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Nurses' knowledge, perceived practice, and associated factors towards sterile techniques in major operation rooms at public hospitals in Addis Ababa, Ethiopia, 2022: a cross-sectional study

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Abstract

Introduction A sterile technique is a standard to reduce microorganism transmission during surgery. Gaps in knowledge and practice in sterile techniques by nurses are common causes of surgical site infections for surgical patients. Even though surgical site infection is a global problem due to lack of knowledge and practice, almost no study has been done in Ethiopia regarding nurses' knowledge and practice of sterile techniques in the operating room. Therefore, this study aimed to assess nurses' knowledge, practice, and associated factors of sterile techniques in Addis Ababa public hospitals, Ethiopia.

Method An institutional-based cross-sectional study was conducted on 423 nurses who were working in sixty-six operation rooms at seven public hospitals in Addis Ababa, Ethiopia, from May 11 to June 26/2022. A simple random sampling method was employed to select study participants. A pre-tested, self-administered questionnaire was used to collect data. Data were entered by Epi-data version 4.6 and analyzed by SPSS version 25. Descriptive statistics were presented by text, table, and figure. Multivariable analysis was used to identify the association between the dependent variable and independent variables. Variables with a P-value < 0.05 were considered statistically significant.

Result Nearly three-fifths (58.1%; 95%CI: 53.2 to 63.7) of respondents had good knowledge, and 56.1% with 95%CI (51.5 to 61.1) had good practice with respect to sterile techniques in the operation room. Training [AOR = 1.989; 95%CI (1.120 to 3.530)], availability of guidelines [AOR = 6.4; 95%CI (3.773 to 10.856)], and supervision [AOR = 2.963; 95%CI (1.693 to 5.184)] were associated with nurses' knowledge about sterile techniques in the operating room. Availability of guidelines [AOR = 1.890, 95%CI (1.123 to 3.182)], presence of supervision [AOR = 4.732; 95%CI (2.643 to 8.471)], and having good knowledge of sterile techniques [AOR = 5.419; 95%CI (3.087 to 9.512)] were associated with nurses' practice of sterile techniques in the operation room.

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Conclusion Operative theater nurses' knowledge and practice of sterile techniques were found inadequate. Training, supervision, availability of guidelines, and knowledge of nurses towards sterile techniques are factors associated with sterile techniques in the operating room. So, it is better to strengthen training, equip wards with standardized guidelines, and provide supervision, which is crucial to enhancing their knowledge and practice.

Keywords Sterile technique, Operation room, Knowledge, Practice, Nurse: Ethiopia

Introduction

A sterile technique is a set of different practices and procedures done to make materials and places free from all microorganisms, and it is a vital patient safety standard that reduces the danger of microbial transmission during surgery [1]. Creating and keeping a sterile technique requires knowledge and practice, and it is among the most essential responsibilities of perioperative nurses to decrease surgical site infections. So, perioperative nurses must coordinate with all operation room team members, and they should be empowered to talk about breaks in sterile techniques [2–4].

World Health Organization (WHO) guidelines imply that health professionals in many settings have a gap in hand hygiene, decontamination, aseptic technique, and sterilization practice [5]. Knowledge of nurses towards sterile techniques varies across different countries; in London 65%, Italy 99.5%, Philippines 95.26%, Egypt 80%, and Iran 72.4% of nurses had good knowledge of aseptic technique procedures [6–11]. On the other hand, in India, 62%, Iraq 20%, Zimbabwe 8%, and Nigeria 68% of nurses had poor knowledge of aseptic techniques in operation theaters [12–16].

Sterile techniques break in the operating room due to a lack of knowledge and adequate practice in many situations. An international journal of nurses study reported that one-quarter of sampled nurses were unable to state all the precautions necessary before handling blood or bodily fluids, and their knowledge was reported to be poor [17]. In Europe, due to a lack of evidence-based studies and wide variation in modalities and locations, there are unclear infection control practices [18]. In China, the practice of surgical instrument packaging errors, including incomplete packages, instrument missing, malfunction, indicator card missing, wrong count of instruments, and wrong instrument determinations, were the essential packaging mistakes recognized within the study, in which 44% of errors happened as a result of wrong instrument identification and packing among the same instruments [19]. In Bharatpur, India, 44% of infections occur due to a shortage of knowledge on aseptic procedures [14]. In South Africa, at Nelson Mandela Metropolitan University, only 20% of nurses had good knowledge of the distance between sterile and unsterile fields [20].

Surgical site infection (SSI) is a major problem that occurs as a result of breaks in aseptic and sterile

techniques in surgical patients, and it increases patients' length of hospital stay and cost [21–23]. According to a WHO study with a special focus on SSI due to breaks in sterile techniques in low and middle-income countries, the pooled prevalence of SSI was 11.2 per 100 surgical patients [24]. A systematic review and meta-analysis study conducted among 488,594 surgical patients worldwide revealed that the incidence of SSI was 11% [25]. SSI rates differ across countries depending on various factors [26, 27]. In 2018–2020, 12 EU Member States and one EEA country reported 19 680 SSIs from a total of 1 255 958 surgical procedures, which was a percentage of SSIs that varied from 0.6% in knee prosthesis surgery to 9.5% in open colon surgery [26]. The incidence of surgical site infection undergoing surgery patients in the United States of America (USA) (SSI) has been estimated to be 2–5%, and in Saudi Arabia, it has been reported to be 2.5%, 3.4%, and 12.9% following orthopedic surgeries, foot and ankle surgeries, and trauma laparotomies, respectively [27–30]. Another systematic review and meta-analysis study conducted in sub-Saharan Africa found the pooled incidence of surgical site infections was 14.8% [31]. In Nigeria, the incidence rate of SSI is reported to range from 5.1 to 60.7%, and in Ethiopia, the pooled prevalence of SSI was 25.22% [32, 33].

As reviewed guidelines and literature indicate, the recent practice of surgical antisepsis involves the employment of sterile techniques in the operating room [34]. Because aseptic and sterile techniques during surgery are mandatory for early recovery and to decrease postoperative infection in the patient [35]. Even though nurses have a major role in preventing surgical site infection by implementing strict sterile techniques in the operating room, different studies indicate that operation room nurses lack knowledge and practice of sterile techniques and vary from country to country. In addition to all these factors, in our search, there is no published study done in Ethiopia regarding nurses' knowledge, practice, and associated factors towards sterile technique in operation rooms, which is the main reason that the investigator was inspired to do this study. Therefore, this study aimed to assess nurses' knowledge, practice, and associated factors on sterile techniques in operation rooms at public hospitals in Addis Ababa, Ethiopia.

Methods

Study design, period, and setting

An institutional-based cross-sectional study was conducted from May 11 to June 26/2022, at public hospitals in Addis Ababa, which is the capital city of Ethiopia. The city administration consists of around 11 sub-cities and 116 woredas. Currently, the city has 14 public hospitals and 116 health centers serving an estimated population of 5,228,000. These public hospitals, namely Tikur Anbesa Specialized Hospital, Saint Paulos Millennium Medical College Hospital, Alert Specialized Hospital, Saint Petros TB Specialized Hospital, Amanuel Psychiatry Specialized Hospital, Yeka Kotebe General Hospital, Zewditu Memorial Hospital, Tirunesh Beijing General Hospital, Yekatit 12 Medical College Hospital, Menilik Specialized Hospital, Gandhi General Hospital, Ras Desta General Hospital, Tor Hailoch Hospital, and Abet Referral Hospital. Seven public hospitals were selected from fourteen hospitals: Tikur Anbesa Specialized Hospital, Saint Paulos Millennium Medical College Hospital, Zewditu Memorial Hospital, Tirunesh Beijing General Hospital, Yekatit 12 Medical College Hospital, Saint Peters TB Specialized Hospital, and Yeka Kotebe General Hospital. According to information obtained from the administrative offices of these hospitals, they have a total of sixty-six operating rooms, and 574 nurses provide services in these operating room departments.

Source population and study population

All nurses who were working in sixty-six operation rooms of seven public hospitals in Addis Ababa, Ethiopia, were the source populations. On the other hand, nurses who were working in sixty-six operation rooms of Tikur Anbesa Specialized Hospital, Saint Paulos Millennium Medical College Hospital, Zewditu Memorial Hospital, Tirunesh Beijing General Hospital, Yekatit 12 Medical College Hospital, St. Peter's Specialized Hospital, and Yeka Kotebe General Hospital during the data collection period were the study population.

All nurses working in the operation rooms of selected public hospitals in Addis Ababa, Ethiopia, were included in this study.

Sample size determination

The sample size was determined by using a single population proportion formula with the assumption of computing for proportion, significantly associated variable, 95% confidence level, and 5% margin of error. Since there is no study done in our country related to nurses' knowledge, practice, and associated factors of sterile technique in the operation room, a proportion of 50% is used to calculate the sample size.

$$n = \frac{(Z_{\alpha/2})^2 \times p(1-p)}{d^2} = \frac{(1.96)^2 \times 0.5(1-0.5)}{(0.05)^2} = 384$$

Where n=estimated sample size.

p=single population proportion.

$Z_{\alpha/2}$ =z-score for two-tailed test based on α level at the 95% confidence level.

($\alpha=0.05$) which is 1.96.

d=margin of error 5% (0.05).

By considering possible 10% non-response rate during the survey, the final sample becomes.

$$384 + (384 \times 10\%) = 422.4 \sim 423$$

Sampling technique

By using the simple random sampling method, seven hospitals were selected. To get the study participants, first the list of all operation room nurses (574) was taken from each selected public hospital of human resource and administration reports; the total number of nurses working in operating rooms was 574. Of all OR nurses, 423 were selected randomly after proportional allocation was done for each selected hospital. After proportionate, the list of nurses' numbers was used as a framework to select participants using the lottery method. Then, the data collectors found the selected participant based on his/her list and provided the questionnaire after obtaining the informed consent (Supplementary Fig. 1).

Operational definition

Knowledge of nurses on sterile techniques was assessed using 30 questions derived from sterile technique implementation guidelines and literature [2, 8].

Good knowledge If the study participants answered the knowledge questions above or were equal to the computed median score (20), they were considered to have good knowledge.

Poor knowledge if the participant scores less than the median score of knowledge questions.

Practice of nurses on sterile techniques was measured by 18 items on a Likert scale containing three response options with a code of 0=never, 1=sometimes, and 2=always [2, 8, 36].

Good practice participants who answered above or equal to the computed median (25) of practice questions were considered to have good practice.

Poor practice the study participants who scored below the computed median score (25) of practice questions.

Presence or availability of supplies the availability of adequate supplies such as a sink or automatic sink, a sterile scrub brush with a nail pick, antiseptic soap, a sterile gown and gloves, and a drying towel in the operation room to maintain sterile technique. If the participants answered yes, the presence of the above-listed supplies in the operating room was said to be adequate.

Operation room nurses All nurses who were working in the operation room.

Instrument counting Surgical instrument counting is performed by perioperative nurses to prevent retained surgical items and improve patient safety [37].

Unwrapped instruments uncover sterilized instruments that cause microbial contamination in the operation room [38].

Personal protective equipment (PPE): materials and supplies necessary for nurses to protect themselves, patients, colleagues, and the community at large from the transmission of infections [39].

Data collection tools

A self-administered structured questionnaire was used to obtain information from participant nurses. A questionnaire used for data collection contains four parts. Part one contains the socio-demographics of the participants and had four questions. Part two includes the working environment and nurses-related factors and had eight questions. Part three of the data collection tool encompasses nurses' knowledge of sterile techniques in the operation room, and it had thirty questions, and part four has nurses' practice in the operation room and had eighteen. Generally, this tool consists of 60 questions, each with two to four options. It was developed by adapting from different literatures [2, 8, 14, 40].

Data collection procedure

Data was collected by using a self-administered questionnaire. The data was collected by seven trained BSc nurses with three MSc nurse supervisors. The data collection process was conducted within the nurses' working hours by assigning data collectors to the night shift of their duty program. Supervisors were responsible for participant recruitment and distribution of the questionnaires. The lottery method was employed for those nurses who fulfilled the inclusion criteria during the study period. Data collectors were informed verbally to operation room nurses about the study. The questionnaire was administered to each nurse during working hours at each hospital, and subjects were informed not to use any resources or not to ask their colleagues the answers while completing the questionnaire.

Data quality control

A pretest was conducted on 5% of the sample size, which is 21 operation room nurses at Menilik hospital, a week before the actual data was collected, and based on the findings of the pretest, unclear questions and ambiguous words were modified for accuracy, completeness, reliability, and consistency, which was checked by computing Cronbach's alpha test. Data collectors and supervisors were trained for one day before data collection about the concept of the questionnaire, the required ethical conduct, the secrecy of the information, and the rights of the participants to ensure consistency and reduce variations between data collectors. They were supervised closely by the supervisor and principal investigator. The completeness of each questionnaire is also checked by the principal investigator and supervisor daily.

Data analysis

Data was entered and coded by Epidata statistical software version 4.6, and analysis was done using SPSS version 25 statistical software. Descriptive statistics were used to present the frequency distribution of some important variables. For analysis, the dependent variables were dichotomized into binary outcome variables showing "sterile techniques knowledge "coded as "good knowledge=1" and "poor knowledge=0" and "sterile techniques practice "coded as "good practice=1" and "poor practice=0." The data nature was not normally distributed, and the median was used to dichotomize into binary outcomes.

Multivariable analyses were done to assess the association between the outcome and independent variables, and multivariable logistic regression was used to identify significant factors based on p -values < 0.05 . The strength of association of a particular variable was expressed by the adjusted odds ratio (AOR) with a 95% confidence interval. Multicollinearity was checked by the VIF, and the Hosmer and Lemeshow goodness of fit tests were used to check for model fitness and fitted at p -values of 0.639 and 0.652 for the knowledge and practice parts, respectively.

Results

Socio-demographic characteristics

A total of 423 participants were included in this study, with a response rate of 97.4%. As depicted in Table 1 below, among respondents, 211 (48.8%) were female. More than half of the participants, 210 (51%) were married, 331 (80.3%) were BSc nurses, 182 (44.2%) were 30–39 years of age, and 119 (28.9%) had 6–10 years of working experience.

Table 1 Socio-demographic characteristics of the study participants at Addis Ababa, Ethiopia, public hospitals ($n=412$), 2022

Characteristics	Category	Frequency(n)	Percentage (%)
Age	20–29 years	105	25.5
	30–39 years	182	44.2
	40–49 years	88	21.4
	More than 50 years	37	9
Sex	Female	211	51.2
	Male	201	48.8
Marital status	Single	197	47.8
	Married	210	51
	Divorced	4	0.97
	Widowed	1	0.24
Level of education of nurses	Diploma	47	11.4
	BSc	331	80.3
	MSC and above	34	8.3

Table 2 Working environment and nurse-related characteristics of the study participants at Addis Ababa, Ethiopia, public hospitals ($n=412$), 2022

Variables	Category	Frequency($n=412$)	%
Year of Experience	1–5 years	205	49.8
	6–10 years	119	28.9
	11–15 years	62	15
	> 15 years	26	6.3
Training	Yes	294	71.4
	No	118	28.6
Use of personal PPE	Yes	324	78.6
	No	88	21.4
Performing counting intraoperative	Yes	186	45.1
	No	226	54.9
Use of unwrapped instrument in OR	Yes	180	43.7
	No	232	56.3
Presence of sufficient supplies in operation room	Yes	273	66.3
	No	139	33.7
Availability of guideline	Yes	237	57.5
	No	175	42.5
Presence of supervision	Yes	171	41.5
	No	241	58.5

Working environment and nurse-related factors

From the total respondents, 294 (71.4%) had taken training on sterile techniques in OR, 324 (78.6%) participants used personal protective equipment, among the study participants, 186 (45.1%) performed counting intraoperative, and 232 (56.3%) did not use unpacked instruments in the sterile procedure. As depicted in Table 2 below, 273 (66.3%) respondents had sufficient supplies in their setting, two hundred thirty-seven (57.5%) of operational theater nurses (OTN) had availability of guidelines, and

one hundred seventy-one (41.5%) of them were conducted by supervision in their setup.

Knowledge level of operation room nurses towards sterile techniques

The overall median knowledge score of the study participants on sterile techniques with an operating room was 20 with an IQR of (17, 22). In this study, two hundred forty (58.3%) nurses who were working in the operating room had good knowledge of sterile techniques in the operating room.

Among the knowledge assessment questions, the majority, which is 375 (91%), and 365 (88.5%) respondents of participants have correctly answered the statement that only they use sterile items in the sterile field, and sterilized packages found in a contaminated area are considered non-sterile, respectively. More than two-thirds of participants incorrectly responded to the statements that an unsterile person is allowed to face and observe sterile areas when passing, and the circulating nurse is allowed to open sterile packages (Table 3).

Factors related to the knowledge of nurses regarding sterile techniques

In multivariable logistic regression analysis, factors that were significantly associated with good knowledge of sterile techniques were training, availability of guidelines, and the presence of supervision.

As it was indicated in Table 4 below of adjusted odds ratio, having training about sterile techniques in the operating room made almost 2 times more likely to have good knowledge when compared to non-trained nurses [AOR=1.989; 95%CI (1.120, 3.530)].

Availability of guidelines were 6.4 times more likely to have good knowledge in sterile techniques than non-guideline user nurses in the operating room [AOR=6.4; 95%CI (3.773, 10.856)].

Nurses who are supervised in the operation room were 2.9 times more likely to have good knowledge of sterile techniques than those non-supervised in their setting [AOR=2.963; 95%CI (1.693, 5.184)].

AOR, adjusted OR; COR, crude OR; 1, reference group; *statistically significant at a p value of <0.05 ; PPE, Personal Protective Equipment.

Practice level of operation room nurses towards sterile techniques

The overall median practice score of the study participants on sterile techniques in the operating room was 25 with an IQR of (24, 29). In this study, two hundred thirty-one (56.1%) nurses who were working in the operation room had good practice in sterile techniques in the operation room.

Table 3 Nurse's responses on the knowledge of sterile techniques in public hospitals of Addis Ababa, Ethiopia, 2022 (n = 412)

Statements about sterile technique	Correct answer		Incorrect answer	
	N	%	N	%
Definition of sterile technique	194	47.1	218	52.9
A gown is considered sterile	228	55.3	184	44.7
A sterile package wrapped in a previous woven material drop to the floor	168	40.8	244	59.2
When the tape on the large abdominal swabs extends over the table edge	258	62.6	154	37.4
The circulating Nurse accidentally contaminates a sterile area indicate your actions as a scrub Nurse.	221	53.6	196	46.4
When draping an unsterile table, how do you drape?	138	33.5	274	66.5
When creating a sterile field for the operation it is preferable to open a pack...	289	70.1	123	29.9
When requiring sterile water during the surgical procedure?	273	66.3	139	33.7
Upon discovering a hole in glove during a surgical procedure, the OR nurse should	132	32.0	280	68.0
The safe distance between an unsterile person and sterile field is:	239	58.0	173	42.0
When a sterile area has been created, does the scrub Nurse...	171	41.5	241	58.5
During a surgical procedure when passing the sterile team members...	245	59.5	167	40.5
An unsterile person is allowed to face and observe sterile area when passing	111	26.9	301	73.1
The circulating Nurse is allowed to open sterile packages	131	31.8	281	68.2
Did you use only sterile items in the sterile field?	375	91.0	37	9.0
Sterilized package found in a contaminated area is considered as no sterile	365	88.6	47	11.4
A dropped package is considered contaminated on the outside	355	86.2	57	13.8
Tables are sterile only at table Level	329	79.9	83	20.1
Anything falling or extending over the table or operating bed edge, such as a piece of suture or suction tip, is contaminated.	320	77.7	92	22.3
The edges of anything that encloses sterile contents are considered unsterile	299	72.6	113	27.4
The sterile field is created as close as possible to the time of use	303	73.5	109	26.5
A sterile field is contaminated whenever a sterile barrier is permeable.	295	71.6	117	28.4
Sterile personnel touch only sterile items or areas; unsterile personnel touch only unsterile items or areas	278	67.5	134	32.5
Sterile personnel must wear sterile gown and gloves	312	76.7	96	23.3
Self-gowning and gloving should be done from a separate sterile surface to avoid dripping water onto sterile supplies or a sterile table	291	70.6	121	29.4
The stockinet cuffs of the gown are enclosed beneath sterile gloves.	317	76.9	95	23.1
Sterile people must keep their hands in sight at all times and at or above waist level or the level of the sterile field	314	76.2	98	23.8
The back of the gown is considered contaminated	308	74.8	104	25.2
Gowns are considered sterile only from the chest to the level of the sterile field in the front, and from 5 cm above the elbows to the cuffs on the sleeves.	334	81.1	78	18.9
The unsterile circulating Nurse does not directly contact the sterile field	332	80.6	80	19.4

Among practice assessment questions, 282 (68.4%) of the respondents always wear a mask, head cover, and proper operating room suit or attire, and 189 (44.9%) of the respondents always initial and final count instruments and supplies with a circulator. Among 412 participants, 99 (24%) of the respondents reported they never segregated waste as the operation progressed (Table 5).

Factors related to the practice of nurses regarding sterile techniques

In multivariable logistic regression analysis, factors that were significantly associated with good practice of sterile techniques were the availability of guidelines, the presence of supervision, and the nurse's knowledge.

As depicted in Table 6 below of the adjusted odds ratio, nurses who use sterile technique guidelines in the operating room were 1.9 times more likely to have good

practice in sterile techniques than non-guideline users [AOR=1.890, 95%CI (1.123, 3.182)].

Being supervised in sterile techniques in the operating room made nurses 4.7 times more likely to have good practice in sterile techniques when compared to non-supervised nurses. [AOR=4.732; 95%CI (2.643, 8.471)].

Similarly, in the in the operating room, nurses who had good knowledge of sterile techniques were 5.4 times more likely to have good practice than nurses who had poor knowledge of sterile techniques [AOR=5.419; 95%CI (3.087, 9.512)].

Discussion

This study aimed to assess nurses' knowledge, practices, and factors associated with respect to sterile techniques in operation rooms at Addis Ababa public hospitals by using a cross-sectional study. Findings of the current study showed that the overall knowledge of nurses about

Table 4 Multivariate logistic regression analysis of factors associated with nurses' knowledge of sterile techniques in public hospitals of Addis Ababa, Ethiopia, 2022 (n = 412)

Variables	Knowledge		P-value	AOR(95%CI)	P-value	
	Poor	Good				
Age						
20-29yrs	46	59	1		1	
30-39yrs	86	96	0.87(0.537,1.411)	0.668	0.586(.261,1.315)	0.195
40-49yrs	25	63	1.96(1.075,3.590)	0.014	0.658(.254,1.138)	0.997
> 50 yrs.	15	22	1.14(0.534,2.448)	0.582	0.364(.091,1.453)	0.152
Sex						
Female	81	130	1		1	
Male	91	110	0.75(0.509,1.115)	0.341	0.675(0.406,1.123)	0.13
Marital status						
Married	90	120	1		1	
Single	82	120	1.09(0.742,1.624)	0.58	.813(.483-1.367)	0.437
Level of education						
Diploma	23	24	1		1	
BSc	139	192	1.32(0.718,2.441)	0.088	1.324(0.718,2.441)	0.369
MSc	10	24	2.3(0.904,5.849)	0.165	2.30(0.904,5.849)	0.08
Year of experience						
1-5 years	74	131	1		1	
6-10yrs	52	67	0.73(0.459,1.154)	0.069	0.837(0.382,1.831)	0.708
11-15yrs	37	25	0.38(0.213,0.683)	0.77	1.955(0.383,9.991)	0.42
> 15yrs	9	17	1.07(0.453,2.513)	0.233	1.928(0.378,9.845)	0.43
Training						
No	72	46	1		1	
Yes	100	194	3.03(1.952,4.723)	0	1.989(1.120,3.530)	0.019*
Use of PPE						
No	34	54	1		1	
Yes	138	186	0.84(0.524,1.375)	0.419	1.194(0.633,2.250)	
Performing instrument counting intraoperative						
No	97	129	1		1	
Yes	75	111	1.11(0.750,1.65)	0.581	1.079(0.647,1.801)	0.77
Use of unwrapped instruments						
No	99	133	1		1	
Yes	73	107	1.09(0.735,1.620)	0.797	1.164(0.702,1.931)	0.555
Presence of sufficient supplies in Operation room						
No	53	86	1		1	
Yes	119	154	0.79(0.525,1.211)	0.357	0.953(0.562,1.615)	0.857
Availability of guideline						
No	110	65	1		1	
Yes	62	175	4.77(3.133,7.283)	0	6.4(3.773,10.856)	0.000*
Presence of supervision						
No	126	115	1		1	
Yes	46	125	2.97(1.952,4.541)	0	2.963(1.694,5.184)	0.000*

sterile techniques in the operating room was 58.3% with a 95%CI (53.2, 62.5). This finding is in line with a study conducted in Philippines 57.14% [8]. On the other hand, the finding of this study was higher than the study done in Nigeria 32% [16], and studies in Egypt 31.7% and 14.7% [10, 41]. The difference in the result might be due to variation in the study participants and study setting. In the previous studies in Egypt (conducted at Benha University Hospital and Meniet EI-Nasr Central Hospital)

and Nigeria, most participants had less than a degree level of education, and the study settings both in Nigeria and Meniet EI-Nasr Central Hospital were done with selected staff nurses, not operation room nurses. In contrast, in the current study, more than 88.6% of the participants had a BSc or master's degree, and the study setting was nurses who were working in the operating room at selected hospitals. Another reason might be the difference in the time of the study because of the

Table 5 Nurses's responses to the practice of sterile techniques in public hospitals in Addis Ababa, Ethiopia, 2022 (n = 412)

Practice of sterile technique	Never		Some times		Always	
	N	%	N	%	N	%
Do you wear mask, head cover and proper OR Suit/Attire?	15	3.6	115	27.9	282	68.4
Did you make sure that instruments, supplies and linens obtained from stock room have been sterilized and wrapped of sterile package?	14	3.4	111	26.9	287	69.7
Could you observe asepsis in preparation of sterile instruments and supplies; Arranges instruments in the field to facilitate handling of instruments.	10	2.4	122	29.6	280	68
Did you prepare sterile instruments, supplies and sterile field as close as possible to the time of use?	21	5.1	140	34	251	60.9
Does skin preparation from the site of incision.	16	3.9	146	35.4	250	60.7
Does surgical scrub from hands up to 2 inches above elbows, Always keeping the hands higher than the elbows.	17	4.1	156	37.9	239	58
Does gowning and gloving used aseptically, also assists in gowning and gloving by surgeon and his assistants/ observing sterile technique.	21	5.1	159	38.6	232	56.3
In draping the patient, is all skin area is covered except the incision site.	35	8.5	155	37.6	222	53.9
Did you avoid touching the part hanging below the table level, when in scrub?	35	8.5	156	37.9	221	53.6
When in scrub, avoids leaning on non-sterile areas; if not (circulating) avoid switching over sterile field.	35	8.5	174	42.2	203	49.3
Maintains cleanliness of the instruments throughout the procedure. Swipes the blood stained instruments with moistened gauze.	40	9.7	174	42.2	198	48.1
Talking, Sneezing and coughing are always kept to a minimum.	47	11.4	165	40.0	200	48.5
Movements within and around sterile area is kept to a minimum.	46	11.2	169	41.0	197	47.8
Did You Keeps contact to sterile items to a minimum.	35	8.5	149	36.2	228	55.3
Provides other supplies, materials and instruments if not in scrub (circulating nurse), careful not to touch unsterile areas.	55	13.3	170	41.3	187	45.4
Does initial and final counting of instruments and supplies with a circulator.	79	19.2	148	35.9	185	44.9
Do you keep the room cool and conducive for the surgical team and patient?	98	23.8	121	29.4	193	46.9
Did you segregate wastes as the operation progresses?	99	24.0	116	28.2	197	47.8

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 the study conducted in Nepal (62% and 37.5% of participants had high and average level of knowledge, respectively) [14], in Malaysia 8 (18.6%) and 35 (81.4%) respondents had medium and high knowledge, respectively [42], Zimbabwe at Bindura University 92% [15], Egypt 80% [9], Iraq 80% [13], Iran 72.4% and 66.1% [11], University of London 65% [6], India 63.24% [12], Rwanda (84.9%) [43], and Nigeria 64.4% [44] and 63.24% [40]. The discrepancy in these results might be due to study design, the difference in economic status, the level of health sector development, learning institutions, and the availability of supplies and consumable materials to maintain sterile techniques. Regarding the study design, in the current study, we have used cross-sectional. In contrast, the previous studies conducted in Nepal and Malaysia used interventional designs. In terms of the difference in socioeconomic status of the participants and the study setting, Ethiopians are in a low-income country compared with those in England, India, Iraq, Malaysia, Nepal, and even Egypt. This indirectly affects the quality of healthcare education and the healthcare setting.

Regarding the determinants of the level of knowledge on sterile techniques, this study has found that nurses who received training about sterile techniques in the operating room were 1.9 times more likely to have good knowledge when compared to their counterparts. This finding is supported by the studies done in Sweden, Malaysia, and Ethiopia [42, 45, 46]. The possible reason might be justified as training is vital to acquire new knowledge on updated nursing art, both theoretical and practical knowledge in every aspect of nursing education [47, 48].

Nurses who are supervised in the operation room were 2.9 times more likely to have good knowledge for sterile techniques than those non-supervised in their setting. This finding might be justified as supervision is important for nurses to maintain the strength and energy needed to carry out their work, and it provides a link between hospital administrators and nurses to monitor the work of nurses, identify their gaps, and take action. It also helps to maintain nurses knowledge within a unit [49, 50].

In this study, nurses who use guidelines in the operating room of sterile techniques were 6.4 times more likely to have good knowledge than those who do not use them. This is also supported by the qualitative study conducted in Ethiopia; the lack of a guideline makes you uneducated and unwilling to give the required activities. For this reason, we believe that guidelines can change the

Table 6 Multivariate logistic regression analysis of factors associated with nurses practice of sterile techniques in public hospitals in Addis Ababa, Ethiopia, 2022 (n = 412)

Variables	Practice		COR(95%CI)	P-value	AOR(95%CI)	P-value
	Good	Poor				
Age						
20-29yrs	58	47	1.620(0.761,3.448)	.245	2.107(0.404,10.993)	0.377
30-39yrs	116	66	2.307(1.126,4.726)	.717	5.282(0.936,29.796)	0.059
40-49yrs	41	47	1.145(0.528,2.482)	.580	0.660(0.113,3.851)	0.644
> 50 yrs.	16	21	1		1	
Sex						
Female	120	91	1.069(0.724,1.578)	.595	0.987(0.603,1.618)	0.960
Male	111	90	1		1	
Marital status						
Single	114	88	1.030(0.698,1.520)	.962	1.116(0.666,1.870)	0.676
Married	117	93	1		1	
Level of education						
Diploma	29	18	1			1
BSc	177	154	0.713(0.381,1.335)	.327	0.598(0.252,1.417)	0.243
MSc and above	25	9	1.724(0.659,4.514)	.267	1.458(0.388,5.476)	0.577
Year of service						
1–5 years	129	76	2.315(1.011,5.298)	.042	3.842(0.603,24.480)	0.154
6-10yrs	58	61	1.297(0.550,3.055)	.502	0.986(0.138,7.054)	0.989
11-15yrs	33	29	1.552(0.616,3.910)	.351	5.689(0.747,43.348)	0.093
> 15yrs	11	15	1		1	
Training						
Yes	183	111	2.404(1.554,3.720)	.000	1.155(0.672,1.986)	0.602
No	48	70	1		1	
Use of PPE						
Yes	180	144	0.907(0.563,1.461)	.588	1.271(0.684,2.361)	0.448
No	51	37	1		1	
Counting in operation room						
Yes	107	79	1.114(0.753,1.648)	.447	0.962(0.580,1.594)	0.879
No	124	102	1		1	
Unpacked Instruments						
Yes	106	74	1.226(0.827,1.817)	.400	1.349(0.826,2.205)	0.232
No	125	107	1		1	
Availability of sufficient supplies						
Yes	148	125	0.799(0.528,1.209)	.356	1.017(0.604,1.712)	0.949
No	83	56	1		1	
Availability of guideline						
Yes	166	71	3.957(2.616,5.985)	.000	1.890(1.123,3.182)	0.017*
No	65	110	1		1	
Presence of supervision						
Yes	131	40	4.618(2.983,7.149)	.000	4.732(2.643,8.471)	0.000*
No	100	141	1		1	
Knowledge						
Good	173	67	5.075(3.322,7.752)	.000	5.419(3.087,9.512)	0.000*
Poor	58	114	1		1	

AOR, adjusted OR; COR, crude OR; 1, reference group; *statistically significant at a p value of <0.05; OR, Operation Room; PPE, Personal Protective Equipment

nurses knowledge by increasing the level of understanding up-to-date subject-specific knowledge's [46]. In this study, 56.1% with a 95% CI (51.5, 61.1) participants had good practice towards sterile techniques in the operating room. This result was higher than the study conducted at

Port Said University of Egypt (29%) [41], Nigeria 22.1% [40], and Sudan 15.6% [51].

The possible justification might be due to differences in the study settings. Study setting of Port Said University Hospital conducted in general, private, and health

insurance and also conducted in staff nurses. The study of Lagos State, Nigeria, was conducted in the surgical, emergency, obstetrics, and gynecologic wards of two teaching hospitals and of Imo State Nigeria's, conducted in different wards of Imo State University hospitals.

On the other hand, this result was lower than the result found in Rwanda (61.3), in Turkey 77.3%, and in south India 68.75% [43, 52, 53]. Its justification might be because of differences in socioeconomic status and level of health sector development.

Nurses who use sterile techniques guidelines in the operation room were 1.9 times more likely to have good practice in sterile techniques than non-guideline users. This result was consistent with studies done in Egypt [41] and in Sweden [54]. This can be justified by the fact that the presence of guidelines was used as guidance on certain actions and activities to maintain sterility and prevent contamination of the sterile field during surgery [2].

Being supervised in sterile technique in the operating room was 4.7 times more likely to have good practice in sterile techniques when compared to non-supervised nurses. It is supported by a study done at Colorado University [55], Sudan of Khartoum Teaching Hospital [51]. This was evidenced by the fact that an increased level of surgical supervision during the surgery has an advantage for better patient outcomes and is helpful to enhance nurses' performance in providing care for patients [55, 56].

Similarly, operation room nurses who had good knowledge on sterile techniques were 5.4 times more likely to have good practice than nurses who had poor knowledge on sterile techniques in the operation room. This factor is supported by the study conducted at Port Said University of Egypt [41], Imo State Nigeria [44], and Ethiopia [46], which is justified as nurses with good knowledge and greater understanding can have good practice on sterile techniques [41, 57].

Strengths and limitations of the study

The limitation of this study was that there might be a social desirability bias, although this was minimized through the use of self-administered questionnaires, and the domains of a nurse's practice were self-reported and might be limited by recall bias. In addition, the content validity of the questionnaires was not formally assessed by independent experts. Lastly, the study results were not triangulated with findings by qualitative approaches (some variables, like the presence of supplies, may be better answered by this approach), which could have enhanced our findings. Despite these limitations, this study covers a large setting (multicenter) area, and clearly shows the knowledge, practice, and associated factors of nurses toward sterile techniques among nurses working

in the operation rooms of public hospitals in Addis Ababa, Ethiopia.

Conclusions

Operation theater nurses knowledge and practice of sterile techniques were found inadequate. Having training, availability of guidelines, and supervision were factors associated with nurse's knowledge. Whereas, availability of guidelines, supervision, and the nurse's knowledge were factors associated with the nurse's practice of sterile techniques in the operating room. Therefore, fulfilling the resources, such as standardizing guidelines, conducting periodical supportive supervision, providing training, and utilizing updated guidelines and literature related to operation room techniques, should be important. Furthermore, we also recommend that future researchers conduct a mixed-methods study to provide sufficient evidence for policymakers.

Abbreviations

AOR	Adjusted Odds Ratio
CDC	Center for Disease Control
CI	Confidence interval
COR	Crude odds ratio
IERB	Institutional ethical review board
OR	Operation room
PPE	Personal Protective Equipment
SSI	Surgical site infection
UK	United Kingdom
UoG	University of Gondar
USA	United States of America
WHO	World Health Organization

Supplementary Information

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Supplementary Material 1

Supplementary Material 2

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Author contributions

Y.W.H. conceived, designed the study, acquired data, analyzed and interpreted the findings. K.B.G and M.A.G revised and provided critical intellectual feedback. A.W.W review and edit the draft manuscript. All authors have been read and approved the final manuscript for submission.

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Data availability

All data are available upon reasonable request and the readers could contact the corresponding author.

Declarations

Ethics approval and consent to participate

This study was conducted in accordance with the principles of the Helsinki Declaration. Ethical clearance was obtained from the University of Gondar, College of Health Sciences Institutional Health Research Ethics Review Committee (IHRERC) on behalf of School of Nursing, approved with a written letter of protocol (Ref No.S/N/243/2014). Following approval, a written official letter of cooperation was submitted to each hospital administration office before the commencement of data collection. Informed written consent was obtained from the study participants, and privacy was ensured throughout data collection.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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