INTENSIVE CARE NURSES' KNOWLEDGE, PRACTICE AND ATTITUDE IN PREVENTION OF CENTRAL LINE-ASSOCIATED BLOODSTREAM INFECTION (CLABSI)

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Abstract

Central line-associated bloodstream infections (CLABSI) are mainly preventable with evidence-based guidelines. However, it needs to be made clear how well these guidelines are followed in critical care units in Malaysia. Therefore, this study evaluates critical care nurses' knowledge, practices, and attitude toward evidence-based guidelines for preventing CLABSIs issued by the Centers for Disease Control and Prevention and the Malaysia Ministry of Health. This study aims to identify the level of knowledge, practice, and attitudes regarding preventing CLABSI among critical care nurses in a teaching hospital. A cross-sectional descriptive study was carried out among 203 nurses working in seven units consisting of the Intensive Care Unit (ICU), Coronary Care Unit (CCU), Intermediate Dependency care Unit (IDCU), Neonatal Intensive Care Unit (NICU), Neurosurgery Intensive Care Unit (Neuro ICU), Cardiac Intensive Care Unit (CICU), and Pediatric Intensive Care Unit (PICU) in University Malaya Medical Center in Kuala Lumpur. Nurses completed online questionnaires regarding their demographic characteristics, knowledge, practices, and attitudes toward evidence-based guidelines for preventing CLABSIs from December 2022 to January 2023. The data was analyzed using T-Test, ANOVA, and Fisher's Exact Test. 203 ICU nurses completed the questionnaire, and none correctly answered all the knowledge-related questions. The response rate of the correct answer regarding the knowledge question was only 49.7%. Mean scores for 11 questions regarding knowledge of evidence-based guidelines for preventing CLABSI were low, 5.85 (± 1.29). Meanwhile, individual total scores were significantly associated with time spent as a nurse in the ICU (2–4 years). The mean score for eight questions related to CLABSI prevention was 4.19 (± 0.50), which was acceptable for the compliance score. There was an association between nurses' gender (p-value: 0.01) and their duration of working experiences in the ICU (*p*-value: 0.04) with the practice regarding the prevention of CLABSI. The overall mean score for nurses' attitudes toward the guidelines was high; 8.63 (± 1.37). However, there was no association between the demographic characteristic and attitude regarding preventing CLABSI. The knowledge and practice of ICU nurses need to be improved. Regular training with the implementation of available guidelines and protocols was essential to improve the knowledge and compliance on preventing CLABSIs in ICUs

Keywords: Central Line-Associated Bloodstream Infections (CLABSI), Intensive CareNurses, Central Venous Catheter (CVC), Teaching Hospital

Introduction

The central venous catheter (CVC) is a catheter that is inserted into the vessel until the tip reaches a more prominent vein near the heart. It is commonly used in the intensive care unit for parenteral nutrition, medication or fluid infusions, withdrawal of blood, and hemodynamic monitoring. However, despite the benefits of CVC function, there is a risk of bacteria or viruses entering the bloodstream through the CVC and causing infections, which are known as central line-associated bloodstream infections (CLABSI). CLABSIs are among the healthcare-associated infections (HAI) that contribute to the worst adverse events; they may cause a severe infection, leading to a prolonged hospital stay, increased hospital costs, and a higher mortality risk (1, 2).

Approximately 250,000 bloodstream infections occur annually throughout the world. The International Nosocomial Infection Control Consortium (INICC) surveillance study from January 2012 to December 2017

in 523 intensive care units (ICUs) in 45 countries from Latin America, Europe, Eastern Mediterranean, Southeast Asia, and Western Pacific reported that the CLABSI rate was 5.05 per 1000 CVC days (3). The rate was high, compared to the CLABSI rate in the United States which is estimated to be 0.8 per 1000 CVC days (4). Meanwhile, the CLABSI rate in Malaysia is reported to be 9.4 per 1000 CVC days (5), indicating that further attention is needed.

The Centers for Disease Control and Prevention (CDC) and the Ministry of Health (MOH) have outlined evidence-based guidelines for preventing CLABSI. Only through the best practices, protocols, checklists, and establishing a culture of patient safety in healthcare institutions, CLABSI can be reduced to zero (4).

It is essential to explore how ICU nurses contribute to preventing CLABSI, as the success of CLABSI prevention depends heavily on monitoring insertion processes and performing routine CVC maintenance (6). Establishing baseline data about nurses' levels of knowledge, practice, and attitudes will help to evaluate the effect of current educational methods and the need for further education and guide interventions for any potential CLABSI outbreaks in the future (7).

In addition, a comparison of these characteristics between critical care units will help to elucidate the possible effect of the variation in the settings where CVCs are used. The knowledge and participation of the nurses in the reduction strategies determined the practice of CLABSI prevention. Hence, adequate knowledge, good practice, and a positive attitude are required to deliver CVC care and maintenance to ensure good quality care and patient satisfaction (8).

Literature review

Six studies were used to assess nurses' knowledge, practices and attitudes towards CLABSI prevention. Two of these studies involved oncology nurses (8, 9), and two studies involved ICU nurses (10, 11). Meanwhile, one study utilized a comparative study between nurses and physicians in medical, surgical and cardiac ICU settings (12) and another study compared ICU nurses and hemodialysis nurses (13).

Studies show that oncology nurses in Jordan need more knowledge (9), as well as ICU nurses in China and Poland (10, 11). On the other hand, studies have found that nurses and physicians of medical, surgical and cardiac ICU settings in Riyadh are generally highly knowledgeable in CLABSI prevention (12); as well as outpatient oncology and chemotherapy nurses in 16 non-teaching and teaching public and private hospitals in southern Italy (8). Finally, in the Kingdom of Saudi Arabia, critical care nurses were found to have more knowledge than non-critical care nurses (13).

Nurses were found to rarely follow CLABSI prevention guidelines (10, 11). This result contradicts a study in Riyadh that found nurses had higher CLABSI prevention practices than physicians (12). In terms of practice areas, critical care nurses were found to have better CLABSI prevention than non-critical care nurses (13). Another factor found to be associated with prevention levels is education level, where nurses with a graduate degree are twice as likely to practice appropriately than those without a graduate degree (8).

In the context of attitude, a study showed that nurses with lower education and those who do not know CLABSI prevention guidelines were more likely to perceive the risk of transmitting an infection (8). A study also found that nurses from non-critical care units were more optimistic about CLABSI prevention than critical care nurses (13).

Materials and Methods

This cross-sectional study was conducted among ICU nurses at seven intensive care units in a teaching hospital. The online questionnaires these nurses completed were based on their demographic characteristics, knowledge, practices, and attitudes toward evidence-based guidelines for preventing CLABSIs, which started from December 2022 to January 2023.

The characteristics chosen were nurses directly involved in patient care with central venous catheters and nurses with more than a year of working experience in the ICU. All respondents voluntarily partook in the survey, and the questionnaire was collected anonymously. The Ethical Approval was gained from the institutional ethics committee, Medical Research and Ethics Committee (MREC) – UiTM Research Ethics Committee with the reference file of FERC/FSK/MR/2022/0317 and UM Research Ethics Committee with the reference file of MREC ID NO: 20222105-11596 and the respondents' consent. In addition, the written consent containing the required information for the study was collected before starting the data collection process. Then, the written consent was separated from the instruments used to maintain the confidentiality and anonymity of the study.

The questionnaire of the data collection instrument was adapted from the previous studies and was primarily based on guidelines issued by the Centers for Disease Control and Prevention (8, 9). The original questionnaire was translated back-to-back by the Malaysian Institute of Translation & Books (ITBM) translator. An ICU Consultant and a nurse expert in ICU validated it. It comprised four sections: demographic, knowledge, practice, and attitude. The overall Cronbach's alpha value for the survey's items was 0.7, indicating that the survey's internal consistency is adequate and good enough to be used in the current study.

Data analysis

All data were collected and gathered from the Microsoft excel then was entered, coded and analyzed using SPSS (Statistical Package for Social Science) Version 26. Descriptive statistics used to determine the mean, standard deviation, frequency and percentage; while to determine the significant association between demographic data and some variables with the knowledge and attitude towards

prevention of CLABSI, one-way ANOVA, T-test independent and Fisher Exact test were used.

Results

Demographic characteristics of respondents

The mean age of the respondent was 30.07 years old (± 6.10). The minimal age of the respondent was 22 years old, while the maximal age was 51 years old. More than half of the respondent was at the age of below 30 years old. Most of the respondents were female nurses (94.1%); who primarily worked as a nurse in charge (93.1%); with a diploma as their education background (93.1%).

The most significant number of nurses participating in this study were from CCU (24.6%), followed by the NICU nurses (21.2%). Most nurses had 5 to 10 years of service as a nurse (40.9%), followed by 31.0% of whom had more than ten years of service. There was nearly a parallel with their year of service as intensive care unit nurses (Table 1).

Table 1: Demographic characteristics of the respondents

Variables	Percentage (%)	Percentage (%)
Age (years-old)		
Mean: 30.07 (± 6.10)		
Minimal Age: 22 years old		
Maximum Age: 51 years old		
< 30	116	57.1
31-40	74	36.5
41-50	12	5.9
> 51	1	0.5
Gender		
Male	12	5.9
Female	191	94.1
Working Area		
ICU	26	12.8
CCU	50	24.6
IDCU	17	8.4
NICU	43	21.2
Neuro ICU	18	8.9
CICU	12	5.9
PICU	37	18.2
Nurse Level		
Nurse In charge	189	93.1
Link Nurse	11	5.4
Champion Nurse	3	1.5
Level of education		
Diploma	189	93.1
Degree	5	2.5
Master	1	0.5
Others	8	3.9
Working Experiences (Nurse) Mean: 8.42 ± 5.63		
< 2 years	29	14.3
2-4 years	28	13.8
5-10 years	83	40.9
> 10 years	63	31
Working Experiences (ICU) Mean: 7.59 ± 5.59		
< 2 years	41	20.2
2-4 years	29	14.3
5-10 years	82	40.4
> 10 years	51	25.1

ICU Nurses' Knowledge Regarding Prevention of CLABSI

Their knowledge was assessed by using 11 multiple-choice questions. Respondents should choose the best answer for each question according to their level of understanding. A correct answer was given one point; nonetheless, an incorrect answer was given zero points. Correct answers ranged from 17.7% to 89.2%. The overall mean knowledge was 5.85 (± 1.29), indicating that the nurses' knowledge of preventing her CLABSI was adequate in this ICU. None of the nurses answered all questions correctly throughout the questionnaire. However, the correct answer rate for the entire questionnaire was 49.7% (Table 2).

Table 2: Responses to the 'Knowledge of CLABSI Prevention Questionnaire

	Question	Freq	%
1.	It is recommended to replace Central Venous Catheter (CVCs) routinely		
	a.Yes, every 7 days	109	53.7
	b.Yes, every 3 weeks	53	26.1
	c.No, only when indicated*	**40**	**19.7**
	d.I do not know	1	0.5
2.	In setting with a high rate of catheter-related infections it is recommended to use a CVC coated or impregnated with an antiseptic agent		
	a.Yes, in patient whose CVC is expected to remain in place for > 5 days*	**153**	**75.4**
	b.No, because the use of catheter is not cost effective	10	4.9

Table 2: Responses to the 'Knowledge of CLABSI Prevention Questionnaire (continued)

	Question	Freq	%
	c.No, because the use of such catheter does not result in a significant decrease in the rate of catheter-related infection	23	11.3
	d.I do not know	17	8.4
3.	It is recommended to change the dressing on the catheter insertion site		
	a.Every 2 days	30	14.8
	b.Every 7days	29	14.3
	c.When indicated (e.g., soiled, loosened) and at leastweekly*	**114**	**70.9**
	d.I do not know	0	0
4.	It is recommended to cover up the catheter insertion site with..		
	a.Polyurethane dressing (transparent, semipermeable)	145	71.4
	b.Gauze dressing	10	4.9
	c.Both are recommended because they not affect the risk for catheter-related infections*	**47**	**23.2**
	d.I do not know	1	0.5
5.	It is recommended to disinfect the catheter insertion site with…		
	a.70% alcohol	27	13.3
	b.2% chlorhexidine gluconate with alcohol*	**172**	**84.7**
	c.Povidone-iodine	3	1.5
	d.I do not know	1	0.5
6.	It is recommended to apply an antibiotic ointment at the insertion site with CVC		
	a.Yes, because it decreases the risk for catheter-related infection	66	32.5
	b.No, because it causes antibiotic resistance*	**36**	**17.7**
	c.No, because it does not decrease the risk for catheter-related infections	69	34.0
	d.I do not know	32	15.8
7.	When blood, blood products, or fat emulsions are administered through a CVC, it is recommended to replace the administrationset…		
	a.Within 24 h*	**171**	**84.2**
	b.Every 72 h	10	4.9
	c.Every 96 h	4	2.0
	d.I do not know	18	8.9
8.	When liquids other than blood, blood products, or fat emulsions are administered continuously the administration set should be replaced….		
	a.Within 24 h*	**105**	**51.7**
	b.Every 72 h	74	36.5
	c.Every 96 h	13	6.4
	d.I do not know	11	5.4
9.	It is recommended to use antiseptic agent to clean the access hubor connector before the connection of the administration set or after unscrewing the dead-end cap closes the catheter.		
	a.Yes, by spraying the access site with 70 % alcohol solution or alcohol chlorhexidine solution	16	7.9
	b.Yes, by wiping with 70 % alcohol solution or alcohol chlorhexidine solution for no less than 15 s*	**181**	**89.2**
	c.It is not recommended because no evidence has beenfound for the relation between the disinfections of the connecting site of administration set and the contamination of fluids or the insertion hub	2	1.0
	d.I do not know	4	2.0
10.	When manipulating the catheter insertion site and hubs, it is recommended…		
	a.To obviate hand hygiene if gloves are used and water for hand hygiene before manipulation	21	10.3
	b.To use clean or sterile gloves and alcohol solutions/antiseptic soap*	**173**	**85.2**
	c.Hand hygiene is only necessary before catheter insertion	6	3.0
	d.I do not know	3	1.5
11.	It is recommended to replace pressure transducers and tubing routinely…		
	a.Yes, every 4 days*	**57**	**28.1**
	b.Yes, every 7 days	81	39.9
	c.No, only when indicated	42	20.7
	d.I do not know	23	11.3
	Total correct answers		**49.7**

ICU nurses' practice regarding prevention of CLABSI

The practices were assessed using Likert's scale of never (1), rarely (2), sometimes (3), mostly (4), and always (5), in which the respondent must choose the best answer for each question according to their practices on prevention of CLABSI in their facility. The mean score for practices regarding the prevention of CLABSI was 4.19 (± 0.50), which indicates that ICU nurses primarily practice the prevention of CLABSI (Table 3).

Table 3: The ICU nurses practices regarding prevention of CLABSI

	How frequently are thesepractices used in your facility	Frequency / Percentage					Mean (SD)
		Never (1)	Rarely (2)	Sometimes (3)	Mostly (4)	Always (5)	
1	Maximum barrier precaution(cap, mask, sterile gown,sterile gloves, and sterile full body drape)	1 (0.5)	4 (2.0)	5 (2.5)	37 (18.2)	156 (76.8)	4.69 (0.67)
2	2% chlorhexidine gluconatefor antiseptic of the insertion site	8 (3.9)	8 (3.9)	7 (3.4)	28 (13.8)	152 (74.9)	4.52 (1.02)
3	Use of suture-less securement devices	34 (16.7)	35 (17.2)	63 (31.0)	40 (19.7)	31 (15.3)	3.00 (1.29)
4	Use of sterile, transparent,semi permeable dressing to cover catheter site	2 (1.0)	6 (3.0)	19 (9.4)	19 (9.4)	176 (86.7)	4.82 (0.52)
5	Transparent dressing replaced at least every 7 days	3 (1.5)	4 (2.0)	23 (11.3)	47 (23.2)	126 (62.1)	4.42 (0.88)
6	Administration sets replacedno more frequently than 96- h intervals, but at least every 7 days	14 (6.9)	17 (8.4)	33 (16.3)	66 (32.5)	73 (36.0)	3.82 (1.21)
7	Prompt removal of catheter when no longer essential	0	3 (1.5)	18 (8.9)	68 (33.5)	114 (56.2)	4.44 (0.72)
8	Routine catheter changes even if there is no suspicion of a CLABSI	7 (3.4)	18 (8.9)	47 (22.7)	67 (33.0)	65 (32.0)	3.81 (1.09)

The application of sterile, transparent, semi-permeable overlaying the catheter site and the application of the maximal barrier precaution was the best practices for preventing CLABSI among the nurses in this study (cap, mask, sterile gown, sterile gloves, and a sterile full body drape).

ICU nurses' attitude regarding prevention of CLABSI

The attitude was assessed using three questions regarding their attitude towards the use of the CLABSI prevention guidelines; their perceived risk of transmitting CLABSI during handling the Central Venous Catheter (CVC); and their rate towards the utility of hand hygiene before and after the replacement of the dressing to reduce CLABSI. A scale of one to ten was given for each of the questions. The mean score for the attitude regarding the prevention of CLABSI was 8.63 (± 1.37), showing that the nurses' attitude toward CLABSI prevention was good.

This current study revealed that the response on how practical the CLABSI prevention guidelines was 9.28 (± 1.31). The mean score for the question regarding the perceived risk of transmitting CLABSI when handling the Central Venous Catheter (CVC) was 7.21 (± 2.68). Overall, they rated the utility of hand hygiene before and after dressing replacement to reduce CLABSI as 9.40 (± 1.33). The attitude regarding preventing CLABSI among the ICU nurses was good (Table 4).

Table 4: The attitudes toward CLABSI prevention guidelines

Variables	Mean	SD
How useful do you think the CLABSI preventionguidelines are	9.28	1.31
How do you perceive your risk of transmitting CLABSI when handling the Central Venous Catheter(CVC)	7.21	2.68
How would you rate the utility of hand hygienebefore and after the replacement of the dressing to reduce CLABSI	9.40	1.33

The scoring for three questions regarding attitudes toward CLABSI Prevention Guidelines by using a three-point Likert-

type scale with the option for "agree," "not sure," and "disagree" is shown (Table 5). Most respondents agreed that monitoring the catheter site visually or by palpation through an intact dressing regularly (n = 185; 91.1%). Additionally, more than half of the respondents agreed that drying the antiseptic at the CVC insertion site prior to catheter insertion and wearing gloves before accessing the injection port eliminated the need for hand washing (n = 132; 65.0%) (Table 5).

Table 5: The attitudes toward CLABSI prevention guidelines

CLABSI prevention:	Agree (3)	Not Sure (2)	Disagree (1)
Monitor the catheter site visually or by palpation through an intact dressing on a regular basis	185 (91.1)	16 (7.9)	2 (1.0)
Allow the antiseptic on the insertion site to dry before catheter insertion	132 (65.0)	9 (4.4)	62 (30.5)
The use of gloves before infusion port accessreplaces the need for hand washing	132 (65.0)	9 (4.4)	62 (30.5)

The comparison of knowledge of CLABSI prevention with the characteristic of the respondents

There was no significant difference between the respondents' age (F: 0.31; p-value: 0.82), gender (t: -0.73; p-value:0.47), nurses' job title (F: 0.45; p-value: 0.64), their working area (F: 0.39; p-value: 0.88), the nurses level of the job description (F: 2.15; p-value: 0.12), level of education (F: 0.88; p-value: 0.45), their working experiences at the current area (F: 2.19; p-value: 0.09); and their intensive care training (t: 1.65; p-value: 0.10). However, there was a significant difference between the respondents' working experiences as a nurse with the knowledge of CLABSI prevention (F: 3.62; p-value: 0.01). The nurses who had worked as nurses for two to four years were reported to have more knowledge regarding CLABSI prevention (Table 6).

Table 6: The comparison of knowledge of CLABSI prevention with the characteristic of the respondents

Variables	Mean	SD	*t*/F	*p*-value
Age (years-old)			**0.31**	**0.82**
< 30	5.78	1.33		
31-40	5.96	1.27		
41-50	5.83	1.19		
> 51	6.00	0.01		
Gender			-0.73	0.47
Male	5.58	1.73		
Female	5.86	1.26		
Working Area			**0.39**	**0.88**
ICU	6.08	1.29		
CCU	5.90	1.23		
IDCU	5.82	1.19		
NICU	5.65	1.39		
Neuro ICU	5.78	1.35		
CICU	6.08	1.31		
PICU	5.81	1.31		
Nurse Level			**2.15**	**0.12**
Nurse In charge	5.81	1.29		
Link Nurse	6.00	1.18		
Champion Nurse	7.33	0.58		
Level of education			0.88	0.45
Diploma	5.81	1.30		
Degree	6.40	1.14		
Master	7.00	0.01		
Others	6.25	1.04		
Working Experiences (Nurse)			3.62	0.01
< 2 years	5.34	1.52		
2-4 years	6.39	1.07		
5-10 years	5.75	1.37		
> 10 years	5.97	1.06		
Working Experiences (ICU)			2.19	0.09
< 2 years	5.63	1.46		
2-4 years	6.38	1.05		
5-10 years	5.76	1.37		
> 10 years	5.86	1.08		
Received ICU Training			1.65	0.10
Yes	6.06	1.14		
No	5.74	1.35		

Note: Independent [a]T-Test, [b]One-way ANOVA, [c]Fisher Exact Test
***significant (p-value ;< 0.05)*

Association between the demographic characteristics and practice regarding prevention ofCLABSI

This study discovered that there was an association between nurses' gender (x: 27.69; p-value: 0.01) and their duration of working experiences in ICU (x: 425.84; p-value: 0.04) with the practice regarding the prevention of CLABSI (Table 7).

Table 7: The association between the demographic characteristics and practice regarding prevention of CLABSI

Characteristic	Chi-Square (95% CI) *	Significance (P-value)
Age	45.06	0.80
Gender	27.69	0.01
Job Title	45.36	0.14
Working Area	129.37	0.08
Nurse Level	46.71	0.09
Level of education	79.65	0.10
Working Experiences (Nurse)	65.48	0.14
Working Experiences (ICU)	425.84	0.04

However, there was no significant association between age (x: 45.06; p-value: 0.80), job title (x: 45.36; p-value: 0.14), working area (x: 129.37; p-value: 0.08), nursing level (x: 46.71; p-value: 0.09), level of education (x: 79.65; p-value: 0.10), the duration of working experience as a nurse (x: 65.48; p-value: 0.14), history of receiving intensive care training (x: 23.40; p-value: 0.18) with the practice regarding prevention of CLABSI.

Association between the demographic characteristics and attitude regarding prevention ofCLABSI

There was no association between the demographic characteristic and the attitude regarding the prevention of CLABSI with a p-value less than 0.05. This current study discovered an association between nurses' gender and the duration of their working experiences in the ICU with the practice of preventing CLABSI. The female and younger nurses were found to have good practice in preventing CLABSI (Table 8).

Table 8: The association between the demographic characteristics and attitude regarding prevention of CLABSI

Characteristic	Chi-Square (95% CI) *	Significance (P-value)
Age	405.33	0.82
Gender	21.16	0.25
Job Title	27.12	0.86
Working Area	132.10	0.06
Nurse Level	44.42	0.64
Level of education	76.91	0.94
Working Experiences (Nurse)	344.35	0.97
Working Experiences (ICU)	313.67	0.99
Received Intensive Care Training	16.25	0.56

* Confidence Interval (CI).

Discussion

This study's questionnaire revealed a fundamental gap between knowledge, practice, and attitudes in caring for CVCs and preventing CLABSI by critical nurses in teaching hospitals. Although CVC care package guidelines, including an introduction and maintenance checklist, have been implemented in most healthcare facilities in Malaysia, our results indicated that knowledge about CLABSI prevention still needs to be improved. These findings were similar to studies in other countries where nurses generally need to understand the basic principles of CLABSI prevention (9, 10, 11).

The CVC Bundle is the responsibility of the nursing staff, especially in the ICU, since it is a daily practice by nurses. They need to comply with all the checklist steps to provide maximum care to patients with CVC. However, our results did not support this assumption. All the nurses were unable to answer all questions correctly. The correct answer rate was 49.7%, which was lower than a study in Poland, whose correct answer rate was 60% (11), but better than studies in Jordan (26.3%) and China (36.6%) (9, 10).

The lowest score of knowledge in this present study was related to the question "applying an antibiotic ointment at the insertionsite with CVC" (17.7%) and "recommended to replace CVCs routinely (19.7%). Most respondents claimed that applying an antibiotic ointment at the insertion site with CVC is not recommended because it does not decrease the risk for catheter-related infections. This may be due to the established policy not to use antibiotics ointment to avoid antibiotic resistance. At the same time, more than half of the respondents claimed that the recommendation to replace CVCs was every seven days. This might be due to the confusion by the nurses related to the hospital, which is to change the transparent dressing every seven days. Furthermore, the MOH or CVC guidelines did not specify these two steps as what stated in previous studies (9, 10).

The highest knowledge score in CLABSI Prevention was maintaining sterility while manipulating the CVC. Most of the nurses comply with using 70 % alcohol solution or alcohol chlorhexidine solution for no less than 15 seconds to clean the access hubor connector before the connection of the administration set or after unscrewing the dead-end cap closes the catheter (89.2%). While they use clean or sterile gloves and alcohol solutions/antiseptic soap during manipulating the catheter insertion site and hubs (85.2%). This showed that ICU nurses were concerned with sterility while manipulating the CVC because it was a practice norm. These findings opposed previous studies in which this practice was not carried out due to a lack of experience and training (11, 12).

This current study showed a significant difference in knowledge of CLABSI prevention by the nursing experience, with nurses who have been in the workforce for 2–4 years reporting better knowledge of CLABSI prevention. Similar to results from other studies, which demonstrate that

more experience and regularized training can improve our knowledge and practice of the prevention of CLABSI (9, 11).

In order to ensure good practice in the prevention of CLABSI, ICU nurses must always comply and adhere to the guideline-recommended practices. This present study found that ICU nurses primarily practice preventing CLABSI, which indicates a good practice. This was similar to other studies that support experiential learning contributed to the high frequency of performing CLABSI prevention (8, 13). The best practice to prevent CLABSI among nurses in this current study was to use a sterile, transparent, semi-permeable dressing to cover the catheter site; and maximum protection (cap, mask, sterile gown, sterile gloves, sterile full body drape). This was similar to a study on Chinese ICU nurses (10). This study also proved that the CVC bundle in this teaching hospital helps to increase nurses' knowledge and practices.

In addition, this study confirms that policies and protocols are essential tools to support employee practices to achieve higher compliance and competent skills. However, regular education, training programs, and periodic assessment of the knowledge and compliance of all personnel involved in CVC insertion and maintenance are also required.

This study also revealed that the female nurses and those who had worked in ICU had better practices in preventing CLABSI. This may be because every new nurse placed in the ICU will undergo intensive training to enable them to provide efficient care. Furthermore, they just finished their preceptorship course to allow them to stay with the practice that is currently being taught during the course.

ICU nurses' attitudes toward CLABSI prevention were positive. They were optimistic about the CLABSI prevention guidelines, the usefulness of pre- and post-dressing hand hygiene to reduce CLABSI, and the perceived risk of transmitting her CLABSI when handling her CVC. In addition, they affirmatively agreed on two essential measures for preventing CLABSI. This suggests allowing the CVC site antiseptic to dry before catheter insertion and routinely monitoring the CVC site visually or by palpation through an intact dressing. This was consistent with results from previous studies (8, 13).

Conclusion

This study concluded that although the critical care nurses had insufficient knowledge of preventing CLABSI, they had good practice and positive attitudes. Nurses with 2-4 years of experience were found to have more knowledge in preventing CLABSI. At the same time, the female nurses and those with more experience in ICU were more compliant in preventing CLABSI. In addition to routine education and training programs in the clinical field such as bedside teaching, continuing nursing education (CNE), workshops, and seminars, we recommend periodic competency assessments related to CVC. Finally, as a teaching hospital, nurses should be given wider opportunities to pursue higher education including post-basic courses, degrees and postgraduates.

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Competing interests

The authors declare that they have no competing interests.

Ethical clearance

We obtained Approval from the UiTM Research Ethics Committee with the FERC/FSK/MR/2022/0317 and UM Research Ethics Committee with the MREC ID NO reference file: 20222105-11596.

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