery one to two, ICU one to one, emergency one to three, and for surgical and orthopedics wards is one to six in Ethiopia. The other reason might be better availability of resources like a thermometer, and warming materials. Also might be most nurses who were working in those two wards took more training than other nurses.

In this study, nurses who were satisfied with their jobs were 2.2 times more likely to have a good level of practice as compared to those who were not satisfied. Job satisfaction of nurses is highly important in building up employee interest and efficiency, as higher job satisfaction determines better employee performance(43). Therefore, hospital administrators need to work on improving working environments, so that nurses become safe and comfortable to result in a positive feeling towards their job.

The other significant variable is nurses who have knowledge of hypothermia were 2.6 times more likely to have a good practice as compared to those who hadn't knowledge of hypothermia prevention. This study has supported studies conducted in Nigeria (44) and Textbook of Brunner & Suddarth (45), AORN, surgical team awareness, education, and understanding of the effects of hypothermia are necessary components to change how clinicians provide quality, cost-effective patient care (46).

Strengths and Limitations of the Study

A self-reported questionnaire measure of knowledge and practice of nurses on the prevention of perioperative hypothermia is prone to social desirability bias and recall bias. Furthermore, this study was not triangulated with a qualitative method. Despite these limitations, this study covers a large setting (multicenter) area.

Conclusion

This study revealed that nurses' knowledge and practice regarding the prevention of perioperative hypothermia was found to be inadequate as compared to the recommended guidelines. Having a higher educational status, being male, and attending training showed a positive and significant association with good knowledge of perioperative hypothermia prevention. Whereas, factors contributing to practice were working ward, training, job satisfaction, and knowledge of nurses. Based on the findings of the study, we recommend to the Amhara regional health bureau and hospital administrators including ward coordinators in collaboration with other stakeholders: Improve sponsored educational opportunities, especially those nurses who have a diploma, promote and strengthen in-service training periodically and regularly, better to motivate those who have knowledge and practiced well, should fulfill the availability of resources like warming materials, thermometers, and updated guidelines/protocols, better to improve working environments so that nurses become safe and comfortable to result in a positive feeling towards their job. Researchers also should do other research for a strong recommendation by adding observational data collection methods.

List of Abbreviation

AOR: Adjusted Odd Ratio; AORN:Association of perioperative Register Nurses; ASPAN: American Society of PeriAnesthesia Nurses; CI: Confidence Interval; DMRH: Debre Markos Referral Hospital; DTCRH: Debre Tabor Comprehensive Referral Hospital; EMS:Emergency Medical Service; EPI INFO: Statistical Package for Epidemiological Information Analysis; FHRH: Felege Hiwot Referral Hospital; ICU: Intensive Care Unit; IPH: Inadvertent Perioperative Hypothermia; OR: Odds Ratio; OR: Operation Room; HP: Perioperative Hypothermia; PI: Principal Investigator; RR: Recovery Room; SPSS: Statistical Package of Social Science; T^{o} c: Temperature In Degree Centigrade; TGSRH: Tibebe Gion Specialized Referral Hospital; UK: United Kingdom; UoGCSRH: University of Gondar Comprehensive Specialized Referral Hospital; USA: United States of America

Declaration

Ethical Approval and informed consent to participate

The Institutional Ethical Review Board of the University of Gondar approved the study. Ethical clearance was obtained from the board on behalf of the School of Nursing (Ref. No. S/R/164/2/2021). Upon this clearance, additional written permission to conduct the study was obtained from the manager of all five referral hospitals when after explaining the purpose, the possible benefit of the study. Informed written consent was obtained from each respondent before fulfilling the questionnaire. It was explained for the respondents that participated in the study were voluntary and private information would be protected. The processes not identify respondents by their name so; the process was done by keeping the privacy of the respondents.

Consent to publish

Not applicable

Availability of data and materials:

All data relevant to the study are included in the article or uploaded as supplementary information

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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Authors' contributions

Ashenafi Worku carried out the study starting from designing the study, analyzing, interpreting data, and reviewing the manuscript. Bezenaw Yimer Mekkonen, Netsanet Tsegaye, and Endalkachew Dellie participated in revising the measurement tool or questionnaire, proposal writing, data analysis, interpretation, and commenting drafts of the paper and manuscript. All authors involved in writing, reviewing and approving the final draft of the manuscript. All authors read and approved the manuscript before submitting it to the journal for publication.

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Table legend:

Supplemental Table: Institutional and other related factors of the respondents on perioperative hypothermia prevention in Amhara Regional State Referral Hospitals, Northwest Ethiopia, 2021 (N=413).

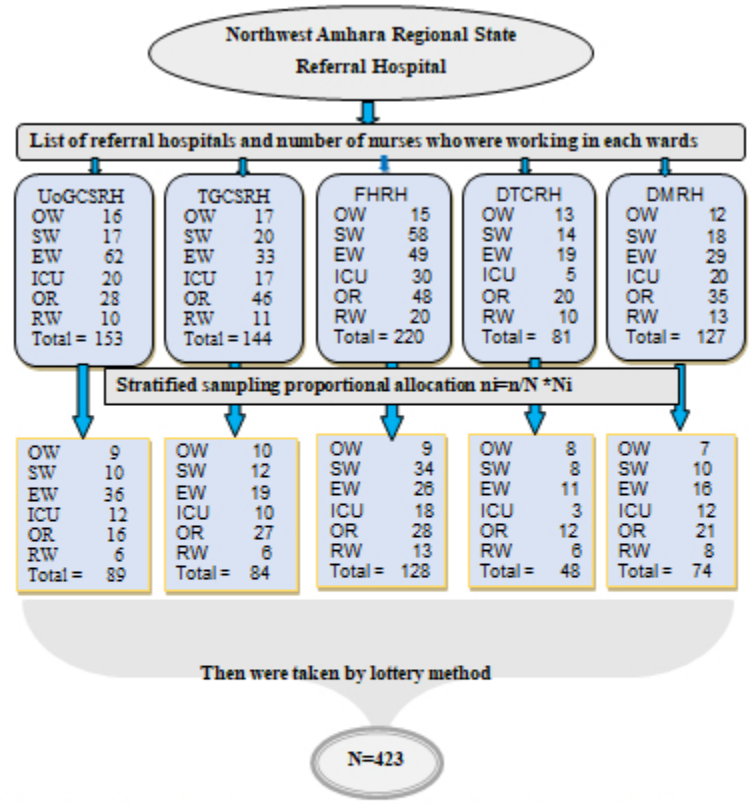
Figure legend:

Supplemental Figure: Schematic presentation of sampling procedure of nurses' knowledge and practice, and associated factors on hypothermia prevention among surgical patients.

Supplemental Table: Institutional and other related factors of the respondents on perioperative hypothermia prevention in Amhara Regional State Referral Hospitals, Northwest Ethiopia, 2021 (N=413).

Variable	Response	Frequency (N=413)	Percentage (%)
Working place (hospital)	TGSRH	84	20.3
	UoGCSRH	83	20.1
	DMCRH	73	17.7
	DTCRH	47	11.4
	FHRH	126	30.5
Ward:	Emergency	103	24.9
	Recovery	39	9.4
	OR	102	24.7
	ICU	53	12.8
	Orthopedics ward	46	11.1
	Surgical ward	70	16.9
Daily working hours	≤ 8 hrs.	354	85.7
	≥9 hrs.	59	14.3
Training on hypothermia prevention	Yes	145	35.1
	No	268	64.9
Presence of protocol/guideline	Yes	121	29.3
	No	292	70.7
Reading updated evidence on hypothermia prevention	Yes	206	49.9
	No	207	50.1

Variable	Response	Frequency (N=413)	Percentage (%)
Availability of thermometer	Yes	145	35.1
	No	268	64.9
Constraints of warming material	Yes	342	82.8
	No	71	17.2
Shortage of blanket	Yes	166	40.2
	No	247	59.8
Shortage of linens	Yes	89	21.5
	No	324	78.5
Shortage of fluid warmer	Yes	132	32.0
	No	281	68.0
Shortage of air warmer/heater	Yes	212	51.3
	No	201	48.7
Shortage of warmer blanket	Yes	217	52.5
	No	196	47.5
Job satisfaction	Satisfied	217	52.5
	Dissatisfied	196	47.5



Supplemental Figure: Schematic presentation of sampling procedure of nurses' knowledge and practice, and associated factors on hypothermia prevention among surgical patients.

315x352mm (38 x 38 DPI)

STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No.	Recommendation	Page No.	Relevant text from manuscript
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract	1	Line (1-3); An institution-based cross-sectional study was conducted for the title of Knowledge and Practice of nurses regarding Perioperative Hypothermia Prevention at Northwest Amhara Regional State Referral Hospitals, Northwest Ethiopia:
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	2	Lines (27 – 50); Abstract
Introduction				
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	3 and 4	Lines (57 – 118); Introduction
Objectives	3	State-specific objectives, including any pre-specified hypotheses	4	Lines (116 – 118); This study aimed to assess nurses' knowledge, practice, and their determinant factors of perioperative hypothermia prevention in Northwest Amhara Regional State Referral Hospitals, Northwest Ethiopia.
Methods				
Study design	4	Present key elements of study design early in the paper	4	Lines (120 – 122); Institutional based cross-sectional study was conducted in perioperative units/wards of five referral hospitals from March 25-May 20/2021.
Setting	5	Describe the setting, locations, and relevant dates,	5	Lines (123 – 140); Study setting

		including periods of recruitment, exposure, follow-up, and data collection		
Participants	6	(a) Cohort study—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up Case-control study—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls Cross-sectional study—Give the eligibility criteria and the sources and methods of selection of participants	5,6, and 7	Lines (141 – 148); Source and study population Lines (164 – 175); A total of 423 nurses were selected through a stratified random sampling technique, and data was collected from 413 nurses. Lines (176– 182); Inclusion and exclusion criteria (eligibility criteria)
		(b) Cohort study—For matched studies, give matching criteria and number of exposed and unexposed Case-control study—For matched studies, give matching criteria and the number of controls per case	N/A	This was a cross-sectional study
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	7	Lines (183 – 199); Operational definition of variables
Data sources/ measurement	8	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	7 and 8	Lines (200 – 211); Data collection tools and procedures
Bias	9	Describe any efforts to address potential sources of bias	8	Lines (212–221); To maintain data quality training was given to data collectors and supervisors. The questionnaire was pretested among 5% of the sample size. Quality was also maintained by

				close monitoring of the procedure, and checking on the completeness of the data on-site by the responsibility of supervisors and the principal investigator.
Study size	10	Explain how the study size was arrived at	5 and 6	Lines (149–163); The sample size was determined by using a formula to estimate a single population proportion with the assumption of a 95% level of confidence, 50% proportion, and a 5% marginal error.
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	9	Lines (228–233); Binary logistic regression was used to determine the significant association between the independent and dependent variables. Those independent variables, which are less than 0.2 in bivariate analysis, were entered into multivariable logistic regressions. Association between the independent variable and dependent variable was considered significant if P-value was less than 0.05 from multivariate logistic regression analysis
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	8	Lines (222–233); Statistical Analysis
		(b) Describe any methods used to examine subgroups and interactions	N/A	There were no subgroups
		(c) Explain how missing data were addressed	N/A	There was no missing data
		(d) Cohort study—If applicable, explain how loss to follow-up was addressed Case-control study—If applicable, explain how matching of cases and controls was addressed Cross-sectional study—If applicable, describe analytical methods taking account of sampling strategy	6	Lines (164– 175); A total of 423 nurses were selected through a stratified random sampling technique, and data was collected from them

		(e) Describe any sensitivity analyses	N/A	
Results				
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	N/A	This was a cross-sectional study with only one stage.
		(b) Give reasons for non-participation at each stage	N/A	
		(c) Consider use of a flow diagram	N/A	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, institutional, other) and information on exposures and potential confounders	9 and 10	Line (238-243); Table 1: Socio-demographic characteristics of the study participants on hypothermia prevention among perioperative patients in Amhara Regional State Referral Hospitals, Northwest Ethiopia, 2021(N=413). Line (248-254); **Institutional and job-related factors of the respondents** of the study participants
		(b) Indicate number of participants with missing data for each variable of interest	N/A	There was no missing data
		(c) Cohort study—Summarise follow-up time (eg, average and total amount)	N/A	This was a cross-sectional study
Outcome data	15*	Cohort study—Report numbers of outcome events or summary measures over time	N/A	This was cross-sectional study
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	N/A	This was a cross-sectional study

		Cross-sectional study—Report numbers of outcome events or summary measures	10, 12,and 13	Lines (257–258); In this study, 244 (59.1%) with 95% CI: (54.7, 63.7) of the participants had good knowledge Lines (269–270); In this study, 208 (50.4%) with 95% CI: (45.5, 55) of the participants had good practice.
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	10, 12, 13, and 20	Lines (257-258); In this study, 244 (59.1%) with 95% CI: (54.7, 63.7) of the participants had good knowledge Lines (269-270); In this study, 208 (50.4%) with 95% CI: (45.5, 55) of the participants had a good practice. Lines (288-290); Table 4- Bi-variable and multivariable analysis of factors associated with knowledge of nurses on perioperative hypothermia prevention in Amhara Region Referral Hospitals, Northwest Ethiopia. Lines (303-305); Table 5- Bi-variable and multivariable analysis of factors associated with the practice of nurses on perioperative hypothermia prevention in Amhara Region Referral Hospitals, Northwest Ethiopia.
		(b) Report category boundaries when continuous variables were categorized	N/A	There was no continuous variable.
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	N/A	There was no estimate of relative risk.
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	N/A	There was no sub groups and sensitivity analysis.
Discussion				

Key results	18	Summarise key results with reference to study objectives	19-22	Lines (308–389); Discussion
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	22	Lines (391–393); A self-reported questionnaire measure of knowledge and practice of nurses on the prevention of perioperative hypothermia is prone to social desirability bias and recall bias. Furthermore, this study was not triangulated with a qualitative method.
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	19-22	Lines (308-394); Discussion and limitation and strength
Generalizability	21	Discuss the generalizability (external validity) of the study results	22	Lines (395-409); This study revealed that nurses' knowledge and practice regarding the prevention of perioperative hypothermia was found to be inadequate as compared to the recommended guidelines. Having higher educational status, being male, and attending training showed a positive and significant association with good knowledge of perioperative hypothermia prevention. Whereas, factors contributing to practice were working ward, training, job satisfaction, and knowledge of nurses.
Other information				
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	24	Lines (439)-This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

BMJ Open

Knowledge and practice of nurses with respect to perioperative hypothermia prevention in the Northwest Amhara Regional State Referral Hospitals, Ethiopia: a cross-sectional study

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Knowledge and practice of nurses with respect to perioperative hypothermia prevention in the Northwest Amhara Regional State Referral Hospitals, Ethiopia: a cross-sectional study

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Abstract

Objectives It has been reported that maintaining a normal body temperature among surgical patients can reduce the length of hospitalization by up to 40%, decrease the risk of surgical site infection by 64%, and reduce mortality fourfold. Nurses are primarily responsible for preventing the occurrence of hypothermia among surgical patients. This study assessed nurses' knowledge and practices with respect to perioperative hypothermia prevention in Northwest Ethiopia, and investigated the factors associated with good knowledge and practice.

Design Cross-sectional study.

Setting Northwest Amhara Regional State Referral Hospitals, Northwest Ethiopia, March 25 to May 20, 2021.

Participants 413 nurses working in the perioperative units of five referral hospitals.

Outcome measures Perioperative hypothermia prevention knowledge and practice among nurses.

Results Nearly three-fifths (59.1%; 95% CI: 54.7-63.7) of respondents had good knowledge and about half (50.4%; 95% CI: 45.5 - 55.0) good practice with respect to perioperative hypothermia prevention. Factors associated with nurses' knowledge of prevention of perioperative hypothermia included male sex (AOR: 1.61, 95% CI: 1.02-2.53), having a bachelor's degree (AOR: 2.50, 95% CI: 1.25-5.00), having a master's degree (AOR: 4.39, 95% CI: 1.45-13.20), and training participation (AOR: 3.68, 95% CI: 2.14-6.33). Factors associated with nurses' practice of prevention of perioperative hypothermia included working in recovery (AOR: 2.87, 95% CI: 1.08-7.58) and intensive care units (AOR: 2.39, 95% CI: 1.09-5.22), training

participation (AOR: 2.64, 95% CI: 1.53-4.57), being satisfied with their job (AOR: 2.15, 95% CI: 1.34-3.43), and having good knowledge (AOR: 2.64, 95% CI: 1.63-4.27).

Conclusion Nurses' knowledge and practice in the prevention of perioperative hypothermia were inadequate. Hospital managers need to design and strengthen training programs and work to enhance job satisfaction.

Keywords: Perioperative hypothermia, Ethiopia, Knowledge, Practice, Nurses.

Strengths and limitations of this study

- This cross-sectional study used a stratified random sampling method and had a high response rate.
- The study might be prone to social desirability bias, although this was minimized through the use of a self-administered questionnaire.
- The content validity of the questionnaire was not formally assessed using independent experts.
- The study results were not triangulated with findings from qualitative approaches, which could have enhanced our findings.
- The research findings may not be generalized beyond the limited study setting.

INTRODUCTION

Hypothermia is a common health problem in patients having surgery that is characterized as a body temperature below 36 °C (96.8°F), and it is usually caused by too much heat loss from cold weather exposure, anesthetic effects, and the administration of cold intravenous or irrigation fluids (1-3). Hypothermia decelerates all physiologic roles, including metabolic rate, mental

awareness, nerve conduction, neuromuscular reaction times, and cardiovascular and respiratory systems, disturbing patients' comfort and leading to longer hospitalizations, higher costs, and increasing mortality (1, 4).

Different studies conducted in different areas revealed that the magnitude of perioperative hypothermia in Brazil was 56.7%(5), in Australia, 74% (6), and in Turkey, the research hospital of Ankara and Trakya University Hospital were 78.6% and 63.3% respectively (7, 8). In other studies conducted in Thailand, the incidence of preoperative, intraoperative, and postoperative hypothermia was 0.4%, 73.5%, and 11.9% respectively (9). While the study was conducted in Germany to evaluate the hypothermia rates achieved with pre-warming and without pre-warming methods, the results revealed patients subjected to pre-warming showed an intraoperative hypothermia rate of 15.8% and a postoperative hypothermia rate of 5.1%. In comparison, patients without pre-warming showed an intraoperative hypothermia rate of 30.4% and a postoperative hypothermia rate of 12.4%. This means a 52% reduction in the intraoperative hypothermia rate and a 41% reduction in the postoperative hypothermia rate for patients who received pre-warming (10). Furthermore, in studies conducted in Ethiopia at Tikur Anbessa Specialized Hospital, the overall magnitude of preoperative, intraoperative, and postoperative hypothermia was 16.2%, 53.2%, and 31.3%, respectively (11). In contrast, at the University of Gondar Comprehensive Specialized Referral Hospital (UoGCSRH), preoperative, intraoperative, and postoperative hypothermia incidence was 23.4%, 49.7%, and 50.6%, respectively (12). However, available literature shows that nurses' knowledge and practice towards perioperative hypothermia prevention is low despite the high incidence, serious consequences, and availability of effective interventions to prevent and treat this frequent surgical complication (2, 13). In intervention studies conducted on perioperative hypothermia prevention in Brazil and Turkey,

55.9% and 61.77% of nurses had good knowledge before training (4, 14). Another cross-sectional study was done in Ethiopia regarding perioperative hypothermia prevention in trauma patients; only 52.1% of nurses had good knowledge (15). In studies conducted in South Africa and Gambia, 46% and 19% of nurses had good perioperative hypothermia prevention practices, respectively (13, 16).

According to the Association of Perioperative Register Nurses (AORN) Guidelines, nurses must have knowledge and skills in preventing hypothermia during the perioperative phase. This includes measuring the patient's body temperature, selecting methods to prevent unintended hypothermia, and implementing the selected insulation and warming interventions (17). Warming intervention measures include warming patients before, during, and after surgery using passive insulation and active warming methods such as warmed cotton blankets, surgical draping, thermal garments, forced-air warming devices, electric warming blankets, and warmed fluids (18, 19).

Preventing heat loss and maintaining a normal body temperature are essential nursing tasks in the early resuscitation phase, as metabolic changes accompanied by injury cannot be corrected when patients are hypothermic (20). Nurses need to be cognizant of the risks associated with each perioperative phase of the patient in the prevention of hypothermia (21). Preserving a normal body temperature during the surgical experience enhances the patient's chance of preventing postoperative complications (22). Different evidence reported that maintenance of a normal body temperature decreases the length of hospitalization by approximately up to 40%, the risk of surgical site infection by 64%, may prevent the costs of potential stay in the intensive care unit by $1,000 and a prolonged hospital stay by $465 per day, and also decreasing mortality rate by fourfold (23-25).

If nurses do not have adequate knowledge and skill in the prevention of perioperative hypothermia, its occurrence is inevitable. Even if nurses' knowledge and practice are important in preventing perioperative hypothermia and its complications, available literature revealed that nurses had significant knowledge and practice gaps (13, 15). Different sociodemographic and institutional factors affect nurses' knowledge and practice, such as age, marital status, educational level, work experience, guidelines and risk assessment protocols, training, reading updated evidence, and job satisfaction, affect nurses' knowledge and practice (2, 13, 15, 26, 27).

In Ethiopia, there is limited evidence regarding the knowledge and practice of nurses in perioperative hypothermia prevention. Therefore, this study assessed nurses' knowledge and practices with respect to perioperative hypothermia prevention in Northwest Amhara Regional State Referral Hospitals, Northwest Ethiopia, and investigated the factors associated with good knowledge and practice.

METHODS

Study design and settings

An institutional-based cross-sectional study was conducted in five referral hospitals' perioperative units or wards from March 25 to May 20, 2021.

The study was conducted in Northwest Amhara Regional State Referral Hospitals, Northwest Ethiopia. Northwest Amhara is found in the northwestern part of Ethiopia. There are five governmental referral hospitals in Northwest Amhara regional state, namely the University of Gondar Comprehensive Specialized Referral Hospital (UoGCSRH), Felege Hiwot Referral Hospital (FHRH), Tibebe Gion Specialized Referral Hospital (TGSRH), Debre Markos Referral

Hospital (DMRH), and Debre Tabor Comprehensive Referral Hospital (DTCRH). All of these hospitals provide both outpatient and inpatient services.

The surgical department is one of the actively serving departments that provide emergency and elective surgery among hospital services. All five hospitals have different surgical units in their surgical departments, such as surgical emergency, operation room, recovery ward, surgical ward, orthopedics ward, and surgical intensive care unit (ICU). According to information obtained from the administrative offices of these hospitals, 1682 nurses provide services. Among those, 725 nurses (153 in UoGCSRH, 220 in FHRH, 144 in TGSRH, 127 in DMRH, and 81 in DTCRH) working in surgical departments (28-32). Nurses in the perioperative unit provide different hypothermia preventive activities like covering patients with linens and blankets, measuring patients' temperatures, warming intravenous fluids, adjusting room temperature, and so on because preventing perioperative hypothermia is crucial for nurses.

Participants

All nurses working in the emergency ward, operation room, recovery ward, surgical ward, orthopedics ward, and surgical ICU of Northwest Amhara Regional State Referral Hospitals were the source populations. Whereas nurses who were working in an emergency ward, operation room, recovery ward, surgical ward, orthopedics ward, and surgical ICU of UoGCSRH, DTCRH, DMRH, TGRH, and FHRH during the data collection period were the study population.

All nurses working in the surgical emergency, operating room, recovery ward, surgical ICU, surgical ward, and orthopedic ward of Northwest Amhara Regional State Referral Hospitals, Northwest Ethiopia, were included in this study. Whereas matron and ward coordinator, nurses

were excluded because those nurses are primarily responsible for coordinating, monitoring, and evaluating the staff nurses rather than doing routine activities.

Sample size and sampling procedure

The sample size was calculated using the single population proportion formula ($n= Z\alpha/2^2 * P (1-P)/ d^2$). A 50% proportion of nurses' knowledge and practice on hypothermia prevention, 95% confidence level, and 5% expected margin of error (d) were used. By considering a 10% non-response rate, the final sample becomes 423.

The study participants were recruited using a stratified sampling technique. Initially, the study participants are stratified by hospital and working ward or unit, and the required sample for each stratum is allocated proportionally. According to all hospitals' human resources and administration reports, the total number of nurses working in these units or wards was 725. The calculated sample size was then proportionally allocated to each hospital according to the number of nurses working in the respective departments or wards (i.e. from 153, 89 in UoGCSRH, from 144, 84 in TGRH, from 220, 128 in FHRH, from 81, 48 in DTRH, and from 127, 74 nurses in DMRH). Finally, study participants were chosen using a simple random sampling technique from each sampling frame (Supplemental Figure).

Variables and measurements

Knowledge of nurses on hypothermia prevention was assessed using twenty-seven questions derived from the association of perioperative register nurse guidelines and literature (3, 13, 21). If the study participants answered the knowledge questions above or were equal to the computed median score, they were considered to have good knowledge.

Practice of nurses on hypothermia prevention is activities performed by nurses to prevent hypothermia. It was measured by fourteen items with Likert scale containing three response options with a code of 0 = never, sometimes, = 1, and always = 2 (3, 13, 15). Participants who answered above or equal to the computed median of practice questions were considered to have good practice.

Job satisfaction is the nurses' degree of negative or positive views about their job or job experience. It was measured using twenty-seven items of a five-point Likert scale (1 = strongly disagree to 5 = strongly agree) (33). When the total score for the job satisfaction questionnaire was greater than or equal to the computed median, we said they were satisfied.

Data collection instruments and procedure

A self-administered structured questionnaire was used to collect the data. The questionnaires were developed based on AORN and NICE perioperative hypothermia prevention guidelines and other literature (3, 13, 15, 21, 34, 35). In addition to the outcome variable, the tool contains sociodemographic, institutional, and other factors (13, 15, 26, 27, 33, 36) (Supplemental File). Five BSc nurses working outside the study wards and two MSc holder nurses were recruited for the data collection and supervision, respectively. Overall, the principal investigator coordinated and supervised the data collection process.

Data quality control

To assure the quality of the data, the questionnaire was first prepared in English, then translated to Amharic (local language), and then translated back to English to check its consistency. One-day training on the purpose of the study and the data collection procedure was provided to the data collectors and supervisors. Additionally, the tool was pretested at Woldia Comprehensive Referral Hospital with 5% of the sample size. For the dependent variable and job satisfaction

questionnaires, internal consistency was checked using Cronbach's alpha test, and its values were in the acceptable range with a minimum value of 0.77. Supervisors and primary investigators conducted routine supervision to verify the consistency and completeness of the questionnaires that were filled out.

Data processing and analysis

After the data was checked for consistency and completeness, data were entered into Epi Info version 7 and exported into SPSS version 25 for analysis. A frequency table described the participant's characteristics, knowledge, and practice scores. Multicollinearity among the dependent variables was assessed using the variance inflation factor, and its values were between 1 and 10. Model adequacy was checked using the Hosmer-Lemeshow goodness of fit test, and the model was fitted well, indicating 0.856 and 0.993 for knowledge and practice, respectively. Binary logistic regression was used to determine the significant association between the independent and dependent variables. Those independent variables, less than 0.2 in bivariable analysis, were entered into multivariable logistic regressions. The association between the independent and dependent variables was considered significant if the P-value was less than 0.05 from multivariate logistic regression analysis. AOR with 95% CI and a p-value of < 0.05 were used to declare associated factors with the knowledge and practice of nurses on hypothermia prevention.

Patient and public involvement

None.

RESULTS

Sociodemographic characteristics of the respondents

In the present study, 413 nurses responded to the self-administered questionnaires with a response rate of 97.6%. The study participants' median age (IQR) was 29 (27, 32) years. Above average, 213 (51.6%) participants were male, and the majority, 235(56.9%) were married. Regarding their educational status, nearly three-fourths of the respondents had a bachelor's degree (Table 1).

Table 1. Sociodemographic characteristics of nurses on perioperative hypothermia prevention in Amhara Regional State Referral Hospitals, Northwest Ethiopia, 2021(N=413)

Variable	Response	Frequency (N=413)	Percentage (%)
Sex	Male	213	51.6
	Female	200	48.4
Age	≤ 25 years	53	12.8
	26-30	224	54.2
	31-35	86	20.8
	≥ 35	50	12.1
Marital status	Single	163	39.5
	Married	235	56.9
	Divorced	12	2.9
	Widowed	3	.7
Educational status	Diploma	59	14.3
	Degree	311	75.3
	Master	43	10.4
Work experience	≤ 5 years	157	38

	6-10	181	43.8
	11-15	57	13.8
	≥ 16	18	4.4
Monthly salary(ETB)	≤ 5000	42	10.2
	5001-7000	158	38.3
	7001-9000	172	41.6
	≥ 9001	41	9.9

ETB= Ethiopian Birr.

Institutional and job-related factors

From 413, 268(64.9%) of nurses did not receive training on perioperative hypothermia prevention. Half of the respondents reported reading or reviewing updated evidence, and only 121(29.3%) participants were notified of guidelines or protocols in their working area. Majority of study participants, 268 (64.9%) and 342 (82.8%) had a thermometers and warming materials shortage, respectively. Nearly half, 217 (52.5%) of the participants were satisfied with their jobs (Supplemental Table).

Knowledge of nurses on hypothermia prevention

The overall knowledge of nurses on perioperative hypothermia prevention was 59.1% (95% CI: 54.7-63.7), the median knowledge score was 18 (IQR: 16, 21). Among a total of knowledge assessment questions, 359(86.9%) participants correctly answered the statement about thermoregulation, while 250(60.5) answered the complications of hypothermia in surgical patients. Only 83(20.1%) of the participants correctly responded in the theatre room; the patient's temperature should be measured every 30 minutes, while in the recovery room, every 15 minutes (Table 2).

Table 2. Nurse's responses on knowledge of perioperative hypothermia prevention (N=413)

Statements about perioperative hypothermia prevention	True / False	Correct answer		Wrong answer/I don't know	
		N	%	N	%
The internal environment of humans can be maintained by thermoregulation.	T*	359	86.9	54	13.1
PH during the perioperative cycle is characterized as a core body temperature < 36 ° C.	T*	288	69.7	125	30.3
Anesthetic drugs decrease heat loss in surgical patients.	F**	311	75.3	102	24.7
Cold IV fluids and blood products increase heat loss.	T*	288	69.5	126	30.5
PH is not associated with complications such as changes in drug metabolism, healing complications, shivering, clotting defects, cardiac morbidity, and prolonged post-anesthetic recovery.	F**	250	60.5	163	39.5
To minimize postoperative complications, nurses should advise patients to bring along additional clothing to help them stay warm before surgery	T*	339	82.1	74	17.9
The pulmonary artery catheter, distal esophagus, urinary bladder, rectum, and zero heat-flux are some of the sites for temperature measurements.	T*	174	42.1	239	57.9
Nurses should be well-trained and knowledgeable about the use of both temperature recording and warming devices	T*	346	83.8	67	16.2
Forced-air warming devices, warm water circulating and conductive devices are not some of the devices for warming surgical patients	F**	241	58.4	172	41.6
The method for temperature monitoring should not be chosen based on the criteria for a procedure	F**	281	68	132	32
To ensure accurate information, the team takes the patient's temperature at 15-minute intervals using different measuring devices at different sites.	F**	138	33.4	275	66.6
Patients with a temperature < 36.0°C undergoing anesthesia & and those having a high risk of cardiovascular complications are at higher risk for IPH	T*	293	70.9	120	29.1
Measuring patients' temperature an hour before departing the ward is unnecessary since it will be measured at the theatre.	F**	279	67.6	134	32.4
Except in urgent circumstances, preoperative patients with temperatures of < 36.0°C should be warmed for 30' by using the active warming method	T*	284	68.8	129	31.2
Special attention should be given to the comfort of surgical patients having difficulties expressing themselves	T*	335	81.1	78	18.9
The method for warming patients should be chosen based on the planned procedure, patient position, IV access site, and warming equipment constraints.	T*	333	80.6	80	19.4

Critical incidence reporting is unnecessary for patients entering into the theatre with a temperature of less than 36.0°C.	F**	259	62.7	154	37.3
Induction of anesthesia should not begin unless the patient's temperature is 36.0°C or above.	T*	203	49.2	210	50.8
The theatre's room temperature should be at least 21°C which can be adjusted to allow better working once active warming is initiated.	T*	273	66.1	140	33.9
All intraoperative irrigation fluids should be warmed in a thermostatically controlled cabinet to 38- 40°C.	T*	214	51.8	199	48.2
Fluid warming devices should be used to warm IV fluids (500 mls or more) & and blood products to 37°C	T*	260	63	153	37
Regardless of patients' temperatures before leaving the ward, they should be warmed using active warming method once in the theatre	T*	256	62	157	38
The surgical patient should be well covered throughout surgery to conserve heat and only be exposed during surgical preparation.	T*	310	75.1	103	24.9
During the postoperative period, hypothermic patients should be warmed using AWM until they become warm before being transferred to the ward.	T*	348	84.3	65	15.7
Patients should be provided with at least one cotton sheet, two blankets, or a duvet during the postoperative phase	T*	319	77.2	94	22.8
While in the OR, the patient's temperature should be measured every 15 minutes and every 30 minutes while in the RR.	F**	83	20.1	330	79.9
The temperature of postoperative patients should be recorded on arrival in the ward and documented as part of a routine 4-hour observation.	T*	337	81.6	76	18.4

T*-True statement, F**-False statement, N- Number of participants.

Practice of nurses on hypothermia prevention

The overall median practice score of nurses on perioperative hypothermia prevention was 18 (IQR: 14, 21), and their overall practice in hypothermia prevention was 50.4% (95% CI: 45.5 - 55.0). Among practice assessment questions, 258(62.5%) of the respondents measured temperature as soon as the patient arrived, and 224(54.2%) always assessed hypothermia's signs and symptoms. Nearly half of the respondents, 213(51.6%) sometimes applied warm intravenous, blood products, and irrigation fluids. About 185(44.8%) respondents reported never

using forced-air warming devices, warm water circulating devices, and conductive devices for warming surgical patients (Table 3).

Table 3. Nurse's responses on the practice of perioperative hypothermia prevention (N=413)

Hypothermia prevention practices	Never		Some times		Always	
	N	%	N	%	N	%
Do you measure temperature as soon as the patient arrives?	21	5.1	134	32.4	258	62.5
Do you measure temperature regularly according to guidelines?	50	12.1	202	48.9	161	39
Do you warm intravenous, blood products, and irrigation fluids using warming devices before administering them to patients?	112	27.1	213	51.6	88	21.3
Do you cover the mattress plastic sheet with dry linen before patient admission?	59	14.3	200	48.4	154	37.3
Do you use forced-air warming, warm water circulating devices, and conductive devices for warming patients?	185	44.8	170	41.2	58	14
Do you communicate your assessment findings on factors that could lead to hypothermia to all members of the perioperative team?	57	13.8	160	38.7	196	47.5
Do you advise patients to inform you when they feel cold during their hospitalization?	53	12.8	195	47.2	165	40
Do you develop and implement care plans for perioperative hypothermia prevention?	73	17.7	217	52.5	123	29.8
Do you document the site for temperature measurement in the patient's file?	63	15.3	156	37.8	194	47
Do you maintain ambient room temperature according to the guidelines?	110	26.6	214	51.8	89	21.5
Do you assess patients for their risk for perioperative hypothermia?	41	9.9	202	48.9	170	41.2
Do you assess for signs and symptoms of hypothermia?	30	7.3	159	38.5	224	54.2
Do you advise patients to stay warm before surgery?	48	11.6	185	44.8	180	43.6
Do you include thermoregulation interventions and patient-related care to thermoregulation in your hand-over report	41	9.9	194	47	178	43.1

Factors associated with the level of knowledge on hypothermia prevention

In the binary logistic regression, ten of fifteen variables had a p-value of < 0.2 and were candidates for multiple logistic regression. In multiple logistic regression, only three variables were significantly associated with knowledge of perioperative hypothermia

prevention. Accordingly, being male [AOR = 1.61, 95% CI (1.02-2.53)], an educational level of degree and master [AOR = 2.50; 95% CI (1.25-5.00), 4.39; (1.45-13.20)] respectively, and taking training on perioperative hypothermia prevention [AOR = 3.68; 95% CI (2.14-6.33)] were significantly associated with their knowledge (Table 4).

Table 4. Bi-variable and multivariable analysis of factors associated with nurses' knowledge in perioperative hypothermia prevention in Amhara Region Referral Hospitals, Northwest Ethiopia

Variable	Knowledge of nurses		COR (95%CI)	P-value	AOR (95% CI)	P-value
	Good	Poor				
Sex						
Female	105	95	1		1	
Male	139	74	1.69(1.14-2.52)	.009	1.61(1.02-2.53)	.038**
Educational status						
Diploma	19	40	1		1	
Degree	191	120	3.35(1.85-6.05)	.000	2.50(1.25-5.00)	.010**
Master	34	9	7.95(3.18-19.8)	.000	4.39(1.45-13.2)	.008**
Hospital						
FHRH	67	59	1		1	
UoGCSRH	48	35	1.20(.69-2.11)	.314	1.18(.631-2.21)	.601
DMCRH	51	22	2.04(1.11-3.76	.056	1.74(.863-3.49)	.118
DTCRH	33	14	2.08(1.01-4.25)	.046	2.16(.933-4.94)	.068
TGSRH	45	39	1.01(.58-1.77)	.955	1.20(.627-2.29)	.581
Ward						
Emergency	52	51	1		1	

Recovery	31	8	3.8(1.59-9.05)	.003	2.24(.862-5.84)	.098
ICU	34	19	1.75(.88-3.46	.106	1.48(.696-3.16)	.307
OR	67	35	1.87(1.07-3.29)	.028	1.51(.799-2.86)	.203
Orthopedics	26	20	1.27(.63-2.56)	.496	1.35(.641-3.02)	.402
Surgical	34	36	.92(.50-1.70)	.805	.850(.431-.1.67)	.640
Monthly salary(ETB)						
≤ 5000	18	21	1		1	
5001-7000	90	74	1.41(.7-2.85)	.477	1.10 (.478-2.35)	.885
7001-9000	107	64	1.95(.96-3.93)	.075	.848(.492-2.49)	.802
≥ 9001	29	10	3.38(1.3-8.79)	.010	1.53(.507-4.67)	.447
Having guideline						
No	124	168	1		1	
Yes	75	46	1.37(.88-2.1)	.153	.848(.490-1.46)	.555
Took Training						
No	128	140	1		1	
Yes	116	29	4.37(2.72-7.01)	.000	3.68(2.14-6.33)	.000**
Reading updated evidence						
No	106	100	1		1	
Yes	138	69	1.88(1.26-2.80)	.002	1.32(.834-2.10)	.234
Shortage of thermometer						
Yes	148	120	1		1	
No	96	49	1.58(1.04-2.41)	.031	1.27(.776-2.08)	.325
Job satisfaction						
Unsatisfied	100	95	1		1	
Satisfied	144	74	1.84(1.24-2.74)	.002	1.38(.873-2.20)	.166

**Statistically significant at p-value <0.05.

Factors associated with the level of practice on hypothermia prevention

In bivariate logistic regression analysis, eleven of sixteen variables were found to have significant predictors at a p-value < 0.2 and were candidates for multiple logistic regression. In multiple logistic regression, only four variables were significantly associated with the practice of nurses on hypothermia prevention at (P<0.05).

Nurses who were working in recovery and intensive care units [AOR = 2.87; 95% CI (1.08-7.58), and 2.39; 95% CI (1.09-5.22)] respectively, having training related to hypothermia prevention [AOR = 2.64; 95% CI (1.53-4.57)], satisfied with their job [AOR 2.15; 95% CI (1.34-3.43)], and good knowledge on hypothermia [AOR 2.64; 95% CI (1.63-4.27)] were significantly associated with their practice (Table 5).

Table 5. Bi-variable and multivariable analysis of factors associated with the practice of nurses on perioperative hypothermia prevention in Amhara Region Referral Hospitals, Northwest Ethiopia

Variable	Practice of nurses		COR (95%CI)	P-value	AOR (95% CI)	P-value
	Good	Poor				
Educational status						
Diploma	16	43	1		1	
Degree	159	152	2.81(1.51-5.20)	.000	1.94(.902-4.20)	.089
Master	24	19	3.39(1.47-7.79)	.002	1.28(.411-4.00)	.669
Working ward						

Emergency	41	62	1		1	
Recovery	30	9	5.04(2.1-11.71)	.000	2.87(1.08-7.58)	.033**
ICU	34	19	2.70(1.36-5.37)	.004	2.39(1.09-5.22)	.029**
OR	59	43	2.07(1.18-3.62)	.010	1.63(.856-3.12)	.136
Orthopedics	20	26	1.16(.575-2.35)	.674	1.17(.527-2.62)	.693
Surgical	24	46	.78(.419-1.48)	.467	.657(.321-1.34)	.250
Work experience						
≤ 5 years	69	88	1		1	
6-10	95	86	1.4(.917-2.16)	.118	1.26(.713-2.23)	.424
11-15	32	25	1.63(.886-3.00)	.116	1.68(.735-3.86)	.217
≥ 16	12	6	2.55(.911-7.14)	.075	3.26(.85-12.44)	.083
Monthly salary(ETB)						
≤ 5000	17	25	1		1	
5001-7000	67	91	1.08(.542-2.16)	.822	1.01(.436-2.35)	.976
7001-9000	98	74	1.94(.987-3.86)	.057	1.26(.517-3.10)	.604
≥ 9001	26	15	2.54(1.05-6.17)	.038	1.05(.310-3.58)	.933
Having guidelines/ protocol						
No	131	161	1		1	
Yes	77	44	2.15(1.39-3.32)	.001	1.42(.824-2.47)	.205
Took training						
No	104	164	1		1	
Yes	104	41	4.00(2.58-6.19)	.000	2.64(1.53-4.57)	.001**
Reading updated evidence						
No	84	122	1		1	
Yes	124	83	2.17(1.46-3.21)	.000	1.37(.853-2.21)	.192
Constraint of thermometer						
Yes	123	145	1.67(1.11-2.51)	.014	1.10(.661-1.83)	.711
No	85	60	1		1	
Shortage of warming material						

Yes	166	176	1.53(.914-2.57)	.105	1.77(.923-3.39)	.086
No	42	29	1		1	
Job satisfaction						
Unsatisfied	71	124	1		1	
Satisfied	137	81	2.95(1.97-4.41)	.000	2.15(1.34-3.43)	.001**
Knowledge						
Good	157	87	4.17(2.74-6.35)	.000	2.64(1.63-4.27)	.000**
Poor	51	118	1		1	

**Statistically significant at p-value <0.05.

DISCUSSION

This study showed that the overall knowledge of nurses on perioperative hypothermia prevention was 59.1%. This finding is higher than the result of a study done in Ethiopia (52.1%) (15). The possible reason might be due to sociodemographic differences. In the previous study, most participants had a degree and diploma level of educational status, and the study area was a single trauma center setting. In contrast, in the current study, more than 10% of the participants had masters, and the study setting was multicenter. The other reason might be the difference in the time of the study because of the advancement of technology, including updated evidence; educational programs were increased when the time was more recent. So, the participant might have to get more information regarding the topics.

However, this finding is much lower than those of studies conducted in Gambia (82%) (13), Turkey (77.5%) (4), Brazil (81.5%) (14), the University of Iowa Hospitals and Clinics, America (71%) (37), Maryland, America (100%) (38), Ireland (39). Besides, our study finding is lower than the NICE, AORN, and ASPAN guidelines for perioperative hypothermia prevention (3, 17, 21). The possible justification for this difference might be due to the level of staff training,

adopted recommended guidelines, socioeconomic status, and sample size. According to training on hypothermia prevention in this study, only a few nurses (35.1%) have been trained, while in the comparison group, except in Gambia, almost all participants were received training on perioperative hypothermia prevention. In terms of using guidelines or protocols, in the studies conducted in America, participants always used recommended guidelines and protocols, while in this study only 29.3% of nurses were reported as having guidelines or protocols. Regarding the difference in socioeconomic status of the participants and the study setting, we Ethiopians are in a low-income country compared to America, Brazil, and Ireland. This indirectly affects the quality of healthcare education and the healthcare setting. In terms of sample size, the present study has a larger sample size (n = 413) compared to all the aforementioned studies (in Gambia (n = 53), Turkey (n = 200), Brazil (n = 21), the University of Iowa Hospitals and Clinics, America (n = 30), Maryland (n = 19), and Ireland (n = 198).

In this study, the overall practice of nurses on perioperative hypothermia prevention was 50.4%. This finding is consistent with the result of studies conducted in Addis Ababa, Ethiopia (52.5%) and Durban, South Africa (46%) (15, 16). However, this result is higher than that of a study done in Gambia (19%) (13). The possible reason might be the difference in sociodemographic characteristics, in which most participants in the Gambia study had less than five years of experience and hadn't had a master's education level. On the other hand, the result of this study is much lower than that of NICE, AORN, and ASPAN recommendation guidelines (3, 17, 21). This discrepancy might be attributed to insufficient warming material, measurement material, guidelines or protocol, and nurse training opportunities.

Regarding nurses' knowledge of hypothermia prevention, this study identified that male nurses had more knowledge than females. This might be explained by the fact that females have

additional responsibilities at home, such as taking care of children, cooking, cleaning, and so on (40). As a result, they might not have the time to read books or guidelines that broaden their knowledge in the field.

This study also dictates that nurses who had BSC and master's degrees were more likely to have good knowledge of hypothermia prevention compared to those who had a diploma. This finding is supported by studies conducted in Iran (26) and Brazil (14). This implies that educational interventions are fundamental for nurses to improve their scientific knowledge which in turn increase the quality of patient care (14). Furthermore, this can be explained by the possibility that nurses with higher educational status may be exposed to different courses related to preventing hypothermia.

Nurses' Knowledge and practice were higher among nurses who received training related to hypothermia prevention compared to those who didn't. This finding is supported by other studies in America (38), Brazil (41), Iran (26), and Turkey (4). This can be explained by the fact that training plays an important role in improving the quality of patient care. This implies the need to promote on-site and off-site training for nurses, which is an invaluable criterion, as training is necessary to update theoretical and practical knowledge in every aspect of nursing education (40).

This study also showed that nurses working in recovery and intensive care units were more likely to have good practice than those working in the emergency ward. This finding is inconsistent with the study conducted in Turkey; ICU nurses had more knowledge than nurses working in other wards, but their practice was not changing (4). The possible reason recovery and ICU nurses had better practice might be that patients admitted to recovery and ICU wards need close follow-up because of their physiological change or disturbance due to surgery or anesthesia. So,

working in two wards, the nurses perform more activities, which maintain thermoregulation. Another reason might be that the nurse-to-patient ratio is better than in other wards; the standard is in recovery one to two, ICU one to one, emergency one to three, and for surgical and orthopedic wards, it is one to six in Ethiopia. The other reason might be the better availability of resources like a thermometer and warming materials. Also, most nurses in those two wards received more training than others.

In this study, nurses who were satisfied with their jobs were 2.2 times more likely to have a good level of practice than those who were not satisfied. Job satisfaction among nurses is highly important in building employee interest and efficiency, as higher job satisfaction determines better employee performance (42). Therefore, hospital administrators need to improve working environments so that nurses feel comfortable, which will result in a positive attitude toward their jobs.

The other significant variable is that nurses who know about hypothermia prevention were 2.6 times more likely to have good practices than those who do not. This study has supported by studies conducted in Nigeria (43) and the Textbook of Brunner & Suddarth (44). AORN guideline also supports, surgical team awareness, education, and understanding of hypothermia are necessary to change how clinicians provide quality and effective patient care (35).

Limitations of the study

The study findings might be prone to social desirability bias, although this was minimized through the use of self-administered questionnaires. In addition, the content validity of the questionnaires was not formally assessed by independent experts. The study results were not triangulated with findings from qualitative approaches, which could have enhanced our

findings. Finally, despite being a multicentre study covering a large area, the research findings may not be generalized beyond the study setting.

CONCLUSION

This study revealed that the knowledge and practice of nurses on the prevention of perioperative hypothermia in the study area was inadequate compared to the recommended guidelines. Higher educational status, being male, and attending training were significantly associated with good knowledge of nurses on perioperative hypothermia prevention. Concurrently, nurse's working wards, training opportunities, job satisfaction, and nurses' knowledge were the factors contributing to good practice of nurses in preventing perioperative hypothermia.

Therefore, hospital and healthcare managers need to design in-service training and long term educational opportunities to improve nurses' knowledge and practice in the area. In addition, hospitals need to fulfill the resources such as warming materials, thermometers, and updated guidelines or protocols, and improve working environments so that nurses become safe and comfortable resulting in a positive feeling towards their job. Furthermore, we recommended that future researchers conduct a mixed methods study to provide sufficient evidence for policymakers.

List of abbreviation

AOR: Adjusted Odd Ratio; AORN: Association of perioperative Register Nurses; ASPAN: American Society of PeriAnesthesia Nurses; CI: Confidence Interval; DMRH: Debre Markos Referral Hospital; DTCRH: Debre Tabor Comprehensive Referral Hospital; EMS:Emergency Medical Service; EPI INFO: Statistical Package for Epidemiological Information Analysis;

FHRH: Felege Hiwot Referral Hospital; ICU: Intensive Care Unit; IPH: Inadvertent Perioperative Hypothermia; OR: Odds Ratio; OR: Operation Room; HP: Perioperative Hypothermia; PI: Principal Investigator; RR: Recovery Room; SPSS: Statistical Package of Social Science; T^{o} c: Temperature In Degree Centigrade; TGSRH: Tibebe Gion Specialized Referral Hospital; UK: United Kingdom; UoGCSRH: University of Gondar Comprehensive Specialized Referral Hospital; USA: United States of America.

Declarations

Ethical approval and consent to participate

Ethical clearance was obtained from the University of Gondar Institutional Review Board (IRB) with this Ref. No. S/R/164/2/2021. After explaining the purpose and possible benefits of the study, a permission letter was obtained from each respective hospitals. Written informed consent was obtained from each study participant before data collection. It was explained to the respondents who participated in the study that voluntary and private information would be protected. The process did not identify respondents by their names and respondent privacy was maintained.

Consent for publication

Not applicable.

Data availability statement

No additional data available.

Competing interests

The authors declare that they have no competing interests.

Funding

None.

Contributors

AWW carried out the study, starting with designing the study, analyzing and interpreting the data, and reviewing the manuscript. BYM, NT, and ED participated in developing the measurement tool or questionnaire, proposal writing, data analysis, interpretation, and commenting on drafts of the paper and manuscript. All authors involved in drafting, reviewing, and editing of the manuscript. All authors read and approved the final manuscript before submitting it to the journal for publication.

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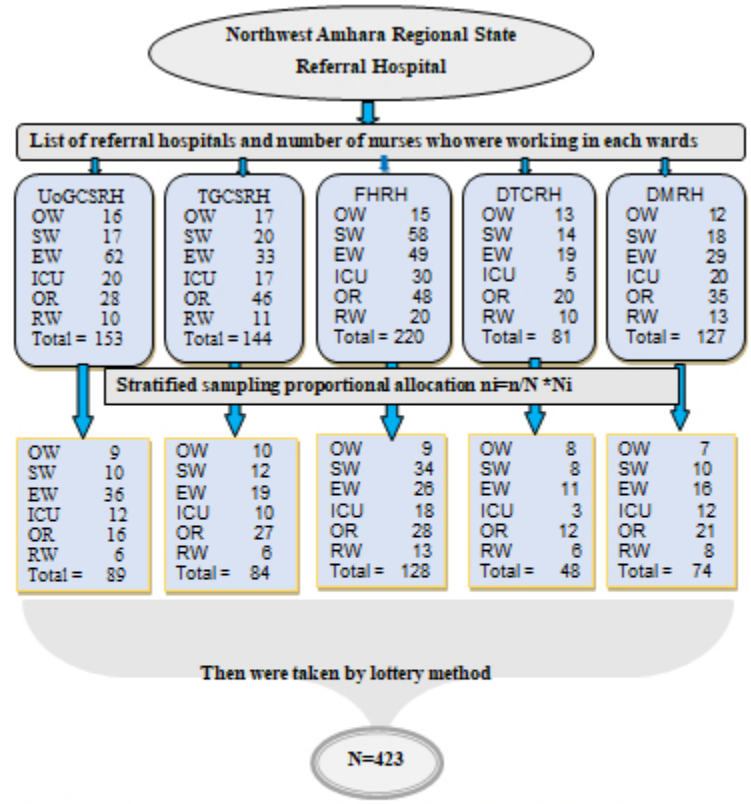
Supplemental Table: Institutional and other related factors of the respondents on perioperative hypothermia prevention in Amhara Regional State Referral Hospitals, Northwest Ethiopia, 2021 (N=413).

Variable	Response	Frequency (N=413)	Percentage (%)
Working place (hospital)	TGSRH	84	20.3
	UoGCSRH	83	20.1
	DMCRH	73	17.7
	DTCRH	47	11.4
	FHRH	126	30.5
Ward:	Emergency	103	24.9
	Recovery	39	9.4
	OR	102	24.7
	ICU	53	12.8
	Orthopedics ward	46	11.1
	Surgical ward	70	16.9
Daily working hours	≤ 8 hrs.	354	85.7
	≥9 hrs.	59	14.3
Training on hypothermia prevention	Yes	145	35.1
	No	268	64.9
Presence of protocol/guideline	Yes	121	29.3
	No	292	70.7
Reading updated evidence on hypothermia prevention	Yes	206	49.9
	No	207	50.1

Variable	Response	Frequency (N=413)	Percentage (%)
Availability of thermometer	Yes	145	35.1
	No	268	64.9
Constraints of warming material	Yes	342	82.8
	No	71	17.2
Shortage of blanket	Yes	166	40.2
	No	247	59.8
Shortage of linens	Yes	89	21.5
	No	324	78.5
Shortage of fluid warmer	Yes	132	32.0
	No	281	68.0
Shortage of air warmer/heater	Yes	212	51.3
	No	201	48.7
Shortage of warmer blanket	Yes	217	52.5
	No	196	47.5
Job satisfaction	Satisfied	217	52.5
	Dissatisfied	196	47.5



Supplemental Figure: Schematic presentation of sampling procedure of nurses' knowledge and practice, and associated factors on hypothermia prevention among surgical patients.

315x352mm (38 x 38 DPI)

Annex I. Instruments (questionnaire)

Introduction: This instrument is divided into 3 sections. Section 1 is related to yours Personal data including job satisfaction. Section 2 is your knowledge regarding Perioperative hypothermia prevention (PHP). Section 3 is your practice regarding PHP.

Identification number: _____

I. Socio-demographic, institutional and other characteristics of study participants

1. Gender: Male ☐ Female ☐
2. Age: _____
3. Marital status A- Single B- Married C- Divorced D- Widowed
4. Educational level: A- Diploma B- Degree C- Masters
5. Working experience in days/months/years: _____
6. Working place (hospital) _____
7. Working unit or ward: _____
8. Daily working hours_____
9. Monthly salary _____
10. Did you receive any in service training on perioperative hypothermia prevention?

    Yes ☐ No ☐
11. Do you have guidelines related to hypothermia prevention in your workplace?

    Yes ☐ No ☐
12. Do you read journals on hypothermia prevention? Yes ☐ No ☐
13. Is there any shortage of thermometers? Yes ☐ No ☐
14. Is there any other resource constraints, which are important for the prevention of? Hypothermia prevention? Yes ☐ No ☐
15. If yes, what type of resource constraints? You can circle greater than one answer if appropriate

A. Blanket B. Linens C. Fluid warmer D. Air warmer/heater E. Blanket warmer

16. Job satisfaction; Please *thick one* ( ) *as per your choice*

Job Satisfaction questions		Strongly Agree 5	Agree 4	Neither 3	Disagree 2	Strongly disagree 1
1	I have a work plan developed with my supervisor					
2	My supervisor gives me feedback to improve my performance					
3	I get the opportunity to be involved in my performance appraisal					
4	my supervisor/head nurse does a good job					
5	I have the opportunity to work independently on my job					
6	I have good feeling towards my job accomplishment					
7	I have a chance for a variety of job responsibilities					
8	There is good flexibility for shift works					
9	I have good relationship with my coworkers					
10	I have good relationship with my supervisor and physicians.					
11	There is good team work spirit in my department					
12	There is good communication between from managers, to employees in the hospital					
13	I got sufficient support during my health problem					
14	There is good safety practice in the hospital					
15	I have a sense of job security					
16	I have the materials and equipment that need to do my work right.					
17	The mission of my organization makes me feel my job is important.					
18	I have got recognition for my good work					
19	There is a fair chance for promotion					
20	I have training that I need to do my job					
21	The hospital provides fair training opportunity					
22	There is high rate of turnover in the hospital					

23	High absenteeism is seen in some employee					
24	I feel stressed in my work					
25	I am satisfied with my Salary					
26	My salary is comparable to others who performing the same or similar jobs					
27	My benefits like transport, housing and duty allowance, etc., are fair compared to other staff at my level					

II. Questions related to knowledge of hypothermia prevention in perioperative patients.

Please select and Put ( ) in the box below for each question.

Item no.	**Statements about perioperative hypothermia prevention**	**True**	**False**	**I Don't Know**
Part 1	**General knowledge**			
1	The internal environment of humans can be maintained by thermoregulation.			
2	Perioperative hypothermia at any time during the perioperative cycle is characterized as a core body temperature < 36 ° C			
3	Anesthetic drugs increase heat loss in surgical patients.			
4	Cold IV fluids and blood products increase heat loss.			
5	Perioperative hypothermia is not associated with complications such as changes in drug metabolism, healing complications, shivering, clotting defects, cardiac morbidity, and prolonged post-anesthetic recovery.			
6	To minimize surgical complications post-operatively, nurses should advise patients to bring along additional clothing to help them stay warm prior to surgery			
7	The pulmonary artery catheter, distal esophagus, urinary bladder, rectum, zero heat-flux are some of the sites for temperature measurements.			
8	Nurses should be well trained and knowledgeable about the use of both temperature recording and warming devices			
9	Forced-air warming devices, warm water circulating devices and conductive devices are not some of the devices for warming surgical patients			

10	The method for temperature monitoring should not be chosen based on the criteria for a procedure			
11	To ensure accurate information, the perioperative team takes the patient's temperature at 15- minute intervals using different measuring devices at different sites.			
Part 2	**Preoperative hypothermia prevention**			
1	Patients with a temperature below 36.0°C undergoing anesthesia & those having a high risk of cardiovascular complications are at higher risk for inadvertent perioperative hypothermia			
2	It is not necessary to measure patients' temperature in the hour before departing the ward since it will be measured at the theatre.			
3	Except in urgent circumstances, preoperative patients with temperatures of less than 36.0°C should be warmed for 30 minutes using active warming methods.			
4	Special attention should be given to the comfort of surgical patients having difficulties expressing themselves			
5	The method for warming surgical patients should be chosen based on the planned surgical procedure, positioning of the patient, Intravenous access site, and warming equipment constraints.			
Part 3	**Intraoperative hypothermia prevention**			
1	Critical incidence reporting is not necessary for patients coming into the theatre with a temperature of less than 36.0°C.			
2	Induction of anesthesia should not begin unless the patient's temperature is 36.0°C or above (unless there is a need to expedite surgery because of clinical urgency).			
3	The theatre's room temperature should be at least 21°C which can be adjusted to allow better working once active warming is initiated.			
4	All irrigation fluids used intraoperative should be warmed in a thermostatically controlled cabinet to a temperature of 38°C to 40°C.			
5	Fluid warming devices should be used to warm Intravenous fluids (500mls or more) & blood products to 37°C			
6	Regardless of the temperatures of patients before leaving the ward or emergency department, they should be warmed using active warming method once in the theatre			

7	The surgical patient should be well covered throughout surgery to conserve heat and only be exposed during surgical preparation.			
Part 4	**Post-operative hypothermia prevention**			
1	During the postoperative period, hypothermic patients should be warmed using active warming method until they become warm before transferring them to the ward.			
2	Patients should be provided with at least 1 cotton sheet, 2 blankets, or a duvet during the postoperative phase			
3	Whiles in the theatre, the patients' temperature should be measured every 15 minutes and every 30 minutes while in the recovery room.			
4	The temperature of post-operative patients should be recorded on arrival to the ward and be taken and documented as part of a routine four hourly observations.			

III- Questions related to practice of hypothermia prevention in perioperative patients.

Please select and Put ( ) in the box below for each *question.*

Hypothermia prevention practices	Never/0	Sometimes/1	Always/2
1. Do you measure temperature as soon as patient arrival?			
2. Do you measure temperature regularly according to guidelines recommendation (for preoperative patient every 1hr, intraoperative every 30', recovery every 15' and post-operative every 4hrs)?			
3. Do you warm intravenous, blood products, and irrigation fluids using warming devices before administering to patients?			
4. Do you cover the mattress plastic sheet with dry linen before patient admission?			
5. Do you use forced-air warming devices, warm water circulating devices, and conductive devices for warming surgical patients?			
6. Do you communicate your assessment findings on factors that could lead to perioperative hypothermia to all members of the perioperative team?			

7. Do you advise patients to inform you when they feel cold during their hospitalization?			
8. Do you develop and implement the care plan for perioperative hypothermia prevention?			
9. Do you document the site for temperature measurement in the patients' file?			
10. Do you maintain ambient room temperature according to the guideline?			
11. Do you assess patients for their risk for perioperative hypothermia?			
12. Do you assess for signs and symptoms of hypothermia?			
13. Do you advise patients to stay warm prior to surgery?			
14. Do you include thermoregulation interventions and patient-related care to thermoregulation in your hand-over report			

STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No.	Recommendation	Page No.	Relevant text from manuscript
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract	1	Line (1-3); An institution-based cross-sectional study was conducted for the title of Knowledge and Practice of nurses on Perioperative Hypothermia Prevention at Northwest Amhara Regional State Referral Hospitals, Northwest Ethiopia:
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	2	Lines (21 – 47); Abstract
Introduction				
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	3 4, 5 and 6	Lines (56– 117); Introduction
Objectives	3	State-specific objectives, including any pre-specified hypotheses	6	Lines (115 – 117); This study aimed to assess nurses' knowledge, practice, and their determinant factors of perioperative hypothermia prevention in Northwest Amhara Regional State Referral Hospitals, Northwest Ethiopia.
Methods				
Study design	4	Present key elements of study design early in the paper	6	Lines (120 – 121); An institutional-based cross-sectional study was conducted in five referral hospitals' perioperative units or

				wards from March 25 to May 20, 2021.
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6 and 7	Lines (122 – 138); Study setting
Participants	6	(a) Cohort study—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up Case-control study—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls Cross-sectional study—Give the eligibility criteria and the sources and methods of selection of participants	7 and 8	Lines (140 – 145); Source and study population Lines (146– 150); Inclusion and exclusion criteria (eligibility criteria) Lines (156 – 164); The study participants were recruited using a stratified sampling technique. Initially, the study participants are stratified by hospital and working ward or unit, and the required sample for each stratum is allocated proportionally.
		(b) Cohort study—For matched studies, give matching criteria and number of exposed and unexposed Case-control study—For matched studies, give matching criteria and the number of controls per case	N/A	This was a cross-sectional study
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	8 and 9	Lines (165 – 178); Variables and measurements
Data sources/ measurement	8	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	9	Lines (179 – 186); Data collection tools and procedures

Bias	9	Describe any efforts to address potential sources of bias	9 and 10	Lines (187–196); To assure the quality of the data, the questionnaire was prepared in English first, then translated to Amharic (local language), and then translated back to English to check its consistency. One-day training on the purpose of the study and the data collection procedure was provided to the data collectors and supervisors. Additionally, the tool was pretested at Woldia Comprehensive Referral Hospital with 5% of the sample size.
Study size	10	Explain how the study size was arrived at	8	Lines (152–155); The sample size was calculated using the single population proportion formula (n= ZI0□^{2} * P (1-P)/ d^2). A 50% proportion of nurses' knowledge and practice on hypothermia prevention, 95% confidence level, and 5% expected margin of error (d) were used. By considering a 10% non-response rate, the final sample becomes 423.
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	10	Lines (204–210); Binary logistic regression was used to determine the significant association between the independent and dependent variables. Those independent variables, less than

				0.2 in bivariable analysis, were entered into multivariable logistic regressions. The association between the independent and dependent variables was considered significant if the P-value was less than 0.05 from multivariate logistic regression analysis. AOR with 95% CI and a p-value of < 0.05 were used to declare associated factors with the knowledge and practice of nurses on hypothermia prevention.
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	10	Lines (198–210); Statistical Analysis
		(b) Describe any methods used to examine subgroups and interactions	N/A	There were no subgroups
		(c) Explain how missing data were addressed	N/A	There was no missing data
		(d) Cohort study—If applicable, explain how loss to follow-up was addressed Case-control study—If applicable, explain how matching of cases and controls was addressed Cross-sectional study—If applicable, describe analytical methods taking account of sampling strategy	8	Lines (156– 164); The study participants were recruited using a stratified sampling technique. Initially, the study participants are stratified by hospital and working ward or unit, and the required sample for each stratum is allocated proportionally. According to all hospitals' human resources and administration reports, the total number of nurses working in these units or wards was 725. The calculated sample size was then proportionally allocated to each hospital according to the number of nurses working in the respective departments or wards (i.e. from 153, 89 in UoGCSRH, from 144, 84 in TGRH, from 220, 128 in FHRH,

				from 81, 48 in DTRH, and from 127, 74 nurses in DMRH). Finally, study participants were chosen using a simple random sampling technique from each sampling frame
		(e) Describe any sensitivity analyses	N/A	
Results				
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	N/A	This was a cross-sectional study with only one stage.
		(b) Give reasons for non-participation at each stage	N/A	
		(c) Consider use of a flow diagram	N/A	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, institutional, other) and information on exposures and potential confounders	11 and 12	Line (216-221); Table 1: Socio-demographic characteristics of the study participants on hypothermia prevention among perioperative patients in Amhara Regional State Referral Hospitals, Northwest Ethiopia, 2021(N=413). Line (225-230); **Institutional and job-related factors of the respondents** of the study participants
		(b) Indicate number of participants with missing data for each variable of interest	N/A	There was no missing data
		(c) Cohort study—Summarise follow-up time (eg, average and total amount)	N/A	This was a cross-sectional study
Outcome data	15*	Cohort study—Report numbers of outcome events or	N/A	This was cross-sectional study

		summary measures over time		
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	N/A	This was a cross-sectional study
		Cross-sectional study—Report numbers of outcome events or summary measures	12, 13, and 14	Lines (233–234); In this study, 244 (59.1%) with 95% CI: (54.7, 63.7) of the participants had good knowledge Lines (243–245); In this study, 208 (50.4%) with 95% CI: (45.5, 55) of the participants had good practice.
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	12, 14, 16 and 18	Lines (233-234); In this study, 244 (59.1%) with 95% CI: (54.7, 63.7) of the participants had good knowledge Lines (243-245); In this study, 208 (50.4%) with 95% CI: (45.5, 55) of the participants had a good practice. Lines (260-261); Table 4- Bi-variable and multivariable analysis of factors associated with knowledge of nurses on perioperative hypothermia prevention in Amhara Region Referral Hospitals, Northwest Ethiopia. Lines (273-275); Table 5- Bi-variable and multivariable analysis of factors associated with the practice of nurses on perioperative hypothermia prevention in Amhara Region Referral Hospitals, Northwest Ethiopia.
		(b) Report category boundaries when continuous variables were categorized	N/A	There was no continuous variable.
		(c) If relevant, consider translating estimates of relative	N/A	There was no estimate of relative risk.

		risk into absolute risk for a meaningful time period		
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	N/A	There was no sub groups and sensitivity analysis.
Discussion				
Key results	18	Summarise key results with reference to study objectives	20-23	Lines (277–354); Discussion
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	23 and 24	Lines (355–361); This study was not triangulated with a qualitative method. The study also might be prone to social desirability bias, which was minimized through 3the use of self-administered questionnaires. In addition, the content validity of the questionnaires was not formally assessed by independent experts. Despite the study being conducted in a multi-center setting or covering a large area, the research findings may not be generalized beyond the study setting, like at a national or global level, because no sample was collected outside our study settings.
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	20-24	Lines (277-361); Discussion and limitation
Generalizability	21	Discuss the generalizability (external validity) of the study results	24	Lines (363-368); This study revealed that the knowledge and

				practice of nurses on the prevention of perioperative hypothermia in the study area was inadequate compared to the recommended guidelines. Higher educational status, being male, and attending training were significantly associated with good knowledge of nurses on perioperative hypothermia prevention. Concurrently, nurse's working wards, training opportunities, job satisfaction, and nurses' knowledge were the factors contributing to good practice of nurses in preventing perioperative hypothermia.
Other information				
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	26	Lines (404)-This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.