Knowledge, Attitudes, and Behaviors of Intensive Care Unit Healthcare Workers in Preventing Central Line-Associated Blood Stream Infections in Selected Hospitals of Zhejiang Province, China

Lixia Chen[1,a,*], EVELYN FELICIANO[1,b]

[1]*Graduate School, Angeles University Foundation, Angeles, Pampanga, 2009, Philippines*
[a]*chen.lixia@auf.edu.ph,* [b]*feliciano.evelyn@auf.edu.ph*
[*]*Corresponding author*

Abstract: *High incidence of central venous catheter-associated bloodstream infections, high morbidity and mortality, and prolonged hospital stays are the main challenges faced by healthcare workers in ICUs, and the knowledge, attitudes, and level of prevention of central venous catheter-associated bloodstream infections among healthcare workers have not yet been adequately assessed. The aim of this study was to find out the current status of knowledge, attitude and behavior of healthcare workers in intensive care unit in preventing central venous catheter-associated bloodstream infections. In this study, a questionnaire was administered to 288 healthcare workers in six hospitals using a cross-sectional survey. Completed all the statistical analyses in the SPSS 20.0 software. A total of 178 nurses and 110 doctors participated in this study and the return rate of the questionnaire was 95.36%. ICU medical staff had a lack of knowledge related to CLABSI prevention guidelines and moderate attitudes and behaviors. There is a difference in knowledge related to compliance with CLABSI prevention guidelines among ICU healthcare workers between age, Nurse position level, years of practice, professional role, and Accessibility of training. There is a difference in the attitude of ICU health care workers to comply with CLABSI prevention guidelines between age, nurse position level, years of practice, and Accessibility of training. There is a difference in the behavioral of ICU health care workers to comply with CLABSI prevention guidelines between nurse position level, years of practice, and Accessibility of training. Positive correlations were found between knowledge and attitudes, knowledge and behaviors, and attitudes and behaviors of intensive care unit healthcare workers in preventing CLABSI. Hospitals should regularly assess the knowledge, attitudes and behaviours of healthcare professionals in the intensive care unit regarding the CLABSI prevention guidelines, and enhance structured education to improve healthcare professionals' adherence to the guidelines in order to ensure patient safety.*

Keywords: *Intensive care unit, Central venous catheter, Central venous catheter-related bloodstream infections, Knowledge, Attitude, Behaviour, Patient safety*

1. Introduction

Central venous catheters are essential to ensure that patients receive treatment during their stay in the intensive care unit[1]. Central venous catheters are used to provide treatment, nutrition, support of renal function, and administration of foaming medications that cannot be administered through peripheral veins in critically ill patients, and are placed in nearly half of all patients admitted to intensive care units (ICU)[2]. However, such invasive interventions may cause complications such as occlusion, deep vein thrombosis and bloodstream infections[3,4], which can seriously compromise patient safety. Central venous catheters can cause bloodstream infections via several routes are the main cause of bacteraemia and sepsis in ICU patients[5], and the occurrence of bloodstream infections is an obstacle to the improvement of patients' condition. Therefore, central venous catheter-associated bloodstream infections are considered a major work challenge for ICU healthcare professionals[6].

Central venous catheter-associated bloodstream infection is defined as a laboratory-confirmed bloodstream infection that is not secondary to an infection elsewhere in the body, and the presence of an eligible central venous catheter on the day of, or one day prior to, the laboratory-confirmed bloodstream infection event and is not associated with an infection elsewhere in the body that occurs within 48 hours of central venous catheter placement[7,8]. Data from a survey conducted by the Centers for Disease

Control and Prevention (CDC) in the United States indicate that approximately 200,000 cases of CLABSI occur annually in the United States, with an average infection rate of 5.5 cases per 1,000 catheter days and an average increase in additional hospitalisation costs of US$20,647, while the overall incidence of CLABSI in China's ICUs is approximately 2.81 per 1,000 population[9,10]. CLABSI as a common complication, can have a mortality rate as high as 28-30 percent[11]. Ziegler et al. demonstrated that the risk of in-hospital death in patients with CLABSI was 2.75 times higher than that in patients without CLABSI[12]. CLABSI contributes to increased healthcare costs, prolonged hospital stays, and increased mortality in ICU patients[13,14], which has a serious impact on patient safety and quality of life.

CLABSI is one of the key patient safety components that hospitals and the state focus on, and in 2021, the National Health and Health Commission of China developed the Guidelines for the Prevention and Control of Vascular Catheter-Related Infections (2021 Edition) and included CLABSI in the top 10 healthcare quality and safety improvement goals, emphasising that the focus should be on the prevention and control of CVC and PICC associated bloodstream infections[15]. CLABSI prevention and evidence-based guidelines have also been developed in countries such as the United States and the United Kingdom[16,17,18], and research and practice have demonstrated the value of these guidelines and policies, and that CLABSI can be largely prevented if evidence-based guidelines for central venous catheter placement and maintenance are followed, such as hand washing, the use of full barrier precautions when placing central venous catheters, cleansing the skin with chlorhexidine, and the removal of unnecessary catheters[19]. The greater the adherence of ICU healthcare workers to CLABSI prevention guidelines, the lower the morbidity and mortality rates of CLABSI in ICU patients and the lower the cost of hospitalisation[19].

One of the fundamental responsibilities of ICU healthcare workers is to place and maintain central venous catheters[20], but the extent to which ICU healthcare workers adhere to these guidelines remains unclear. The National Report on Safety in Healthcare and Quality showed that the current status of CLABSI in inpatients in our secondary and higher hospitals has not improved[21]. Studies have shown that Central Line Bundles are effective in preventing central venous catheter-related bloodstream infections and have been widely promoted and implemented internationally[22]. Velasquez Reyes et al.[23] conducted a systematic review of CLABSI prevention in adult intensive care units. The review identified several interventions that can reduce or prevent CLABSI and are essential for preventing or reducing CLABSI in adult intensive care units.

Chi et al. investigated nurses' knowledge and practice of CLABSI prevention guidelines, but this study only investigated ICU nurses in Guangdong province, and more than half of the nurses had been working for less than one year[24]. Currently, there are CLABSI prophylaxis guidelines in place at the researcher's hospital, but CLABSI still exists, with a hospital-wide central venous catheter infection rate of 0.2/1,000 by 2022, with a central venous catheter infection rate of 0.379/1,000 in the intensive care unit. Some hospitals in Zhejiang Province have developed intensive care programmes, including strict implementation of hand hygiene norms, use of maximum sterile barrier for tube placement, assessment and selection of optimal puncture sites, and selection of standard-compliant skin disinfectants. However, there were deficiencies in the implementation of intensive care measures by healthcare professionals. Perceptions and behaviours of CLABSI prevention guidelines are inconsistent in different regions, and adherence to CLABSI prevention guidelines by our medical staff has not been adequately assessed. Patients in intensive care units are critically ill and require professional management. Placement of central venous catheters in ICU patients is critical due to the complexity of treatment. Surgical adult intensive care units are also the focus of our attention. Therefore, the aim of this study was to understand the current status of knowledge, behaviours and attitudes of ICU healthcare professionals in Zhejiang Province towards CLABSI prevention guidelines, in order to provide a theoretical basis for reducing the incidence of CLABSI and improving patient safety and quality of life.

2. Methods

2.1. Study Design and Setting

Any text or figures outside the aforementioned margins will not be printed.This study will be a cross-sectional survey analysis study. We investigate the knowledge, behaviours and attitudes of ICU healthcare workers towards the prevention guidelines for the prevention of central venous catheter related bloodstream infections at a given time. We expect to survey six hospitals, all of which are tertiary hospitals with high-quality operations in China. This study will be conducted in the researcher's hospital, the Fourth Hospital Affiliated to Zhejiang University School of Medicine, which a tertiary general

hospital located in the central part of Zhejiang province, with 1,229 open beds, of which the Intensive Care Unit has 55 beds, and it is expected that a large number of respondents will be enrolled in the study, and the center expects to enroll 120 respondents, which will support the general applicability of the results. The hospital is closely focused on the strategic orientation of "higher quality, more excellence, more respect and more dreams", and the great goal of building a world-class international medical center with Chinese characteristics.

2.2. Study Participants

The full text of the article must be typeset in single column.In this study, the convenience sampling method was used to select the healthcare workers of six hospitals in Yiwu City in February 2023 as the study population. The sample size was calculated according to the cross-sectional survey research sample size formula[25]. Shao[26] and others showed that compliance with central venous catheter-related bloodstream infection prophylaxis was 74.5%; therefore, P=0.745, δ=0.05 is the permissible error, and the sample size was approximately 282 cases. Considering that 10% of incomplete data may be excluded, 314 cases were proposed for inclusion.

Inclusion criteria may include the following: (a) registered nurses and physicians in intensive care units at six hospitals; (b) at least 12 months of intensive care unit experience and (c) voluntary consent to participate in the study. Interns or nurses unqualified to operate central venous catheters and the pediatric intensive were excluded.

2.3. Research Instruments

This study describes the demographics of the intensive care unit: sex, age, nurse position level, years of practice, education level, accessibility of training, sources of knowledge.

The CLABSI Prevention Knowledge, Belief, and Behavior Scale contains three dimensions of knowledge, attitude, and behavior, with a total of 69 entries. The knowledge dimension consisted of 26 entries, with the questions being single-choice, with correct answers scoring 1 point, wrong answers scoring 0 points, and no knowledge or a little bit of knowledge but not sure being incorrect, with a total score ranging from 0-26 points, with higher scores indicating a higher level of knowledge about CLABSI prevention. The attitude dimension of 16 entries was scored on a Likert-5 scale, with a score of 5-1 representing strongly agree to strongly disagree, respectively, and a total score range of 16-80, with higher scores indicating more positive attitudes toward preventing CLABSI. Behavioral dimension has 27 entries and is scored on a Likert-5 scale, with a score of 5 for very compliant, 4 for relatively compliant, 3 for compliant, 2 for relatively non-compliant, and 1 for very non-compliant, and the total score ranges from 27 to 135, with the higher the score indicating a stronger tendency towards positive behaviors[27]. The Cronbach's coefficient and test-retest reliability of each dimension and the total scale are all above 0.9, indicating a highly reliable and standardized questionnaire for use[27].

2.4. Data Collection

Questionnaires were collected online using Questionstar for this study. Verbal consent to conduct the study in their hospitals was established by the researcher by contacting the hospital nursing managers by telephone to explain the plan and nature of the study and to obtain consent. A QR code for the questionnaire and detailed instructions for completing the questionnaire were distributed to the hospital nursing managers to recruit eligible healthcare workers.

2.5. Enthical Considerations

Before starting data collection, this study was approved by the Human Research Ethics Committee of the Fourth Affiliated Hospital of Zhejiang University School of Medicine (NO.: k2023054). Participants give informed consent and participate in the study voluntarily and have the right to withdraw from the study at any time without any potential loss of benefits. This study contains no risks and will not have any impact on your work. Participant data will be presented anonymously and all data will be used for this study only.

2.6. Statistical Analysis

All statistical analyses were completed in SPSS 20.0 software. Measurement data meeting the normal

distribution are presented as mean ± standard deviation. Count data are expressed by frequency number and composition ratio. The t-test and ANOVA test were used to analyse the differences in knowledge, attitudes and behaviours of healthcare workers with different characteristics regarding CLABSI prevention, Data that do not conform to a normal distribution are tested using non-parametric tests such as Kruskal Wallis and Mann-Whitney. Spearman's correlation was used to analyze the correlation between knowledge, attitudes, and behaviors of CLABSI prevention guidelines among healthcare workers in the ICU.

3. Results

A total of 314 questionnaires were returned in this study, of which 288 were valid, with a validity rate of 95.36%. The demographic characteristics of the healthcare workers are shown in Table 1.

Table 1: Demographic characteristics of healthcare workers.

Variables	Categories	N	Percentage (%)
Sex	Male	81	28.12
	Female	207	71.88
	Total	288	100
Age	≤ 29	147	51.04
	30-39	126	43.75
	40-50	15	5.21
	Total	288	100
Education Level	Specialist Qualification	18	6.25
	Bachelor's degree	263	91.32
	Postgraduate	7	2.43
	Total	288	100
Nurse Position Level	Primary title	176	61.11
	Middle title	99	34.38
	High title	13	4.51
	Total	288	100
Years of Practice	1-5	121	42.01
	6-10	105	36.46
	≥ 11	62	21.53
	Total	288	100
Professional Role	Nurse	178	61.81
	Doctor	110	31.89
	Total	288	100
Source of Knowledge	Professional Guide	84	29.16
	Training	113	39.23
	Network	54	18.75
	Others	37	12.85
	Total	288	100
Accessibility of Training	≤ 5	202	70.14
	6-10	75	26.04
	≥ 10	11	3.82
	Total	288	100

The total knowledge score for prevention of central catheter-related bloodstream infections among healthcare workers in the ICU was 20.44±2.81. The total attitude score of health care workers in ICU to prevent central catheter related bloodstream infections was 70.52±5.392. 90.07% of participants indicated that they should be proactive in learning best clinical practices for CLABSI prevention, and 85.07% indicated that they should be knowledgeable about CLABSI cluster intervention strategies. The total behavioural score for prevention of central catheter-associated bloodstream infections among healthcare workers in the ICU was 124.39±10.721. 72.91% of the healthcare professionals reported that hand hygiene was strictly enforced when performing central venous catheter placement and maintenance, and 70.2% reported that they would jointly assess the necessity of indwelling catheters on a daily basis, and immediately remove catheters that did not need to be left in place.

There is a difference in knowledge related to compliance with CLABSI prevention guidelines among ICU healthcare workers between .age, Nurse position level, years of practice (p = 0.007, 95% CI: 0.179

~ 1.15), professional role, and Accessibility of training ($p < 0.05$). There is a difference in the attitude of ICU health care workers to comply with CLABSI prevention guidelines between age, nurse position level, years of practice, and Accessibility of training ($p < 0.05$). There is a difference in the behavioral of ICU health care workers to comply with CLABSI prevention guidelines between nurse position level, years of practice, and Accessibility of training ($p < 0.05$). See Table 2.

Table 2: Univariate analysis of knowledge, attitudes and behaviours of ICU healthcare workers adhering to CLABSI prevention guidelines.

Variable	knowledge dimension		Attitudinal dimensions		Behavioural dimensions	
	Z/H	P	Z/H	P	Z/H	P
Sex	1.762[a]	0.078	1.376[a]	0.169	1.102[a]	0.27
Age	44.91[a]	0.00*	7.891a	0.019*	1.534[a]	0.464
Education level	4.652[a]	0.098	2.723[a]	0.256	2.095[a]	0.351
Nurse position level	25.524[a]	0.00*	12.924[a]	0.002*	9.007[a]	0.011*
Years of practice	33.447[a]	0.00*	22.484[a]	0.00*	20.117[a]	0.000*
Professional Role	4.28[a]	0.00*	0.153[a]	0.878	1.082[a]	0.279
Sources of knowledge	2.503[a]	0.475	0.316[a]	0.957	0.968[a]	0.809
Accessibility of training	33.781[a]	0.00*	11.985[a]	0.002*	12.039[a]	0.002*

a: nonparametric test; * P<0.05

Positive correlations were found between knowledge and attitudes, knowledge and behaviors, and attitudes and behaviors of ICU healthcare workers in preventing CLABSI. See Table 3.

Table 3: Spearman correlation analysis between knowledge, attitudes, and behaviors of ICU healthcare workers in the prevention of CLABSI.

	Knowledge	Attitudes	Behaviors
Knowledge	1	0.186*	0.16*
Attitudes		1	0.24*
Behaviors			1

* P<0.05

4. Discussions

This study analysed the compliance of healthcare workers with CLABSI prevention guidelines in ICUs in Zhejiang Province from three perspectives: knowledge, attitudes and behaviours, and analysed their influencing factors.

The percentage of nurses with bachelor's degree in this survey is 91.32%, with the improvement of education level and the limitations of the institute's recruitment system in hospitals, nursing bachelor's degree and postgraduate students are more favored by healthcare institutions, so the percentage of bachelor's degree is the highest in healthcare institutions. Due to the nature of nursing work and heavy clinical tasks, the front-line nursing staff tends to be younger, so there are no nurses over the age of 50 and under the age of 39 accounted for 94.79% of the nurses in this study, and the proportion of nurses with more than 11 years of work experience is only 21.53%. In this survey, the lack of appropriate knowledge related to CLABSI prevention guidelines among intensive care unit healthcare workers is consistent with national studies in Egypt[28], Jordan[29], and Greece[30]. Only 67% of healthcare workers in the intensive care unit were aware of the knowledge related to the risk factors of CLABSI. Hand hygiene, maximum sterile barrier, length of ICU stay, and longer central venous indwelling time are risk factors for CLABSI[31], and knowledge of the risk factors can enable the implementation of preventive measures as early as possible to reduce the incidence of CLABSI. Hand hygiene as the most convenient and cost-effective method of preventing CLABSI, only 76.59% of healthcare workers in the intensive care unit knew the five moments of hand hygiene, and adherence to proper hand hygiene is an effective way to reduce the risk of CLABSI infections, and is a common measure for infection prevention in hospitals[32]. Only 60.56% of healthcare workers were aware of the appropriate timing for changing tubes for transfusion of blood, blood products, or fat emulsions, based on the CLABSI evidence-based practice recommendation that, for the prevention of CLABSI, devices for transfusion of blood and blood products should be changed every 12 hours or according to the manufacturer's recommendations, and devices used for total parenteral nutrition infusion should generally be changed every 24 hours. The data from this

survey showed that 70.21% of healthcare workers were aware of the need for daily assessment of the necessity of central venous catheter retention, Votes[33] based on a rule of thumb suggesting that the risk of CLABSI increases quadratically with increasing catheter retention time, and that catheter retention time significantly increases the risk of central venous catheter infection, and that healthcare workers need to work together to assess the necessity of catheter retention on a daily basis.

Healthcare workers with more years of experience and more CLABSI training had significantly better knowledge of CLABSI prevention practice guidelines than other healthcare workers. Doctors' knowledge about CLABSI prevention practice guidelines was superior to nurses, unlike a Jordanian study[34], and the reason for this was considered to be due to the differences between the Chinese and Jordanian healthcare systems and cultures. Doctors in the hospitals investigated in this study were responsible for central venous catheter placement, while nurses' main responsibility was to maintain the catheter. These findings should guide clinical practice, theoretical knowledge is the basic condition to guide clinical practice, hospitals and departments should conduct structured education as well as evidence-based practice and seminars on CLABSI prevention guidelines to improve the knowledge of healthcare professionals related to CLABSI prevention practice guidelines.

The results of this study indicate that intensive care unit healthcare workers have a positive attitude towards adherence to CLABSI prevention guidelines, and similar results were obtained from a cross-sectional survey of oncology nursing nurses' knowledge, attitudes and practices regarding the prevention of midline-associated bloodstream infections conducted in Italy[35]. More than 90% of healthcare workers indicated that they should actively learn the best clinical practices for CLABSI prevention and that hospitals should develop standardised and regulated processes for CLABSI prevention. The best clinical practices and guidelines for CLABSI prevention can provide guidance for healthcare workers' clinical behaviours, which is conducive to preventing the occurrence of CLABSI. Healthcare workers with long years of experience and high knowledge of CLABSI prevention guidelines have better attitudes than other healthcare workers regarding compliance with CLABSI prevention guidelines, and low seniority healthcare workers should take the initiative to learn about CLABSI evidence-based guidelines and related training.

Knowledge and attitude guide practice behaviour, and healthcare workers with high levels of knowledge and positive attitudes adhere to CLABSI prevention guideline behaviour better than other healthcare workers. Senior nurses should actively guide junior nurses to develop a positive work ethic and emphasize CLABSI in the ICU. The results of this study showed a positive correlation between knowledge, attitude and behavior of ICU healthcare workers in preventing CLABSI. Having a high level of knowledge and positive attitudes among healthcare workers in the ICU is conducive to improving their preventive behaviors. Knowledge and attitude guided behavior, and healthcare workers with high levels of knowledge and positive attitudes adhered to CLABSI prevention guideline behaviors more than other healthcare workers. Central catheter-associated bloodstream infections are largely preventable if evidence-based guidelines are followed[19]. The results of this study indicate a high level of CLABSI prevention behaviors among healthcare workers in the ICU, and in order to ensure patient safety and reduce the incidence of infections, healthcare workers should actively adhere to central venous catheter-associated bloodstream infection prevention guidelines.

To ensure patient safety and reduce the incidence of infection, healthcare professionals should have knowledge of the guidelines for the prevention of bloodstream infections associated with central venous catheters and follow them in a positive manner. Studies such as Badparva[36] suggested that nurses' knowledge, attitudes and perceptions as internal factors may be barriers to following CLABSI evidence-based guidelines in clinical practice. Hospitals incorporating evidence-based guidelines for CLABSI prevention into their educational curricula and providing ongoing educational programmes for healthcare workers in the intensive care unit are necessary to help them improve their knowledge and attitudes. The Centers for Disease Control and Prevention (CDC) in the United States of America has developed a clustered checklist for the prevention of central venous catheter-associated bloodstream infections[22], which has been widely disseminated and implemented internationally. Several studies have shown that following the clustered list is conducive to improving healthcare workers' adherence and reducing the incidence of CLABSI[37,38,39]. Domestic interventions to improve healthcare worker adherence should also be explored on the basis of foreign advanced experiences that are suitable for China's healthcare system.

The cross-sectional survey study also had some limitations. Firstly, due to the potential limitations of the study design, exact causal relationships between variables could not be analysed. Second, this study used a questionnaire star to collect data, and healthcare workers may cater to the researcher's expectations and hide their true behavioural attitudes, and there may be some bias in self-reporting. Finally, this study

only investigated the adherence to CLABSI prevention guidelines among healthcare workers in the intensive care unit in Yiwu, China, and there are some limitations to the generalisability of the findings. Due to the inherent limitations of the convenience sampling method, and the differences between random sampling, there may be errors between the sample and the whole, and in the future, the sample size needs to be expanded and scientific sampling methods need to be used.

5. Conclusion

This study concludes that there is a need to comprehensively improve the knowledge, attitudes and behaviours of healthcare professionals in following the CLABSI prevention guidelines, and that hospitals should regularly assess the knowledge, attitudes and practices of healthcare professionals in the intensive care unit regarding the CLABSI prevention guidelines, carry out structured education and training, and proactively organise interventions to improve the adherence to the CLABSI prevention guidelines by healthcare professionals, reduce the incidence of CLABSI, and safeguard the safety of patients.

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