ORIGINAL RESEARCH article

Assessment of staff knowledge level and evaluation of medical staff for the prevention of central-line-associated bloodstream infections

Soad S. Hashad [1, 2] *, **Hala M. Etayari** [2], and **Esam M. Mejrab** [1]

[1] Tripoli Children's Teaching Hospital, Ministry of Health, Tripoli, Libya
[2] Department of Pediatrics, Faculty of Medicine, University of Tripoli, Tripoli, Libya
* Author to whom correspondence should be addressed

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Abstract: Although most of the central line-associated bloodstream infections can be prevented by following evidence-based recommendations, the extent to which these guidelines are followed in Libyan hospitals and their intensive care units remains unclear. This cross-sectional study aims to evaluate medical staff's behavior, knowledge, and attitudes toward the prevention of central line-associated bloodstream infections. A standardized structural questionnaire (The CLABSI TAP Facility Assessment Tool V4.0 - last updated May 2022) was distributed to healthcare providers working at Tripoli Children's Teaching Hospital from March 2024 to June 2024. The questionnaire collected data on demographic and occupational traits as well as awareness of evidence-based strategies for CLABSI prevention. 49 staff physicians and nurses from Tripoli Children's Teaching Hospital were chosen using an easy sampling technique. Most participants showed good knowledge about central line insertion sites and techniques, but there is a considerable gap in adherence to established safety practices. Several expressed dissatisfactions with current infection control measures, highlighting the critical need for enhanced training and stricter enforcement of guidelines.

Introduction

Evidence-based interventions, such as nursing bundles with education, staff commitment, and institutional commitment, have been shown to reduce the incidence of central line-associated bloodstream infections (CLABSIs), several groups have developed questionnaires to evaluate the familiarity of ICU nurses with the guidelines for reducing CLABSIs [1]. The use of suture-less securement devices, changing transparent dressings at least once every seven days, and maintaining a maximum sterile barrier precaution were among the recommendations made by guidelines that many pediatric ICU nurses in Australia and New Zealand did not adhere to. Increased knowledge of evidence-based recommendations was necessary [2]. Evidence-based policies and training can assist nurses in improving their understanding, application, and attitude toward reducing CLABSIs. CLABSIs, the majority related to the use of the central venous catheter (CVC), are the most important complications in critical care. Several worldwide organizations have released clinical practice guidelines for the prevention of CLABSIs, which often include specific procedures that health care professionals (HCWs) who insert and handle a CVC should take [3]. However, research from numerous nations has shown that ICU nurses do not always follow best practices recommended by organizations like the US CDC. It is essential to evaluate the nursing staff's familiarity with and adherence to national standards

for CLABSI prevention in order to pinpoint areas that require improvement. Then, targeted educational interventions can be put into place to boost compliance, lower the risk of CLABSI, and enhance patient outcomes [4].

A prospective study determined the clinical epidemiology and outcomes of nosocomial bloodstream infections caused by short- and mid-line peripheral venous catheters among a group of non-intensive care unit patients. There were forty-two cases of CVC-associated bloodstream infections (CA-BSIs), a gram-positive bacterium was recovered in 57.0%, gram-negative bacteria in 17.0%, and Candida spp. in 14.0% [5]. A study showed that antimicrobials have been incorporated into the bulk material of CVC or applied to their surfaces as a coating in an attempt to reduce the incidence of CVC colonization and infection, the study examines the effect of a silver zeolite-impregnated catheter on catheter-related colonization and infection in critical care patients, the overall colonization rate was significantly lower in the silver zeolite-impregnated CVC tips [6]. A risk factor for CVC-associated CRBSI is contamination of entry ports; thus, interventions reducing contamination could subsequently reduce rates of CRBSI. Patients in surgical ICUs require CVCs for drug administration and hemodynamic monitoring, which puts them at risk for CRBSI Published data reported that the incidence rate of CRBSI by the German National Reference Center for the Surveillance of Nosocomial Infections is 1.02 per 1000 catheter-days in surgical ICUs [7]. In Libya, few studies have been done on this subject. To evaluate occupational health professionals' knowledge, attitudes, and practice adherence to national evidence-based standards for reducing CLABSIs, this study looked at ICU staff in the largest children's hospital in Libya.

Materials and methods

Study design: This was a cross-sectional structural study conducted in the Tripoli Children's Teaching Hospital. A total of 49 participants completed the survey, working in the hospital; all participants were enrolled as medical staff working in the Pediatric Critical Care Unit (PICU).

Subjects: Participant selection criteria were: (1) medical staff working or used to work in a pediatric intensive care unit in the Tripoli Children's Teaching Hospital, where they use central venous catheters; (2) the medical staff participated in the maintenance of the central venous catheter. Data were collected and analyzed over a 3-month period from March to June 2024.

Ethical approval: The study protocol was reviewed and approved by the Libyan Medical Board and the Department of Pediatrics, Tripoli Children’s Teaching Hospital, Ministry of Health, Tripoli, Libya. All participants were informed about the objectives of the study, and written informed consent was obtained prior to participation. The study was conducted in accordance with the principles of the Declaration of Helsinki.

Selection and exclusion criteria: The inclusion criteria in this study for healthcare providers were: 1) registered medical staff, 2) full-time medical staff, and 3) at least one year of experience. Staff with less than one year of experience were excluded.

Statistical analysis: The questionnaire was designed to assess knowledge and practices related to central line care, based on internationally recognized infection-prevention strategies. It was adapted from the CDC Strategies for Prevention of CLABSIs, specifically the CLABSI Targeted Assessment for Prevention (TAP) Facility Assessment Tool, version 4.0 (May 2022), and translated or reworded for local clarity. For analysis, responses were recoded so that higher scores reflected better practice or knowledge (never: 1, rarely: 2, sometimes: 3, always: 4; Yes/No items: Yes: 4, No: 1). I don’t know responses were treated as missing values and excluded from internal-consistency calculations. Cronbach’s alpha was calculated for the complete set of items and for each subscale, with $\alpha \geq 0.70$ considered acceptable for group-level comparisons. Using the 49 fully completed questionnaires, the overall scale demonstrated acceptable reliability ($\alpha=0.782$).

Results

The current study presents the results with the highest level of evidence concerning measures implemented to prevent CLABSI among Libyan patients in TCTH. Data on demographic and occupational characteristics, as well as staff knowledge, were acquired using the questionnaire. Evidence-based research approaches for the study identified significant knowledge gaps among the Libyan participants. As shown in **Table 1**, based on the demographic data from the current poll, 53.1% of respondents were male and 46.9% were female. The participants' ages range from 20 to 50 years old. 12.2% of participants are nurses, and the majority of the participants were Libyan physicians (87.8%). The finding showed that the percentage of staff with experience between one and four years is 38.8%, five to nine years is 46.9%, while others have more than ten years of experience is 14.2% (**Figure 1**).

Table 1: Demographic data of the sample study

Demographic variable		Count	Percent
Gender	Male	26	53.1%
	Female	23	46.9%
Age	20-30 years	09	18.4%
	30-40 years	38	77.6%
	40-50 years	02	04.1%
Occupation	Physician	43	87.8%
	ICU nurse	06	12.2%
Years of experience	1-4 years	19	38.8%
	5-9 years	23	46.9%
	10- 14 years	06	12.2%
	15-19 years	01	02.0%

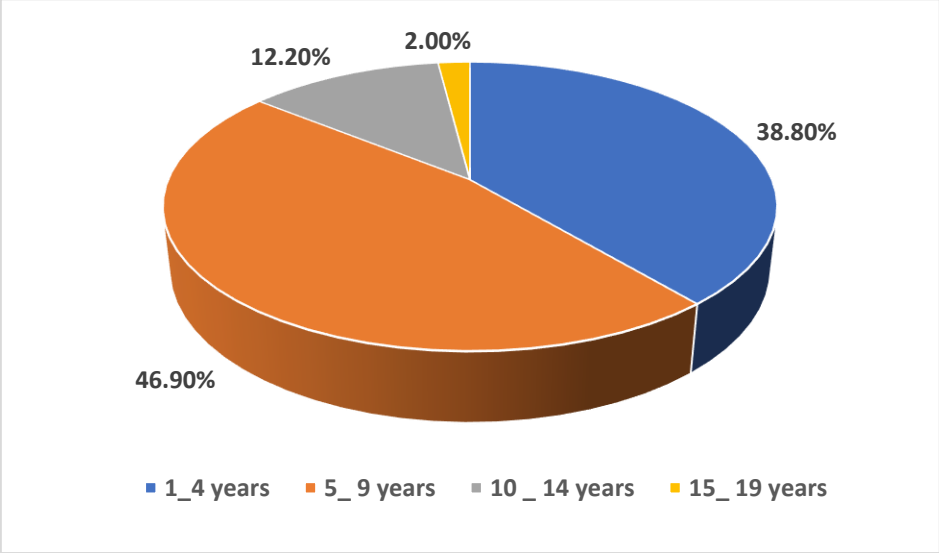


Figure 1: Duration of experience in years

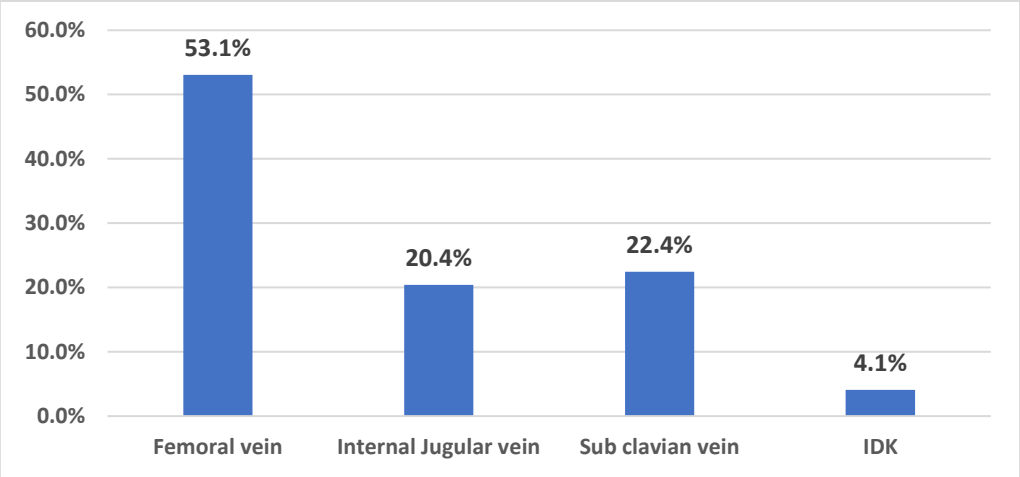
When a CLABSI happens, the healthcare institution uses an evaluation to find possible flaws and learn from them. The study's findings revealed that 42.9% of the respondents were not aware of an approach that the health institution employed to detect and learn from potential defects when a CLABSI occurred. This highlights the importance of training and infection control practices in healthcare settings, as well as the importance of hospital policies and awareness regarding central-line procedures. Similar findings were reported in about whether the femoral site is avoided or not. The finding revealed that 51.0% of the respondents were not avoiding the femoral site, as shown in **Table 2**.

Table 2: Importance of training and infection control practice

	Responses	Count	Percent
Does your facility conduct on assessment to identify and learn from potential defect when a CLABSI occurs?	Yes	15	30.6%
	No	21	42.9%
	IDK	13	26.5%
Does your facility routinely audit (monitor and document) adherence of all healthcare personal to site selection (avoidance of the femoral site)?	Yes	11	22.4%
	No	25	51.0%
	IDK	13	26.5%

In regard to the insertion sites, 98.0% of the participants knew the insertion sites; and showed that the most common places known to the medical staff for inserting central line are the femoral (53.1%) then subclavian and internal jugular, with a percentage (22.4% and 20.4%, respectively), as evidenced in the chart findings from the survey of responders.

Figure 2: Knowledge of risk of infection for the central line site



Regarding to the general infrastructure, the medical staff's knowledge about central line, the methods and locations of their insertion is one of the important things to reduce potential risks and reduce the incidence of CLABSI. The study shows that most of the participants have good information about central catheters, methods and knowledge of the locations of their insertion. Most of the healthcare providers were not satisfied with infection control, especially in the PICU (71.4%). Regarding the training courses, the vast majority (55.1%) have received training courses about prevention of CLABSI. 63.3% of the participants did not follow the written policy from the hospital regarding admission methods and prevention of CLABSI, as shown in **Table 3**. It's encouraging to see that most respondents are informed about central lines, but there's room for improvement in adhering to written policies for maintenance.

Table 3: Written policy from the hospital regarding admission methods and prevention of CLABSI

	Responses	Count	Percent
Do you have information about central line?	Yes	47	95.9%
	No	02	04.1%
Did you get proper training on the insertion of central-line?	Yes	39	79.6%
	No	10	20.4%
Do you get any training on the methods of prevention of (CLABSI)?	Yes	27	55.1%
	No	22	44.9%
Are you satisfied with infection control methods in the ICU?	Yes	14	28.6%
	No	35	71.4%
Do you follow a written policy of the hospital for central-line insertion maintenance?	Yes	18	36.7%
	No	31	63.3%

Central line placement under ultrasound guidance, use of sterile technique, and insertion by a trained individual help with more accurate placement of a central venous catheter while lowering the risk of associated complications. The presented data related to healthcare personnel practices during central line insertion from the point of view of the person who installs the central line and whether or not they had received the appropriate training. 55.0% of the respondents indicated that central-line insertions are sometimes done by trained personal, suggesting that there is room for improvement in ensuring consistent adherence to competency-based practices. A substantial proportion (69.0%) reported performing barrier precautions always, which is encouraging. But the fact that 40.8% of respondents reported sometimes maintaining aseptic technique during insertion is definitely concerning. About washing and sterilizing hands and maintaining sterilization during insertion answer was always as shown in **Table 4**, that concluded using a Likert scale. It is important to cover the wounds with sterile gauze to avoid infection. In this study, the results were that wounds were always covered with sterile gauze and changed if they were wet or contaminated. As for the answers about using standard sterilization barriers, the answers oscillated between always and sometimes and rarely, that also concluded using a Likert scale. The attitudes reflected in the table suggest a general adherence to safety protocols, but also highlight areas where compliance could be improved.

Table 4: Washing and sterilizing hands and maintaining sterilization during insertion

		Count	Percent	Mean	STD deviation	Attitude
Are central-line insertion only by trained personal who have demonstrated competency?	Never	01	02.0%	3.22	0.69	Sometimes
	Rarely	04	08.2%			
	Sometimes	27	55.1%			
	Always	17	34.7%			
Do healthcare personal perform hand hygiene before and after palpating central line insertion site?	Never	00	00.0%	3.65	0.56	Always
	Rarely	02	04.1%			
	Sometimes	13	26.5%			
	Always	34	69.4%			
Is aseptic technique maintained during central line insertion?	Never	00	00.0%	3.47	0.62	Always
	Rarely	03	06.1%			
	Sometimes	20	40.8%			
	Always	26	53.1%			

Central line placement under ultrasound guidance lowers the risk of associated complications. About using the ultrasound device during insertion, the answer of most of the participants was never, also they implied that sometimes the installation of the central line was stopped when it was difficult and unnecessary, but never installed without stitching as shown in **Tables 5** and **6**, that concluded using a Likert scale. The healthcare professionals should prioritize consistent use of ultrasound guidance, empower themselves to intervene when necessary, and consider adopting securement devices to enhance patient care during central line procedures.

Table 5: Adopting securement devices to enhance patient care during central line procedures

		Count	Percent	Mean	STD deviation	Attitude
Is ultrasound guidance used to reduce central line insertion attempts and mechanical complication?	Never	28	57.1%	1.51	0.65	Never
	Rarely	17	34.7%			
	Sometimes	04	08.2%			
	Always	00	00.0%			
Are healthcare personal empowered to stop non emergent central line insertion if proper procedures are not followed?	Never	02	04.1%	2.78	0.65	Sometimes
	Rarely	11	22.4%			
	Sometimes	32	65.3%			
	Always	04	08.2%			
Are suture-less securement device used to secure central line?	Never	32	65.3%	1.57	0.89	Never
	Rarely	08	16.3%			
	Sometimes	07	14.3%			
	Always	02	04.1%			

Table 6: Different methods for the prevention of infection in the central line

	Count	Frequency	Percent	Mean	STD. Deviation	Attitude
Are central line insertion site covered with either a sterile gauze or sterile transparent, semipermeable dressing?	Never	01	02.0%	3.49	0.77	Always
	Rarely	05	10.2%			
	Sometimes	12	24.5%			
	Always	31	63.3%			
Are dressing that are wet, soiled, or dislodged immediately replaced?	Never	02	04.1%	3.35	0.83	Always
	Rarely	05	10.2%			
	Sometimes	16	32.7%			
	Always	26	53.1%			
Cap	Never	21	42.9%	2.12	1.13	Rarely
	Rarely	08	16.3%			
	Sometimes	13	26.5%			
	Always	07	14.3%			
Mask	Never	04	08.2%	2.92	0.84	Sometimes
	Rarely	07	14.3%			
	Sometimes	27	55.1%			
	Always	11	22.4%			
Sterile gloves	Never	00	00.0%	3.94	0.24	Always
	Rarely	00	00.0%			
	Sometimes	03	06.1%			
	Always	46	93.9%			
Sterile gown	Never	01	2.0%	2.98	0.75	Sometimes
	Rarely	11	22.4%			
	Sometimes	25	51.0%			
	Always	12	24.5%			

While studying the relationship between the occupation and choosing the appropriate place to insert the catheter using Chi-square test, it was found that there is no relationship between them, p=0.873. But it turned out that there is a relationship between choosing the appropriate place and years of experience, as p<0.001.

Table 7: Occupation and of experience on the most recommended central line site to reduce risk of infection

	Most recommended central line site					
	Femoral vein	**Internal Jugular vein**	**Subclavian vein**	**IDK**	**Chi square**	***P* value**
Occupation						
Physician (%)	23 (53.5%)	09 (20.9%)	09 (20.9%)	02 (04.7%)	0.699	0.873
ICU nurse (%)	03 (50.0%)	01 (16.7%)	02 (33.3%)	00 (00.0%)		
Duration of experience						
1-4 years (%)	08 (42.1%)	05 (26.3%)	06 (31.6%)	0 (00.0%)	28.926	0.001
5-9 years (%)	14 (60.9%)	05 (21.7%)	03 (13.0%)	01 (04.3%)		
10-14 years (%)	04 (66.7%)	00 (0.00%)	02 (33.3 %)	00 (00.0%)		
15-19 years (%)	00 (00.0%)	00 (00.0%)	00 (00.0%)	01(100%)		

While studying the relationship using the Chi-square test between years of experience and some important questions to evaluate the knowledge of the medical staff. It was found that there was a relationship between years of experience and training in prevention methods, where the p=0.04. But there is no strong evidence to conclude that experience level has a clear impact on the practices measured, such as hand hygiene, aseptic technique, dressing replacement, and use of sterile gloves, as the p>0.05. This could mean that more experienced staff have a better understanding or preference based on their years in the field, which influences their choice of central line site for reducing infection risk.

Table 8: Knowledge and the duration of experience of central line infection

	Duration of experience					
	1-4 years (%)	5-9 years (%)	10-14 years (%)	15-19 years (%)	Chi square	*P* value
Did you get proper training on the insertion of central-line						
Yes	13 (33.3%)	19 (48.7%)	06 (15.4%)	01 (03.7%)	3.383	0.336
No	06 (60.0%)	04 (40.0%)	00 (00.0%)	00 (00.0%)		
Do you get any training on the methods of prevention of CLABSI						
Yes	07 (25.9%)	13 (48.1%)	06 (22.2%)	01 (02.6%)	8.283*	0.04
No	12 (54.5%)	10 (45.5%)	00 (00.0%)	00 (00.0%)		
Do you follow a written policy of the hospital for central-line insertion maintenance						
Yes	06 (33.3%)	07 (38.9%)	05 (27.8%)	00 (00.0%)	6.797	0.079
No	13 (41.9%)	16 (51.6%)	01 (03.2%)	01 (03.2%)		
Does your facility conduct on assessment to identify and learn from potential defect when a CLABSI occurs?						
yes	08 (53.3%)	04 (26.7%)	03 (20.0%)	00 (00.0%)	6.820	0.338
No	08 (38.1%)	11 (52.4%)	01 (04.8%)	01 (04.8%)		
IDK	03 (23.1%)	08 (61.5%)	02 (15.4%)	00 (00.0%)		
Does your facility routinely audit (monitor and document) adherence of all healthcare personal to site selection (avoidance of the femoral site)?						
Yes	07 (63.6%)	02 (18.2%)	02 (18.2%)	00 (00.0%)	7.447	0.281
No	09 (36.0%)	12 (48.0%)	03 (12.0%)	01 (04.0%)		
IDK	03 (23.1%)	89 (69.2%)	01 (07.7%)	00 (00.0%)		

Table 9: Practice and the duration of experience of central line infection

	Duration of experience					
	1-4 years (%)	5-9 years (%)	10 -14 years (%)	15-19 years (%)	Chi square	P value
Do healthcare personal perform hand hygiene before and after palpating central line insertion site						
Rarely	00 (0.0%)	01 (50.0%)	01 (50.0%)	00 (00.0%)	4.634	0.592
Sometimes	04 (30.8%)	07 (53.8%)	02 (15.4%)	00 (00.0%)		
Always	19 (38.8%)	23 (46.9%)	06 (12.2%)	01 (02.0%)		
Is aseptic technique maintained during central line insertion						
Rarely	01 (33.3%)	01 (33.3%)	01 (33.3%)	00 (00.0%)	2.850	0.827
Sometimes	08 (40.0%)	09 (45.0%)	02 (10.0%)	01 (05.0%)		
Always	10 (38.5%)	13(50.0%)	03 (11.5%)	00 (00.0%)		
Are dressing that are wet, soiled, or dislodged immediately replaced						
Never	01 (50.0%)	01 (50.0%)	00 (0.0%)	00 (00.0%)	5.480	0.791
Rarely	01 (20.0%)	02 (40.0%)	02 (40.0%)	00 (00.0%)		
Sometimes	07 (43.8%)	07 (43.8%)	02 (12.5%)	00 (00.0%)		
Always	10 (38.5%)	13 (50.0%)	02 (07.7%)	01 (03.8%)		
Sterile gloves						
Sometimes	02 (66.7%)	01 (33.3%)	00 (00.0%)	00 (00.0%)	1.224	0.747
Always	17 (37.7%)	22 (47.8%)	06 (12.2%)	01 (02.0%)		

Discussion

The current survey at Tripoli Children's Teaching Hospital highlights a pronounced gap between what staff know and what they actually do when it comes to preventing CLABSIs. Although almost all of the respondents correctly identified appropriate central line insertion sites, more than a quarter reported adhering to a formal catheter maintenance policy, and a quarter routinely avoided the femoral site despite its known infection risk. A similar finding was described in Australia and New Zealand, where less than half of the participants consistently applied maximal sterile barrier precautions even though most understood the guidelines [3]. Strong theoretical understanding does not automatically translate into consistent bedside practice. More than a quarter of staff use transparent dressings and suture-less securement devices interventions that have been shown to reduce catheter-related infections by a third in pediatric populations [6]. Compared to Saudi Arabia, where the use of transparent dressing was observed in all of the patients [8], another study has shown a rigorous

scrubbing of the hub protocols can lower CLABSI incidence by a quarter in neonatal and pediatric wards [9]. A study in the UK evaluated silver zeolite impregnated catheters in critical care and found infection rates lower than with standard lines; although their focus was on antimicrobial catheters rather than securement devices, the principle is the same: adjunctive technologies can markedly decrease CLABSI rates when adopted [6, 10]. Underuse of these devices suggests that, even when supportive evidence exists, resource constraints or gaps in supply chains can impede uptake. Half of the respondents never used real-time ultrasound guidance when placing central lines. In Brazil, less than half of CVCs were inserted under ultrasound guidance [11]. In a single-center study done in Turkey, all ICU patient who had a central line inserted using an ultrasound guide had a complete success rate [12]. A Greek study demonstrated that ultrasound guidance in critical care patients halved mechanical complication rates and reduced the number of insertion attempts [7]. Thus, routine adoption of ultrasound not only improves procedural success but likely decreases CLABSI risk by minimizing multiple passes and inadvertent vascular trauma. The stark difference between the European high-resource setting and TCTH highlights how limited equipment access and inadequate training can be a barrier to best practice. Two-thirds of TCTH staff reported receiving general training on line insertion, and half completed structured CLABSI-prevention modules. In other low resources countries researchers found that healthcare workers often rely predominantly on informal, on-the-job training and have scant access to up-to-date learning materials [13]. This reliance on learn-as-you-go perpetuates outdated techniques and reduces awareness of evolving guidelines. In Cyprus and Canada, systematic educational programs incorporating hands-on sessions and regular feedback led to sustained reductions in CLABSI rates over 12 months [14]. Such data underscore the importance of implementing robust, ongoing training curricula tailored to TCTH's pediatric context. Some respondents felt empowered to stop a nonemergent central line insertion if sterile technique was compromised. Research in the USA emphasized that a key tenet of CLABSI prevention is a stop-the-line policy where any team member may interrupt a procedure at the first sign of protocol deviation [15, 16]. In institutions without explicit authority structures, minor lapses in aseptic technique can become normalized. In Michigan ICUs, empowering nurses and physicians to call for an immediate pause to address deviations reduced CLABSI rates [17, 18]. Thus, cultivating a nonpunitive, collective responsibility culture is essential to bridge the gap between knowledge and action. >90.0% of the staff reported always using sterile gloves, and 63.3% maintained a sterile dressing during line maintenance. These high compliance figures echo the general attitude reported by European studies which suggests that even in resource-strapped environments, staff recognize the importance of fundamental infection control behaviors. In China, 43.0% of nurses reported always using maximum barrier precautions [19], while in Jeddah, 5.0% reported complete adherence to evidence-based practices for preventing CLABSIs [20]. Nonetheless, our data reveal that compliance always drops when considering more complex interventions such as ultrasound use indicating that knowledge alone is insufficient without institutional support and accessible resources. 71.4% of respondents expressed dissatisfaction with current infection-control measures, and 63.3% admitted to not following written policies for line maintenance. The rate of CLABSI was the lowest in Jordan hospitals that applied the CVC bundle of care as nurses' knowledge about CLABSI prevention practices was correlated with their compliance CVC maintenance care bundle [11]. The current data is explained by studies done in low resources countries like Ethiopia which described how-resource limitations ranging from lack of readily available chlorhexidine dressings to intermittent power supply hamper adherence to recommended bundles [13].

Conclusion: This study underscores a critical challenge at Tripoli Children's Teaching Hospital, where healthcare providers possess foundational knowledge of CLABSI prevention, significant gaps persist in translating this knowledge into consistent clinical practice. Despite the staff correctly identifying insertion sites and reporting familiarity with central line protocols, adherence to evidence-based practices remains low. These gaps mirror challenges observed in resource-limited settings globally, where systemic barriers as inconsistent training, limited access to technology, and weak enforcement of safety protocols, hinder progress.

References

1. Perin DC, Erdmann AL, Higashi GD, Dal Sasso GT. Evidence-based measures to prevent central line-associated bloodstream infections: a systematic review. Revista Latino-Americana de Enfermagem. 2016; 24: e2787. doi: 10.1590/1518-8345.1233.2787
2. Ullman AJ, Long DA, Rickard CM. Prevention of central venous catheter infections: a survey of paediatric ICU nurses' knowledge and practice. Nurses Education Today. 2014; 34: 202-207. doi: 10.1016/j.nedt.2013.09.002
3. Bianco A, Coscarelli P, Nobile CGA, Pileggi C, Pavia M. The reduction of risk in central line-associated bloodstream infections: Knowledge, attitudes, and evidence-based practices in health care workers. The American Journal of Infection Control. 2013; 41(2): 107-112. doi: 10.1016/j.ajic.2012.02.038
4. Dedunska K, Dyk D. No Prevention of central venous catheter-associated bloodstream infections: a questionnaire evaluating the knowledge of the selected 11 evidence-based guidelines by Polish nurses. American Journal of Infection Control. 2015; 43(12): 1368-13671. doi: 10.1016/j.ajic.2015.07.022
5. Pujol M, Hornero A, Saballs M, Argerich MJ, Verdaguer R, Cisnal M, Peña C, Ariza J, Gudiol F. Clinical epidemiology and outcomes of peripheral venous catheter-related bloodstream infections at a university-affiliated hospital. The Journal of Hospital Infection. 2007; 67(1): 22-29. doi: 10.1016/j.jhin.2007.06.017
6. Khare MD, Bukhari SS, Swann A, Spiers P, McLaren I, Myers J. Reduction of catheter-related colonization by the use of a silver zeolite-impregnated central vascular catheter in adult critical care. Journal of Infection. 2007; 54(2): 146-150. doi: 10.1016/j.jinf.2006.03.002
7. Foka M, Nicolaou E, Kyprianou T, Palazis L, Kyranou M, Papathanassoglou E, Lambrinou E. Prevention of central line-associated bloodstream infections through educational interventions in adult intensive care units: A systematic review. Cureus. 2021; 13(8): 1729. doi: 10.7759/cureus.17293
8. Al-Abdely HM, Alshehri AD, Rosenthal VD, Mohammed YK, Banjar W, Orellano PW, et al. Prospective multicentre study in intensive care units in five cities from the Kingdom of Saudi Arabia: Impact of the International Nosocomial Infection Control Consortium (INICC) multidimensional approach on rates of central line-associated bloodstream infection. Journal of Infection Prevention. 2016; 18(1): 25-34. doi: 10.1177/1757177416669424
9. Woeltje KF, McMullen KM, Butler AM, Goris AJ, Doherty JA. Electronic surveillance for healthcare-associated central line-associated bloodstream infections outside the intensive care unit. Infection Control and Hospital Epidemiology. 2011; 32: 1086-1090. doi:10.1086/662181
10. Nguyen H-P, Ha V-T, Tran T-V-A, Ha H-A. Antibiotic stewardship in a Vietnamese public security hospital: Addressing antimicrobial resistance challenges through the AWaRe framework. Mediterranean Journal of Pharmacy and Pharmaceutical Sciences. 2025; 5(3): 19-27. doi: 10.5281/zenodo.15870874
11. Marques M, Cesar R. Ultrasound-guided central venous catheterization: A protocol to be followed in pediatrics? Open Journal of Pediatrics. 2017; 7: 128-139. doi: 10.4236/ojped.2017.73016
12. Karakitsos D, Labropoulos N, De Groot E, Patrianakos AP, Kouraklis G, Poularas J, et al. Real-time ultrasound-guided catheterization of the internal jugular vein: A prospective comparison with the landmark technique in critical care patients. Critical Care. 2006; 10(6): e162. doi: 10.1186/cc5101
13. Andualem M, Kebede G, Kumie A. Information needs and seeking behavior among health professionals working at public hospital and health centres in Bahir Dar, Ethiopia. BMC Health Services Research. 2013; 13: 534. doi: 10.1186/1472-6963-13-534
14. Chi X, Guo J, Niu X, He R, Wu L, Xu H. Prevention of central line-associated bloodstream infections: a survey of ICU nurses' knowledge and practice in China. Antimicrobial Resistance and Infection Control. 2020; 9(1): 186. doi: 10.1186/s13756-020-00833-3
15. O'Grady NP, Alexander M, Dellinger EP, Gerberding JL, Heard SO, Maki DG, et al. Guidelines for the prevention of intravascular catheter-related infections. Morbidity and Mortality Weekly Report. Recommendations and Reports. 2002; 51: 1-29. doi: Nil.
16. Pronovost PJ, Watson SR, Goeschel CA, Hyzy RC, Berenholtz SM. Sustaining reductions in central line-associated bloodstream infections in Michigan intensive care units: A 10-year analysis. American Journal of Medical Quality. 2016; 31: 197-202. doi: 10.1177/1062860614568647
17. Pronovost PJ, Watson SR, Goeschel CA, Hyzy RC, Berenholtz SM. Sustaining reductions in central line-associated bloodstream infections in Michigan intensive care units: A 10-year analysis. American Journal of Medical Quality. 2016; 31: 197-202. doi: 10.1177/1062860614568647
18. Giwa HB, Jamiu MO, Aiyelero OM, Abdul A, Giwa A, Eniayewu OI, Giwa FAS. Budget impact analysis of alternative strategies for initiating antiretroviral therapy in Nigeria. Mediterranean Journal of Pharmacy and Pharmaceutical Sciences. 2025; 5(4): 11-20. doi: 10.5281/zenodo.17307273
19. Almalki AI, Alghamdi HA, Tashkandy NA. Assessment of knowledge, attitude, and adherence to National Guidelines for Preventing Central Line-Associated Bloodstream Infections among ICU nurses of adult patients in Jeddah, Saudi Arabia: A cross-sectional survey. Cureus. 2023; 15(7): e42304. doi: 10.7759 cureus. 42304

20. Matlab AA, Al-Hussami MO, Alkaid Albqoor M. Knowledge and compliance to prevention of central line-associated blood stream infections among registered nurses in Jordan. Journal of Infection Prevention. 2022; 23(4): 133-141. doi: 10.1177/17571774211066778

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