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Healthcare Workers' Knowledge, Practice and Associated Factors Towards Prevention of Central Line-Associated Blood Stream Infections in Cardiac Centers of Addis Ababa, Ethiopia, 2024

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ABSTRACT

Introduction: Preventing central line-associated bloodstream infections in healthcare settings reduces morbidity, mortality, and healthcare costs. This study aimed to assess healthcare workers' knowledge, practice, and associated factors regarding central line-associated bloodstream infection prevention in Addis Ababa cardiac units.

Methods: From May 20 to June 20, 2024, in seven cardiac centers in Addis Ababa, we employed a hospital-based cross-sectional study design and participants were chosen by simple random sampling. Data were entered using EpiData version 3.1 and exported and analyzed using SPSS version 25. A multivariable logistic regression analysis and variables with p-value <0.05 were considered as statistically significant.

Results: The magnitude of healthcare workers' knowledge and practice towards the prevention of central line-associated bloodstream infections was 85.8% (95% CI: 82.38%, 89.22%) and 73.5% (95% CI: 69.17%, 77.83%), respectively. After adjusted analysis, a bachelor's degree or higher (AOR: 2.086, 95% CI: 1.127, 3.860), participating in a peer education program (AOR: 2.365, 95% CI: 1.274, 5.713), and training (AOR: 2.820, 95% CI: 1.392, 9.590) were factors associated with knowledge. Male sex (AOR: 2.059, 95% CI: (1.223, 3.467)), more than five years of work experience (AOR: 2.073, 95% CI: (1.149, 3.739)), and training (AOR: 3.857, 95% CI: (2.180, 6.826)) were factors associated with practice.

Conclusions: More than three-fourths and approximately three-fourths of health care workers in cardiac centers in Addis Ababa had good knowledge and had good practice towards prevention of central line-associated bloodstream infections. Healthcare professionals involved in patient care should receive ongoing, updated CLABSI prevention training integrated into professional development initiatives.

Abbreviations

BSI: Bloodstream Infection

CDC: Centers for Disease Control and Prevention

CI: Confidence Interval

CLABSIs: Central Line-Associated Blood Stream Infections

CRBSI: Catheter-Related Bloodstream Infection

CRI: Catheter-Related Infection

CVAD: Central Venous Access Device

CVC: Central Venous Catheter

CVL: Central Venous Line

EPIC: European Prevalence of Infection in Intensive Care

ETB: Ethiopian Birr

HAI: Hospital Acquired Infection

HCW: Health Care Workers

ICU: Intensive Care Unit

INICC: International Nosocomial Infection Control Consortium

NGO: Non-Governmental Organization

UK: United Kingdom

US: United States

USA: United States of America

WHO: World Health Organization

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Introduction

Healthcare-associated infections (HAIs) are a major public health concern worldwide, being a leading cause of illness and death among hospitalized patients [1]. Central line-associated bloodstream infections (CLABSIs), primarily stemming from the use of central venous catheters (CVCs), represent a major complication in critical care and emergency medicine environments [2].Central venous catheters allow healthcare professionals to measure central venous pressure, which in turn offers an indication of fluid status and right ventricular function [3]. When major surgery carries a significant risk of blood loss or if the patient has a serious heart condition, central venous pressure monitoring is recommended. Furthermore, patients needing long-term treatment with total parenteral nutrition, chemotherapy or antibiotics, and medications that can harm smaller veins may benefit from having a CVC placed [4].

Catheter-related bloodstream infection (CRBSI) is a type of bacteremia that originates from an intravenous catheter. This infection typically arises due to the introduction of microorganisms from the patient's skin or the hands of healthcare personnel involved in catheter insertion or maintenance. It has been noted that approximately 60% of CRBSI results from this form of contamination. Infections can have serious consequences for patients, potentially progressing from local symptoms to widespread systemic illness, including conditions like endocarditis, and in severe cases, can be fatal. The length of inpatient stay increases by approximately one week in intensive care and by two to three weeks in the hospital as a result of CRBSI. This has implications for the patient and his or her family, as well as the service provider [1, 5].

Central line-associated bloodstream infections are characterized as bloodstream infections that develop at least 48 hours after a central catheter is placed and are not linked to any other source of infection. In intensive care settings, a number of factors have been linked to an increased risk of CLABSIs. These include how long the catheter stays in, microbes found at the insertion site and on the catheter itself, and not properly maintaining the CVC after it's placed [2].

Central line-associated bloodstream infections contribute to extended hospitalizations, escalating healthcare expenditures, and heightened mortality rates. An estimated 250,000 bloodstream infections occur annually, and most are related to the presence of intravascular devices. Central line-associated blood stream infections are common HAIs with a reported mortality of 12-25% [3].

Prevention of CLABSI involves meticulous hand hygiene prior to central venous catheter care, utilizing either an alcohol-based hand sanitizer or an antibacterial soap with thorough water rinsing [6]. According to the WHO, up to 30% of intensive care unit (ICU) patients develop HAIs, primarily bloodstream infections linked to catheter presence in veins [5].

Several international organizations have published clinical practice guidelines for preventing CLABSIs, intended for healthcare workers (HCWs) who insert and manage CVCs. ICU nurses have the most direct and continuous role in high-risk CVC procedures. Therefore, they are well-positioned to implement the recommendations and have a unique opportunity to contribute to the primary prevention of these infections via evidence-based best practices [3].

The International Nosocomial Infection Control Consortium (INICC) reports a pooled CLABSI incidence of 4.9 infections per 1,000 central-line days across its ICUs (Africa, Asia, Europe, and Latin America), nearly five times higher than US rates [2]. The Centers for Disease Control and Prevention (CDC) estimated that HAIs affect 2 million patients annually, causing nearly 100,000 deaths.

These infections increase mortality, prolong hospital stays, and raise healthcare costs for patients, insurers, and facilities [7]. In 2020, U.S. ICUs had a CLABSI rate of 0.87 per 1,000 central line days [8].

United States (US) hospitals experience nearly 250,000 CLABSIs annually, resulting in 28,000 deaths and a $2.3 billion burden on the healthcare system [9]. The CDC considers CLABSIs the deadliest healthcare-associated infection (HAI), with a mortality rate of 25%, making it the most devastating HAI consequence [7]. Patients with CLABSI have a 2.75-times higher risk for hospital death as compared to those without CLABSI [10].

Central line-associated bloodstream infections cost an estimated $49,201 per case [7]. In the US, CLABSIs have an 18% mortality rate, cost about $18,432, and result in an average hospital stay of 12 days [11]. Central line-associated bloodstream infections pose a serious risk to neonatal health [9]. Additionally, CLABSIs are the second leading cause of death among patients with renal issues [12]. Moreover, CLABSI are the most important complications in critical care and cancer settings [1].Healthcare workers may struggle to consistently follow CLABSI prevention guidelines due to various internal and external barriers [13]. Assessing HCW contributions to CLABSI prevention is crucial, as success relies on monitoring insertion processes and routine CVC maintenance [14, 15].

To minimize CLABSI incidence, the CDC recommends guidelines focusing on education and training, maximal sterile barrier precautions, use of >0.5% chlorhexidine with alcohol for skin antisepsis, avoiding routine catheter replacement, and implementing bundled strategies [4]. Studies indicate that inadequate knowledge and skills among healthcare workers are key barriers to preventing CLABSIs [4]. Despite inconsistencies, sex, length of time of ICU nursing, educational level, nursing level, hospital grade, and incidence of CLABSI are the factors associated with HCWs' knowledge and practice in preventing CLABSI [10]. In our country, there is a lack of evidence on healthcare workers' knowledge, practice, and factors for preventing CLABSIs, making it essential to evaluate these factors in cardiac units. Therefore, this study is intended to assess health workers' knowledge, practice, and associated factors towards CLABSIs in cardiac units of Addis Ababa, Ethiopia, in 2024.

Methods and Materials

Study Area and Period

This study was conducted in seven cardiac centers in Addis Ababa from March to April, 2024. Addis Ababa is composed of 11 sub-cities and 118 woredas and has an estimated total population of 3,854,863, including 2,004,529 females and 1,850,334 males [16]. Cardiac centers in Addis Ababa consist of: Cardiac Center-

Ethiopia, St. Peter's Specialized Hospital Cardiac Center, Tazma Medical & Surgical Specialized Center, Tikur Anbessa Hospital Cardiac Center, Elouzeir Cardiac Center, Gesund Cardiac Center and Addis Cardiac Hospital. Cardiac centers in Addis Ababa give cardiac outpatient services, including echocardiography, electrocardiogram, cardiac ward, cardiac catheterization, cardiac operation theater, and cardiac intensive care unit services. The total number of healthcare workers in the seven cardiac centers is 588.

Study Design and Population

We employed a hospital-based cross-sectional study design. The source population comprised all HCWs working in the seven cardiac centers of Addis Ababa, Ethiopia. The study population included all HCWs working in the cardiac unit of the selected cardiac centers.

Inclusion and Exclusion Criteria

All HCWs who worked six months and above in the cardiac unit involving central line catheterization practice and were available during the data collection period were included in the study. Those who were seriously ill during the data collection period and HCWs who do not have direct patient care responsibilities involving CVL were excluded from the study.

Sample Size Determination and Sampling Procedures

The sample size was calculated by using the single population proportion formula by taking the proportion of knowledge and practice towards prevention of CLABSIs (P) at 50%. Since there was no study conducted in our country regarding this title, the margin of error (d) was 0.05, with a 95% confidence interval and a non-response rate of 5%. The sample size became 403. Where n is minimum sample size required for the study, d is margin of error, p is proportion of knowledge and practice towards prevention of CLABSIs, and $Z\alpha/2$ is the value of the standard normal distribution.

Sampling Techniques and Procedures

All seven cardiac centers in Addis Ababa (Cardiac Center-Ethiopia, St. Peter's Specialized Hospital Cardiac Center, Tazma Medical & Surgical Specialized Center, Tikur Anbessa Hospital Cardiac Enter, Elouzeir Cardiac Center, Gesund Cardiac Center, and Addis Cardiac Hospital) were included in the study. Data reviewed from each cardiac center showed that the number of HCWs in each center was: Cardiac Center-Ethiopia = 50, St. Peter's Specialized Hospital Cardiac Center = 111, Tikur Anbessa Hospital Cardiac Enter = 121, Tazma Medical & Surgical Specialized Center = 101, Addis Cardiac Hospital = 57, Elouzeir Cardiac Center = 75, and Gesund Cardiac Center = 73.

The total sample size was then proportionally allocated to the selected using Baurley's method of proportionate allocation technique based on the number of HCWs in each cardiac center [17]. Baurley's method of proportional allocation follows the formula b=n(ni)/N, where n is the number of HCWs from each hospital, ni is the total estimated sample size of the study, and N is the total HCWs of the study area. Finally, during the data collection period, the study participants were chosen by using a simple random sampling technique (Figure 1).
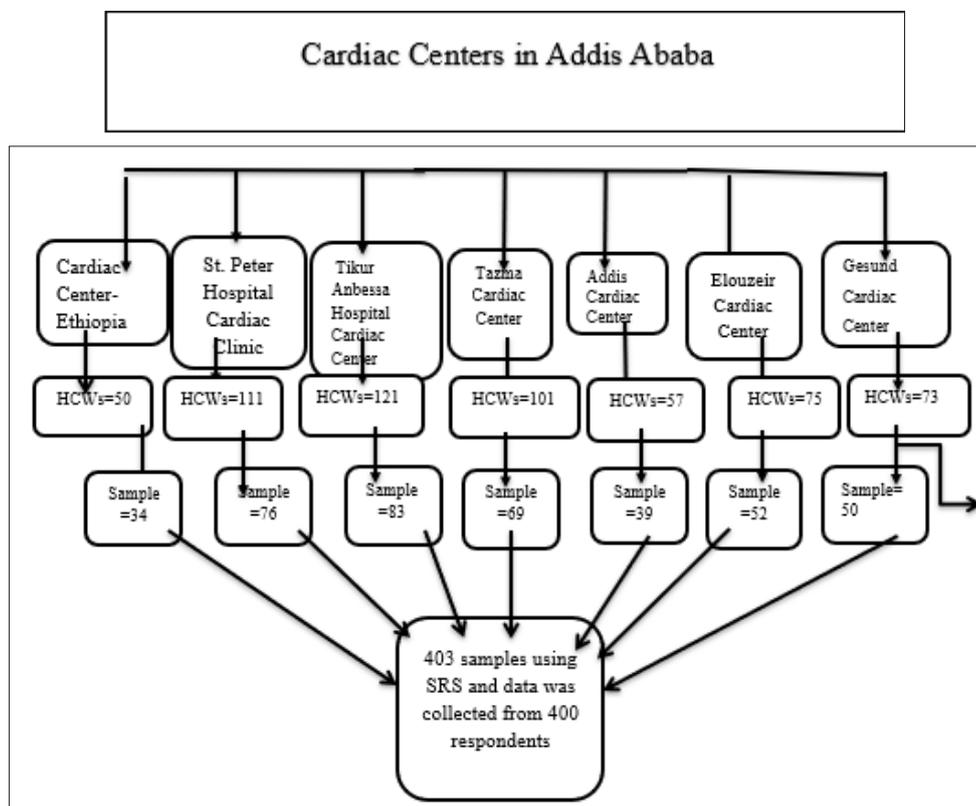

Figure 1: Schematic presentation of sampling procedure for the study of assessment of Knowledge and Practice and factors associated towards prevention of CLLABSIs

Measurement

Study Variables

Dependent variables

Knowledge towards prevention of CLABSIs

Practice towards prevention of CLABSIs

Independent variables

Socio-demographic professional Characteristics: age, gender, marital status, education level, and work experience

Profession and job-targeted factors: infection prevention training, participating in peer education programs, presence of guidelines

Workplace-related factors: infection prevention equipment, water supply

Data collection tools and procedures

Data was collected using a pretested, self-administered questionnaire. The questionnaire contains open-ended and closed-ended questions designed to collect data on socio-demographic factors, knowledge and practice towards the prevention of CLABSI, the presence of guidelines, profession- and job-targeted factors, and workplace-related factors. After reviewing literature, the questionnaire to assess knowledge and practice was modified from CDC recommendations and questions related to independent variables were prepared after reviewing different literature [3, 9, 14, 18, 19]. Data was collected by four BSc nurses for one month with close supervision of the assigned supervisors. The data collectors and supervisors were given three days of training on confidentiality and the objective of the study. During data collection, the completeness of each questionnaire was checked on a daily basis. The instrument tried to cover all relevant aspects of the construct being measured. The study used a standard CDC checklist for the prevention of central line-associated blood stream infections. In addition, pilot testing of the instrument was conducted before the actual study.

Operational Definitions

CLABSI is a bloodstream infection that happens because of pathogens entering the bloodstream through a central line in a patient who had a central line at the time of infection or within 48 hours before the development of infection [20].

given two days of training on the study's objective, relevance, and confidentiality of information, respondents' rights, informed consent, and interview techniques. In addition, a practical interview demonstration was held in a classroom.

During data collection, the data collection was strictly supervised throughout the data collection period by the assigned supervisors and the principal investigator. The questionnaires were checked for completeness and consistency at the site of the data collection by the principal investigator.

During data entry and analysis, the collected data were coded and entered into EpiData software version 3.1. The quality of the data was controlled through skipping patterns that must enter and reduce transportation errors in EpiData. Finally, cleaning and analysis were performed using SPSS version 25.

Health Care Workers: are individuals who work in a healthcare setting and provide direct or indirect patient care, or who handle patient data or materials.

Knowledge towards prevention of CLABSIs was assessed using knowledge questions from the CDC Checklist for Prevention of Central Line-Associated Blood Stream Infections. The questions were modified. Eight questions were used to assess the knowledge towards the prevention of CLABSIs with three response options. Among the questions, one question is reverse coded, which says, "It is recommended to use topical antibiotic ointment on the catheter insertion site." Correct responses were recorded as 1, and incorrect responses were recorded as 0. Then responses were summed up, and a mean score was calculated [1, 19].

Good knowledge: participants who scored above or equal to the mean score of the CDC Checklist for Prevention of Central Line Associated Blood Stream Infections

Poor knowledge: Participants who scored below the mean score of the CDC Checklist for Prevention of Central Line Associated Blood Stream Infections

Practice towards prevention of CLABSIs was assessed using practice questions from the CDC Checklist for Prevention of Central Line-Associated Blood Stream Infections. A correct response was recorded as 1, and incorrect responses were recorded as 0. Then responses were summed up and a mean score was calculated [19].

Good practice: participants who scored above or equal to the mean score of the CDC Checklist for practice towards Prevention of Central Line Associated Blood Stream Infections.

Poor practice: Participants who scored below the mean score of the CDC Checklist for practice towards Prevention of Central Line Associated Blood Stream Infections.

Data Quality Control

Before data collection: Before data collection, the questionnaire was pretested on 5% of the total sample at the International Cardiac and Medical Center (ICMC) Hospital's HCWs to determine the response rate, clarity, sequence, and consistency of the questionnaire. The sequence of the tool was adjusted based on the results of the pretest. An inter-rater reliability test was performed for nurses who were collecting the data using pilot testing, training, and standardization. The data collectors were

Data Processing and Analysis

Data was coded and entered using EpiData version 3.1 and exported to SPSS version 25 for further analysis. Data were cleaned by performing the frequency of each variable to check the accuracy, inconsistency, and missed value of the data. Before analysis of the data, the recoding of variables was employed to make it easy for analysis. Descriptive statistics including frequencies, mean, median, and interquartile range were computed. Additionally, for continuous variables, normality was checked using histograms, boxes, and whisker plots.

Bivariate logistic regression analysis was employed to determine the association between each independent variable and knowledge and practice among HCWs on the prevention of CLABSIs. Before performing bivariate logistic regression analysis, assumptions for logistic regression were checked. Those variables

with p-value < 0.25 on bivariate logistic regression analysis were selected as candidate variables for multivariable logistic regression analysis.

Finally, multivariable logistic regression analysis was performed to identify the independent predictors of knowledge and practice of HCWs towards the prevention of CLABSIs. Those variables with a p-value < 0.05 on multivariable logistic regression analysis were considered statistically significant, and the strength of association between the dependent and independent variables was assessed using an odds ratio with a 95% confidence interval at a p-value <0.05.

Ethics approval and consent to participate

Prior to conducting the study, an ethical clearance letter was obtained from Saint Paul's Hospital Millennium Medical College, institution review board (IRB). Written informed consent was obtained from each study participant to ensure willingness. Information about the benefits and harms of the study, the usefulness of their participation, the confidentiality of the information, and the right not to participate were given to the participants. The data collectors were given two days of training on the study's objective, relevance, and confidentiality of information, respondents' rights, informed consent, and interview techniques in order to address potential ethical vulnerabilities of participants not to feel obliged to participate in the study.

Results

Socio-demographic Characteristics

From the total of 403 HCWs recruited, 400 completed the questionnaire adequately, making the response rate of 99.25%. Two hundred twenty-three (55.8%) of the respondents were male. The mean age of the respondents was 34.27± 8.819 SD years. From the participants, 141 (35.3%) of them were diploma nurses in profession, and 211 (52.8%) were married. Approximately half (51%) of the respondents had five years and below work experience. The majority (25%) of the respondents were ordinary nurses (Table 1).

Table 1. Socio-demographic characteristics of HCWs at cardiac centers in Addis Ababa, Ethiopia, 2024 (n = 400)

Variable	Categories	Frequency (n)	Percent (%)
Sex	Male	223	55.8
	Female	177	44.2
Age category	< 30 years	123	30.8
	> 30 years	277	69.2
Educational qualification	Diploma nurse	141	35.3
	BSc nurse	69	17.3
	General practitioner	42	10.7
	MSc in clinical science	92	23
	M.D with specialty	51	12.7
	Other	4	1
Marital status	Single	163	40.8
	Married	211	52.8
	Divorced	23	5.8
	Widowed	3	0.6
Work experience	< 5 years	204	51
	>5 years	196	49
Professional role	Ordinary nurse	100	25
	Head nurse	46	11.5
	Ordinal physician	92	23
	Head physician	86	21.5
	Senior doctors	69	17.2
	Resident	7	1.8

Knowledge of the participants' towards Prevention of CLABSIs

From the participants, 343 (85.8%) had good knowledge towards prevention of central line-associated bloodstream infections. Three hundred fifty-seven (89.3%) of them answered the recommendations correctly concerning flushing the lumen with saline after the administration of medication or fluid. In addition, 373 (93.3%) answered the recommendations correctly concerning using sterile gauze or a sterile transparent semi-permeable dressing to cover the catheter site. Three hundred twenty-three (80.7%) of the participants answered the recommendations to comply with hand hygiene requirements correctly. Three hundred twelve (78%) of them answered the recommendations correctly to replace catheter site dressings every two days for gauze dressings, every seven days for sterile semipermeable dressings, or if the dressing becomes visibly soiled or loosened. Two hundred eighty-one (70.3%) of

the participants answered incorrectly regarding applying topical antibiotic ointment on the catheter insertion site. Three hundred three (75.8%) of them answered the recommendations to replace the IV administration sets for continuous infusions for blood and blood products every 24 hours correctly. Finally, 282 (70.5%) of them answered the recommendations correctly using 2% chlorhexidine gluconate for antiseptic of the insertion site (Table 2).

Table 2: Knowledge of HCWs towards prevention of CLABSIs at cardiac centers in Addis Ababa, Ethiopia, 2024 (n = 400)

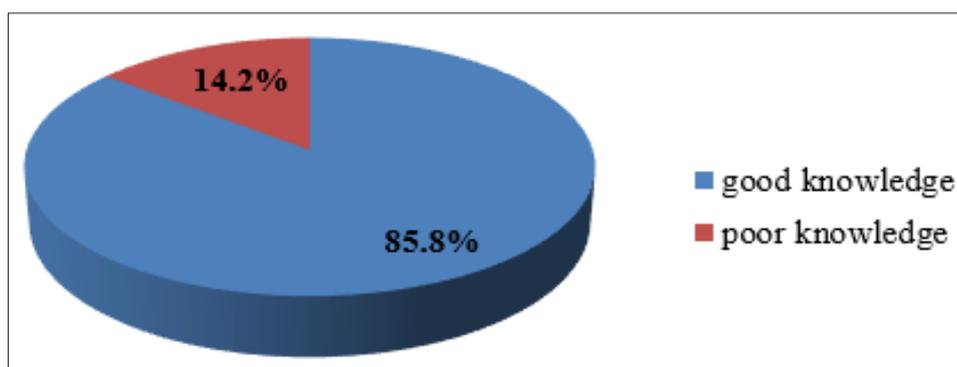| Variable	Categories	Frequency (n)	Percent (%)
It is recommended to flush the lumen with saline after the administration of medication or fluid	Yes	357	89.3
	No	28	7.0
	Don't know	15	3.7
It is recommended to use sterile gauze or a sterile transparent semi-permeable dressing to cover the catheter site	Yes	373	93.3
	No	23	5.8
	Don't know	4	1.0
It is recommended to comply with hand hygiene requirements	Yes	323	80.7
	No	65	16.3
	Don't know	12	3.0
It is recommended to replace catheter site dressing every two days for gauze dressings, every seven days for sterile semipermeable dressing or if the dressing becomes visibly soiled or loosened	Yes	312	78.0
	No	77	19.2
	Don't know	11	2.8
It is recommended to use topical antibiotic ointment on the catheter insertion site	Yes	281	70.2
	No	86	21.5
	Don't know	33	8.3
It is recommended to replace the IV administration sets for continuous infusions for blood and blood products every 24 hours	Yes	303	75.8
	No	82	20.5
	Don't know	15	3.7
It is recommended to use 2% chlorhexidine gluconate for antiseptic of the insertion site	Yes	282	70.5
	No	114	28.5
	Don't know	4	1
It is recommended to use sterile devices to access catheters	Yes	349	87.3
	No	46	11.5
	Don't know	5	1.2

Figure 2: Overall knowledge status of HCWs towards prevention of CLABSIs at cardiac centers in Addis Ababa, Ethiopia, 2024 (n = 400)

Practice of the participants towards Prevention of CLABSIs

From the participants, 294 (73.5%) of them had good practice towards prevention of central line-associated blood stream infections. From the participants, 344 (86%) of them used to change the dressing on the CVC insertion site. Two hundred ten (52.5%) of them used to clean the CVC site before disinfection. The majority of the participants (66.5%) used to allow the antiseptic to dry before proceeding. The majority (78.3%) of them used to perform the disinfection of the CVC access port before administering therapy. Finally, two hundred sixty-six (66.3%) of them used to replace the intravenous (IV) administration sets (Table 3).

Table 3. Practice status of HCWs towards prevention of CLABSIs at cardiac centers in Addis Ababa, Ethiopia, 2024 (n = 400)

Variable	Categories	Frequency (n)	Percent (%)
Do you change the dressing on the CVC insertion site	Yes	344	86
	No	56	14
Do you utilize maximum barrier precaution (cap, mask, sterile gown,	Never	2	0.6
	Rarely	29	8.4
	Sometimes	49	14.2
	Often	65	18.9
	Always	199	57.8
Use 2% chlorhexidine gluconate for antiseptic of the insertion site	Never	5	1.5
	Rarely	28	8.1
	Sometimes	59	17.2
	Often	28	8.1
	Always	224	65.1
What kind of gloves do you use	non-sterile	18	5.2
	non-sterile for removing the dressing then sterile	66	19.2
	Sterile	260	75.6
Do you clean the CVC site before disinfection?	Yes	210	52.5
	No	190	47.5
Do you perform the disinfection of the CVC access port before administering therapy	Never	3	0.6
	Rarely	25	6.3
	Sometimes	59	14.8
	Often	133	33.2
	Always	180	45
Do you allow the antiseptic to dry before proceeding	Yes	266	66.5
	No	134	33.5
Do you replace the intravenous (IV) administration sets	Yes	265	66.3
	No	135	33.2
Do you wash your hands before the replacement of administration sets	Never	5	1.4
	Rarely	15	4.2
	Sometimes	48	13.5
	Often	137	38.5
	Always	151	42.4
Change gauze dressings at least every two days or semipermeable dressings at least every 7 days	Rarely	1	0.3
	Sometimes	42	11.8
	Often	113	31.7
	Always	200	56.2
Prompt removal of central lines when no longer essential	Never	75	19.2
	Rarely	47	12.1
	Sometimes	118	30.3
	Often	37	9.5
	Always	113	29

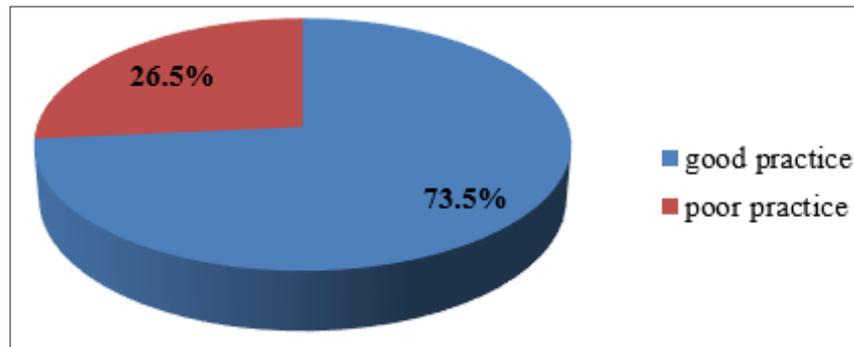|			
Do you flush the CVC lumens after IV therapy	Never	27	8.6
	Rarely	27	8.6
	Sometimes	80	20
	Often	86	21.5
	Always	180	45.3
Practice status	Good	294	73.5
	Bad	106	26.5

Figure 4: Overall practice status of HCWs towards prevention of CLABSIs at cardiac centers in Addis Ababa, Ethiopia, 2024 (n = 400)

Sources about prevention of CLABSIs

Health care workers' indicated workshops and courses (31%) as their main source of information about the prevention of CLABSIs, followed by colleagues (22%), and the internet (12.7%). The vast majority (86.3%) reported that they would like to learn more (Table 4).

Table 4: Source of information of HCWs towards prevention of CLABSIs at cardiac centers in Addis Ababa, Ethiopia, 2024 (n = 400)

Variable	Categories	Frequency (n)	Percent (%)
From which of the following sources did you receive information about CLABSIs	None	40	10
	Guidelines	37	9.3
	Workshop/courses	124	31
	Colleagues	88	22
	Scientific journals	27	6.8
	Internet	51	12.7
	Professional organization	33	8.2
Do you feel you need more Do you feel you need more information about CLABSIs	Yes	345	86.3
	No	55	13.7

Profession and job-targeted factors towards the prevention of CLABSIs

From the participants, 332 (83%) of them liked their profession. Three hundred forty-four (86%) of them were not satisfied with their salary. Two hundred twenty-four (56%) of them have taken training regarding infection prevention on CLABSIs. Two hundred twenty-one (55.3%) of them have never been recognized for their best performance (Table 5).

Table 5. Profession and Job Targeted Factors of HCWs towards Prevention of CLABSIs at Cardiac Centers in Addis Ababa, Ethiopia, 2024 (n = 400)

Variable	Categories	Frequency (n)	Percent (%)
Do you like your profession?	Yes	332	83
	No	68	17
Are you satisfied with your salary?	Yes	56	14
	No	344	86
Are you satisfied with your salary?	Yes	224	56
Have you taken training regarding infection prevention on CLABSIs?	No	276	44
Do you have a regular work shift?	Yes	278	69.5
	No	122	30.5
Have you ever been recognized for your best performance?	Yes	179	44.7
	No	221	55.3
Have you ever been warned and punished for your wrong action and decision	Yes	112	28
	No	288	72
Do you have a peer education program	Yes	216	54
	No	184	46
Have you ever attended a session on infection prevention on CLABSIs session?	Yes	130	32.5
	No	270	67.5

Work-place-related variables

Of the participants, 352 (88%) thought that their work place was suitable for them, and 361 (90.3%) of them thought that their work unit is well designed for ventilation. Three hundred eighty (95%) of them knew that the garbage pit is always available at the work unit (Table 6).

Table 6. Workplace-related factors of HCWs towards prevention of CLABSIs at cardiac centers in Addis Ababa, Ethiopia, 2024 (n = 400)

Variable	Categories	Frequency (n)	Percent (%)
Do you think your work environment is suitable for work?	Yes	352	88
	No	48	12
Do you think your work department/unit is well designed for ventilation?	Yes	361	90.3
	No	39	9.7
Is a garbage pit always available in your work department/unit?	Yes	380	95
	No	20	5
Is soap for hand washing always available in your work department/unit?	Yes	352	88
	No	48	12
Is water for hand-washing always available in your department/unit?	Yes	366	91.5
	No	34	8.5

Factors associated with healthcare workers' knowledge towards prevention of CLABSIs

Bivariate analysis was conducted to identify factors associated with health care workers' knowledge towards CLABSIs. Sex of respondents, age category, educational level, work experience, participating in peer education programs, and having training regarding infection prevention on CLABSIs were found to have p<0.25 and entered into multivariable analysis. Then, multivariable binary logistic regression analysis was performed to examine the effect of each predictor variable on health care workers' knowledge towards prevention of CLABSIs. Educational level, participating in peer education programs, and having training on CLABSI prevention were significantly associated with health care workers' knowledge towards CLABSIs.

The odds of having good knowledge towards prevention of CLABSIs by health care workers' in this study were two times higher among health care workers' having bachelor's degree or higher as compared to those with diploma educational level (AOR: 2.086, 95% CI: 1.127, 3.860), P-value = 0.019). The study also revealed that those healthcare workers who participated in peer education programs had two times higher odds of having good knowledge towards the prevention of CLABSIs as compared to those who didn't participate in peer education programs (AOR: 2.365, 95% CI: (1.274, 5.713), P-value = 0.006). In addition, the odds of having good

knowledge towards prevention of CLABSIs by health care workers in the study were four times higher among health care workers having training on CLABSIs prevention as compared to their counterparts (AOR: 2.820, 95% CI: (1.392, 9.590), P = 0.004) (Table 7).

Table 7: Bivariate and multivariate analysis Knowledge of HCWs towards prevention of CLABSIs at cardiac centers in Addis Ababa, Ethiopia, 2024 (n = 400).

Variable	Knowledge status		COR(95% CI)	AOR (95% CI)	p-value
	Good n (%)	Poor n (%)			
Sex					
Male	197(49.2)	26(6.5)	1.609(0.916, 2.826)	1.114(0.601, 2.065)	0.731
Female	146(36.5)	31(7.8)	1	1	
Age category					
<30	99(24.8)	24(6.0)	1	1	
>30	244(61.0)	33(8.2)	1.792(1.008, 3.187)	0.992(0.512, 1.924)	0.982
Educational level					
Diploma	125(31.2)	16(4.0)	1	1	
Degree & above	249(62.3)	10(2.5)	2.526(1.431, 4.459)	2.086(1.127, 3.860)	0.019
Work experience					
< 5 years	164(41.0)	40(10.0)	1	1	
>5 years	179(44.8)	17(4.2)	2.568(1.401, 4.706)	1.522(0.757, 3.059)	0.238
Participating in peer education program					
Yes	205(51.2)	11(2.3)	1.654(0.740, 3.697)	2.365(1.274, 5.713)	0.006
No	169 (42.2)	15(3.8)	1	1	
Having training					
Yes	196(49.0)	20(5.0)	2.467(1.375, 4.425)	2.820(1.392, 9.590)	0.004
No	147(36.7)	37(9.3)	1	1	

Factors associated with healthcare workers' practice towards prevention of CLABSIs

Bivariate analysis was conducted to identify factors associated with healthcare workers' practice of CLABSIs. Sex of respondents, age category, educational level, work experience, participation in peer education programs, and training regarding infection prevention on CLABSIs were found to have p < 0.25 and entered into multivariable analysis. Then, multivariable binary logistic regression analysis was performed to examine the effect of each predictor variable on healthcare workers' practice toward the prevention of central venous line-associated bloodstream infections. Sex of respondents, work experience, and having training on CLABSI prevention were significantly associated factors with health care workers' practice towards prevention of CLABSIs.

The odds of having good practice of health care workers towards CLABSIs in the study were two times higher among males as compared to females (AOR: 2.059, 95% CI: (1.223, 3.467), P = 0.007). Additionally, the odds of having good practice towards prevention of CLABSIs by health care workers were two times higher among health care workers having more than five years of work experience as compared to those who had five years and below work experience (AOR: 2.073, 95% CI: 1.149, 3.739, P = 0.016). Finally, the odds of having good practice towards prevention of CLABSIs by health care workers in the study were eight times higher among health care workers' having training on CLABSIs prevention as compared to their counterparts (AOR: 3.857, 95% CI (2.180, 6.826), P = 0.000) (Table 8).

Table 8. Bivariate and multivariate analysis practice of HCWs towards prevention of CLABSIs at cardiac centers in Addis Ababa, Ethiopia, 2024 (n = 400)

Variable	Practice status		COR(95% CI)	AOR(95% CI)	P-value
	Good n (%)	Poor n (%)			
Sex					
Male	186(46.5)	37(9.3)	3.212(2.018, 5.110)	2.059(1.223, 3.467)	0.007
Female	108(37.0)	69(17.2)	1	1	
Age category					
<30	67(16.7)	56(14.0)	1	1	
>30	227(56.8)	50(12.5)	3.795(2.375, 6.064)	1.727(0.992, 3.004)	0.053
Educational status					

Diploma	90(22.5)	51(12.8)	1	1	
Degree & above	204(51.0)	55(13.7)	2.102(1.334, 3.312)	1.432(0.844, 2.431)	0.183
Work experience					
< 5 years	123(30.8)	81(20.3)	1	1	
>5 years	171(42.6)	25(6.3)	4.504(2.719, 7.462)	2.073(1.149, 3.739)	0.016
Participating in peer education program					
Yes	169(42.3)	47(11.7)	1.697(1.085, 2.655)	1.499(0.896, 2.509)	0.123
No	125(31.2)	59(14.8)	1	1	
Having training					
Yes	200(50.0)	24(6.0)	7.270(4.336, 12.187)	3.857(2.180, 6.826)	0.000
No	94(23.5)	82(20.5)	1	1	

Discussion

Health care workers' Knowledge towards Prevention of CLABSIs

The study showed that 85.8% (95% CI: 82.38%, 89.22%) of the study participants had good knowledge towards prevention of CLABSIs. This was in line with a study conducted in Debre Markos (84.7%) and Dessie (86.4%) [21, 22]. This level of knowledge was lower than a study conducted in Malaysia (94.2%) and Gonder (90%) [23, 24]. The possible explanation for this difference might be due to differences in sampling procedure, sample size, study period, and study population.

This level of knowledge was higher than a study conducted in Saudi Arabia (71%), Italy (43% to 72.9%) (26), Nigeria (64.4%), Alexandria (20.6%), Axum Saint Mary Hospital (52.5%), Northeast Ethiopia (70.8%), Northwest Ethiopia (40.3%), Southern Ethiopia (45.5%), and Arsi (53.7%). This might be due to the difference in study period, sample size, and socio-demographic characteristics with other European and African countries [25-33].

Educational level was significantly associated with HCWs knowledge towards prevention of CLABSIs. Those HCWs who have a bachelor's degree or higher had two times higher odds of good knowledge as compared to those having a diploma educational level. This was supported by a study conducted in Debre Markos, and Southern Ethiopia [21, 32]. This might be due to the fact that being at higher education level enables the HCWs to improve their capability of reading and understanding.

Participating in peer education programs is important in increasing knowledge of HCWs' towards prevention of CLABSIs. In this study, the odds of good knowledge towards the prevention of CLABSIs were two times higher among HCWs who participated in peer education programs as compared to those who didn't. This could be because experience sharing is vital in improving the knowledge of HCWs.

On-the-job training is important to refresh HCWs motivation to work and close the knowledge gap. Training on CLABSIs prevention was significantly associated with knowledge HCWs had towards the prevention of CLABSIs. Those HCWs who got training on prevention of CLABSIs had three times higher odds of good knowledge than those who didn't have training. This was supported by a study conducted in Axum Saint Mary Hospital, Southern Ethiopia, Northeast Ethiopia, and Northwest Ethiopia. This might be due to the fact that training improves knowledge

and gives new insight for the participants [29-32].

Health care workers' Practice towards Prevention of CLABSIs

This study revealed that the magnitude of good practice towards prevention of CLABSIs was 73.5% (95% CI: 69.17%, 77.83%). The level of good practice in this study is lower than studies done in Malaysia (88.4%) [23]. The discrepancy might be due to a difference in knowledge towards infection prevention, methodological, sample size, socio-demographic differences between Malaysia and Ethiopia. In addition, it could be due to a lack of in-service training and infection prevention supply and professionals' non-adherence to infection prevention.

The level of good practice in this study is greater than studies done in: Saudi Arabia (65%), Nigeria (27.5%), Alexandria (44%), Axum Saint Mary Hospital (48.6%), Northeast Ethiopia (55%), Debre Markos (57.3%), Southern Ethiopia (64.8%), Gonder (36%), Dessie (23%), Arsi (36.3%) and Northwest Ethiopia (48.75%). The possible reason for this discrepancy could be due to sample size differences in Nigeria, Alexandria, Axum, Gonder and Dessie where these studies conducted with smaller sample sizes than this study. Additionally, study period differences could have contributed to the discrepancy [21, 22, 24, 25, 27-33].

In this study, the odds of good practice towards prevention of CLABSIs among males were two times higher as compared to females. This finding is supported with studies done in Ghana [34]. The odds of having good practice about prevention of CLABSIs by HCWs in the study were two times higher among health care workers' having more than five years of work experience as compared to those who had five years and below work experience. This finding is supported with studies done in Axum Saint Mary Hospital and Debre Markos [21, 29]. The possible reason could be that as the work experience year increases, HCWs will improve their practice through time. Additionally, HCWs with more prolonged exposure to patient care have a greater chance to learn how to prevent CLABSIs from their own mistakes and their colleague's experience.

Finally, in this study, HCWs who had taken training on CLABSIs prevention were four times more likely to have good practice towards the prevention of CLABSIs as compared to their counterparts. This finding is supported with studies done in Northeast Ethiopia and Arsi [30, 33]. The possible reason could be the fact that training on current guidelines could upgrade

the knowledge and skill of HCWs in that they would easily understand basic principles standards of practice and implement them consistently. In addition, up-to-date knowledge and skill regarding infection prevention could also increase the confidence of HCWs in complying with recommended guidelines and the available supply.

Limitations of the Study

This study has several limitations. Reliance on questionnaires for assessing knowledge and practice can be susceptible to recall bias and social desirability bias. Healthcare workers might overestimate their knowledge or underreport practices they perceive as negative. Since there was limited observation of practice, the questionnaire might not capture the actual practice of healthcare workers in real-world clinical settings. Direct observation of practices would provide a more accurate assessment but can be challenging to implement. The study might not comprehensively assess all relevant contextual factors that influence HCWs' behavior, such as workload, staffing levels, and organizational culture. As the study used a cross-sectional study design, it is difficult to relate the temporal relationship. It also has a short duration of study.

Conclusion

In this study, more than three-fourths of health care workers in cardiac centers in Addis Ababa had good knowledge towards the prevention of CLABSIs. Furthermore, approximately three-fourths of health care workers in cardiac centers in Addis Ababa had good practice towards the prevention of CLABSIs. Educational level, participation in peer education programs, and training on CLABSI prevention were factors associated with knowledge towards the prevention of CLABSIs. Additionally, sex, work experience, and training on CLABSIs prevention were factors associated with practice towards prevention of training on CLABSIs prevention.

Cardiac centers should give mandatory and regularly updated training on CLABSIs prevention for all HCWs involved in patient care, particularly those working in high-risk units (e.g., ICU, surgery). They should also integrate CLABSIs prevention training and peer education into existing professional development programs for new hires and continuing education initiatives. In addition, they should utilize multiple training modalities (e.g., online modules, workshops, simulations, case studies) to cater to different learning styles and ensure knowledge retention.

Furthermore, implementing peer education programs through training peer educators and establishing a peer education network is recommended. Finally, implementing structured mentorship programs that pair experienced HCWs with newer colleagues and offering opportunities for skill development and training that are tailored to different levels of work experience are recommended.

Healthcare professionals should actively participate in CLABSIs prevention training and utilize the knowledge gained in their daily practice. Additionally, they should embrace continuous learning and advocate for the implementation of best practices and protocols related to CLABSIs prevention within their teams and departments. Furthermore, they should foster collaboration and communication between different HCWs involved in patient care to ensure consistent adherence to CLABSIs prevention strategies.

Educational institutions should integrate CLABSIs prevention education into nursing, medical, and other healthcare professional curricula. In addition, they should consider developing specialized training programs focused on CLABSIs prevention for HCWs. Moreover, they should collaborate with healthcare organizations to provide practical training experiences and opportunities for students to apply their knowledge in real-world settings.

Declarations

Consent to publication

Not applicable

Availability of data and materials

All necessary materials used and/or analyzed during the current study were included in the manuscript.

Competing Interest

The authors declare that they have no competing interests.

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Authors' contributions

AWG: conception, design, acquisition, data collection, analysis and interpretation of the data, and drafting of the manuscript. ADW critically reviewed the study design, analysis, write-up of the report, and interpretation and drafted the manuscript. Both authors read and approved the final manuscript.

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