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The Effect of Nurses' Implementation of Central Vascular Catheter Maintenance Care Bundle on Bloodstream Infection among ICU Patients in KFGH and KAAUH

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Abstract: Background: Bloodstream infections (BSIs) are the most common type of healthcare-associated infections in clinical settings. Bloodstream infections are a leading known cause to increase the risk of patients' morbidity, mortality and length of hospital stay, and additionally, are typically increased in patients with severe underlying diseases. The study of CVC bundle implementation has not been adequately explored in Saudi Arabia (SA). This study aimed to assess the effect of nurses' implementation of central vascular catheter maintenance care bundle on blood stream infection among intensive care unit patients at King Fahd General Hospital (KFGH) and King Abdul-Aziz University Hospital (KAAUH).

Objectives: Assess the effect of nurses' implementation of central vascular catheter maintenance care bundle on blood stream infection.

Methods: This study used quantitative research as a cause of defining the relationships between the variables which are the nurses' implementation of the central vascular catheter maintenance care bundle and the bloodstream infection rate. An observational study were as it enables the researcher to focus on specific behaviours. The tools used in this study were Central vascular catheter maintenance care bundle checklist was used to assess the effect of nurses' implementation of a central vascular catheter maintenance care bundle on blood stream infection. A convenience sample of 63 patients of both sexes with central vascular catheter was selected from the two institutions. Ethical approval was granted from KAAUH and KFGH. Data collection was conducted for six months.

Results: A total of 63 patients and 37 nurses participated in this study. The average age of the study population was 51 years old (SD score of 51±20 years). The majority of gender were male (65%) of the admitted patients were male (78%) had poor knowledge scores about contraception before counseling. The study reveals that the majority had diploma level education (87%) while (13%) had a bachelor's degree. As the researcher observed the nurses implementation of central vascular catheter maintenance care bundle, the table revealed that there was statistically significant difference between nurses' performing hand washing in relation to patients' bloodstream infection (P-value=0.001). There were (53.9%) of the nurses at both hospitals didn't perform hand washing techniques which lead to exposure of patients to infection. Other influencing factors included misapplication of chlorhexidine antiseptic at KFGH which increased exposure to infection and showed significant statistical difference (P-value = 0.000). The fourth element of proper central vascular catheter site selection indicated the elevation of infection at the jugular vein site in (36.5%) of the cases followed by the femoral site (19%) it was not found at the subclavian vein site as recommended in current evidence. In addition, it was also noted that there was no significant correlation between exposure to infection and the daily review of central vascular catheter necessity

Conclusions and Recommendations: The relationship between nurses' implementation of central vascular catheter maintenance care bundle and bloodstream infection has had a positive effect on patients' bloodstream infection rates of intensive care unit As a result, this study recommends sustained efforts to educate the healthcare workers regarding the importance of bundle implementation and central vascular catheter care and provision of prompt feedback on adherence to aseptic technique. Moreover, healthcare providers should be involved in educational sessions on central line insertion, handling and maintenance.

Keywords: Nurses' implementation, central vascular catheter maintenance care bundle, central line associated bloodstream infection.

INTRODUCTION

Nosocomial bloodstream infections are one of the major complications of nosocomial infection with the risk for infection increasing with use of central vascular catheter devices in the absence of proper insertion techniques and management of the line [1,2]. As a consequence, bloodstream infection predisposes increased average incidence of morbidity and mortality as well as prolonged hospital days and in addition it is costly [3]. The centre for disease control guidelines for central line associated bloodstream infection prevention supports these recommendations of applying the five central vascular catheter care bundle elements jointly [4,5]. The Institute for Health-care Improvement of central line bundle consists of five key components which are: 1- Hand hygiene before central line insertion, before and care. 2- Wearing of personal protective equipment (mask, gloves, sterile gown, face shield). 3- Using of effective antibacterial skin antiseptics

(chlorhexidine). 4- Proper selection of central line site by avoiding the femoral vein and emphasis on the use of the subclavian or jugular vein site.

5- Daily check of line necessity with rapid removal of unnecessary lines [6].

Nurses need to continuously update their knowledge and act from an evidence-based approach rather than working solely from experience [7].

Study significance:

Performing the central vascular catheter maintenance care bundle is effective on infection rates among intensive care unit patients [8,9,10]. In SA, there were no study done in this topic. Therefore, the investigator as infection control nurse selected the given research problem from the clinical observation of a significant rise in bloodstream infection rates, which indicated poor compliance in applying the central vascular catheter maintenance care bundle. These may be evidenced by several factors such as neglecting hand

washing, lack of good skin antiseptics, suboptimal catheter site selection and malpractice of the maximal barrier precaution upon insertion of central vascular catheter insertion [11,12]. The implications of this study will provide advantages for patients and healthcare workers, as well as supporting policy makers who need evidence-based information for making decisions about patient care [13].

Central vascular catheters are a fatal cause of catheter related bloodstream infections [14,15,16]. Suboptimal care direct to serious complications [17]. The need for optimizing central vascular catheter care is recommended to ensure that Central vascular catheters care does not cause the patient's harm, this can be accomplished by monitoring the central vascular maintenance care bundle procedures among intensive care unit patients [18,19]. In addition, the use of the central vascular catheters maintenance care bundle by professional critical care nurses can greatly improve patient care and reduce the incidence of complications [20,21], this study is aimed to evaluate the effectiveness of CVC bundle on bloodstream infection rate in KAUH and KFJH. The research objective is to : Assess the effect of nurses' implementation of central vascular catheter maintenance care bundle on blood stream infection .

MATERIAL AND METHODS

Research Design:

This study used a quantitative research to answer the research questions and defining the relationships between the variables which are the nurses' implementation of the central vascular catheter maintenance care bundle and the bloodstream infection. The study was carried out in the medical intensive care units at King Fahd General Hospital under the Ministry of Health (MOH) and King Abdul Aziz University Hospital in Jeddah city in Jeddah.

Sampling:

A convenience sample of patients and nurses were selected from the two institutions KFGH and KAAUH, the convenience method was used to enable the most conveniently available people to be the participants on certain criteria. Patients involved in the study were from medical intensive Care Unit with central vascular catheters, admitted to the hospital for more than 48 hours and aged from 18 to 87 years old. Patients undergoing surgical operations were excluded to prevent confusion between surgical site infection and bloodstream infection.

Study Tools:

The researcher of the current study used the checklist, because the checklist enables the researcher to focus on specific behaviours this checklist was divided in to two sections, Tool I part 1, Socio-demographic and clinical data, This section was used to collect patients' personal data, such as name, age, gender, nationality and marital status.. part 2: was used to collect patient's clinical data.

Tool II, Central Vascular Catheter Maintenance Care Bundle checklist, this checklist was developed by the Centres for Disease Control and for this study some modifications were made after extensive review of relevant literature data were collected with the aid of this checklist to evaluate the effect of nurses' implementation of a central

vascular catheter maintenance care bundle on bloodstream infection, it composed of five elements, 1-Performing hand hygiene before and after all central vascular catheter maintenance/access procedures. 2-Nurses' demonstration of use of personal protective equipment during central vascular catheter care.

3-Checking of the necessary of central vascular catheter remaining and immediate removing of unnecessary lines. 4-Suitable site selection of central vascular catheter. 5- Use of Chlorhexidine gluconate 2% (or solution compatible with central vascular catheter) for cleaning the insertion site during dressing changes, with this checklist nurses' implementation was assessed as 'done' or 'not done'.

Data collection process:

The researcher gathered the data with following steps: As the patients were unconscious, consent forms were obtained from the patients' family or the intensive care unit supervisor after explanation of the aim of study, patients were based on the mentioned criteria, sample contained 63 medical intensive care unit patients, the study avoided the patients under surgical operations to avoid the mixing between surgical site infected cases and bloodstream infection patients, patients were protected against harm and injuries and having the rights to withdraw at any time, the researcher visited the medical intensive care unit daily from 08:00 am to 02:00 pm, to collect patients' demographic and patients' clinical data by filling out the checklist using Tool 1 part 1, the researcher assessed the patients' signs and symptoms of bloodstream infection since admission until discharge or transfer to other unit using Tool 1 part 2, signs and symptoms of BSI includes: Fever, elevation of WBCs count, central line site infection which are (redness, hotness, pus or discharge), and proved laboratory positive blood culture results, then the researcher were checking and recording the blood culture and followed up daily to ascertain the presence of bloodstream infection or not, and to be sure that the infection is relating to the hospital, patients' BSI occurrence must exceed 48 hours since admission, and finally this results checked with surveillances of infection control department ,observation of bedside nurses' implementation of the central vascular catheter maintenance care bundle for the selected patients according to the inclusion and exclusion criteria was carried out using Tool 2, nurses implementation of CVC care bundle were observed three times a day at their whole shift, data collected from the medical records were used only for the propose of conducting the study, privacy, confidentiality, and anonymity were maintained, and after thesis submission, all the information will destroyed .

Ethical considerations:

Official permission was obtained from the Ethical Committee of Nursing Faculty at KAU. Next, permission was obtained from KFJH and KAAUH to initiate data collection.

Statistical Analysis:

In this study, the data was coded and entered by using SPSS version 16 software package, this software were used because it is easy entering the data and available at the university The following statistical measures were used, different statistical procedures (frequencies, median,

Interquartile Range (IQR), and cross tabulation) to check the validity of data and to spot any errors, descriptive statistics such as frequency distribution, mean, median, Interquartile range, and standard deviation described the selected profile of the studied population, the Kolmogorov–Smirnov test was used to examine the normality of data distribution, and linear correlation using the Spearman Rho correlation coefficient was conducted. The significance of the results was at the 5% level of significance. Then the knowledge level was categorised as poor, adequate or excellent in Table (1).

Table 1: Level of Nurses' Education .

Level of Nurses' Educational	Score in percentage
Bachelor's degree	21.6 %
Diploma degree	78.4 %
More Than 2 Years of experience	100 %

RESULTS

At this study, the respondents were 63 patients aged between 18 and 80 years with (n= 14 ,22.2%) of them in the 18-30 years age group, while only (n= 6, 9.5%) were 31-40 years old, As shown in table (2), the mean age was fifty one (mean age = 51). The marital status of the hospitalized patients elucidates that (n= 36, 59%) were married and (n=3, 5%) were divorced. In relation to gender, (n= 41, 65%) of the admitted patients were male. As regards patients' nationalities, study showed that Saudi patients represented 62% while non-Saudi patients were 38%.

Table 2: Demographics and characteristics of patients

Demographics and characteristics of respondent patients (n = 63).		
Demographic	Count n	Percentage %
Age Mean	51	—
18 ≤ 30 yrs.	14	22.2
31 ≤ 40 yrs.	6	9.5
41 ≤ 50 yrs.	10	15.8
51 ≤ 60 yrs.	8	12.7
61 ≤ 70 yrs.	13	20.6
71 ≤ 80 yrs.	12	19
Marital Status		
Married	37	58.7
Single	16	25.4
Widower	7	11.1
Divorced	3	4.8
Gender		
Male	41	65
Female	22	35
Nationality		
Saudi	36	62
Non-Saudi	27	38

The study analysis result of patients' length of stay among admitted patients describes the relationship between the length of hospital stay among intensive care unit patients and exposure to infection in KFGH and KAAUH, most patients (n=33, 52.4%) were admitted for between four to five weeks and acquired bloodstream infection (n=14, 22.2%) while few (n=3, 4.8%) only stayed from one to two weeks and got BSI with the rate of (4.8%), that clarifies the

association of patients' length of hospital stay and exposure to infection with susceptibility to infection increasing as hospitalization days increased (see table 3).

Table 3: The relationship between length of hospital stay among intensive care unit patients and exposure to infection

Items	Pt. Exposed to BSI	Pt. not Exposed to BSI
Length of hospital stay		
1 < 2 weeks	4.8	0
2 < 3 weeks	11.1	0
3 < 4 weeks	27	4.7
4 < 5 weeks	22.2	30.1

Results at table (4) represented the relationship between nurses' implementation of central vascular catheter maintenance care bundle and bloodstream infection, which has had a positive effect on patients' bloodstream infection rates of intensive care unit through observation of bundle checklist (fig.1), as the researcher observed the nurses implementation of central vascular catheter maintenance care bundle, the table revealed that there was statistically significant difference between nurses' performing hand washing in relation to patients' bloodstream infection (P-value=0.001). There were (53.9%) of the nurses at both hospitals didn't perform hand washing techniques which lead to exposure of patients to infection. Other influencing factors included misapplication of chlorhexidine antiseptic at KFGH which increased exposure to infection and showed significant statistical difference (P-value = 0.000), (fig. 2). The fourth element of proper central vascular catheter site selection indicated the elevation of infection at the jugular vein site in (36.5%) of the cases followed by the femoral site (19%) it was not found at the subclavian vein site as recommended in current evidence. In addition, it was also noted that there was no significant correlation between exposure to infection and the daily review of central vascular catheter necessity.

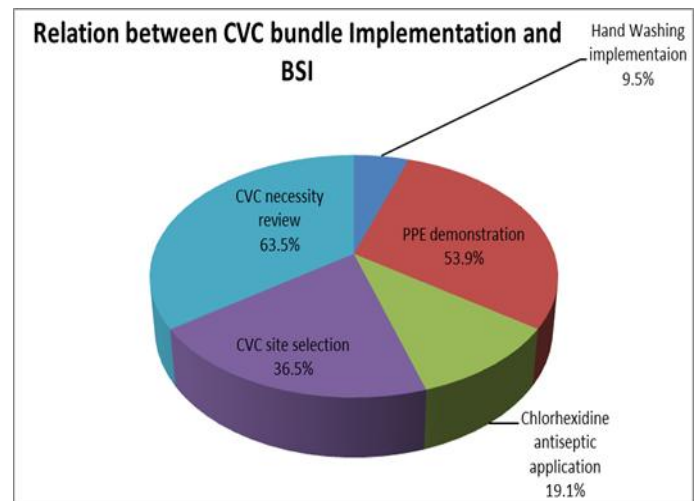


Figure 1: Relationship between nurses' implementation of CVC Maintenance Care Bundle and exposure to BSI.

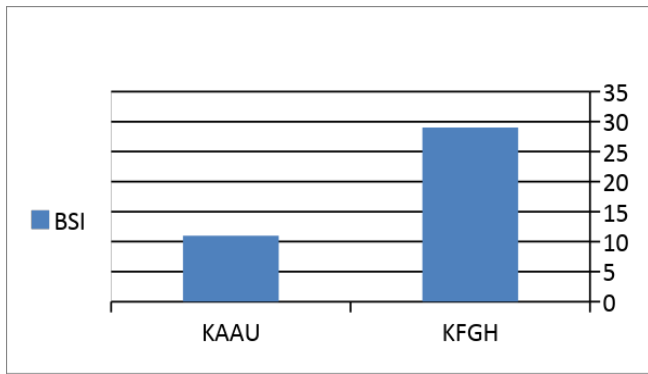


Figure 2: Frequency distribution of the patients in KFGH and KAAUH as regards infection occurrence.

Table 4: The relationship between nurses' implementation of CVC Maintenance Care Bundle as observed and patients' exposure to BSI.

Central vascular catheter maintenance care bundle factors	Pt's exposed to infection n= 63		Pt's not exposed to infection n= 63		Chi-square	P
	N	%	N	%		
1)Hand washing					11.953	0.47
a)Done	6	9.5	13	20.6		
b)Not done	34	53.9	10	16		
2)PPE demonstration					Nil	Nil
a)worn	40	63.5	23	36.5		
b) not worn	0	0	0	0		
3)Chlorhexidine antiseptic application					9.258	0.002
a)Applied	12	19.1	16	25.4		
b)Not applied	28	44.4	7	11.1		
4)Proper CVC site selection					7.72	0.021
a) JV	23	36.5	12	19		
b) SC	5	8	9	14.3		
c) FM	12	19	2	3.2		
1)Daily review of CVC necessity					Nil	Nil
a)Done	40	63.5	23	36.5		
b)Not done	0	0	0	0		

DISCUSSION

In relation to gender, more than half (65%) of the patients were male, this finding supports with that of Eckenrode andHogonnet, who stated that a higher incidence of BSI can be due to the increase of road traffic accidents and smoking prevalence of males [22,15], but in this descriptive study discovered that there were no significant differences regarding nationality, gender, marital status, admission diagnosis, or patient transfer, in relation to bloodstream infection. Regarding nurses' educational level and experience, the present study signified that the majority of the nurses had a diploma level of education and experience about each patient, While this studies' compliance with central vascular catheter insertion and maintenance was being explored, it was observed that most of the nurses had a good educational level. In fact,, nurses have the unique

opportunity to optimize infection prevention and to reduce the potential for hospital-acquired infections in critical patients by utilizing the skills and knowledge of evidence based practice, as found in a cross sectional study B. G. Mitchell, this study of final year graduate nursing students at six Australian universities which focused on examining the knowledge of standard precautions and its application, after academic education regarding infection prevention and control, they concluded that nursing students have enough knowledge and an acceptable level of standard precaution application [24].Another study conducted by Polit and his colleagues whose clarified the factors influencing the development of evidence-based practice among nurses, wherein a self-report survey examined factors influencing the implementation of evidence based practice among nurses in a large Norwegian university hospital, they reported that nurses largely used experienced-based knowledge collected from their own observations, colleagues and other collaborators for support in practice while evidence from research was seldom used [25,19], this research result is compatible with the current study In returning to revise and update the association between a prolonged intensive care unit length of stay and bloodstream infection, many studies proved the connection [19]. Admission to a critical care unit is evidently associated with many risks that lead to more complexity and severity of diseases, which predisposes patients to a higher risk of mortality and a longer hospital stay [22,26], Zimmerman andEckenrode,clarified in their study between 2002 and 2003 in 104 intensive care units in 45 United of State hospitals, the association with exposure to infection, the results of their study showed significant statistical differences among intensive care unit stays which corresponds with the result of the present investigation as mentioned above [27],The five elements of the bundle must be implemented; the effectiveness of these five interventions are supported by scientific evidence based practice [28].

The central vascular catheter maintenance care bundle includes, consistently performing hand hygiene as a routine habit before each central line procedure, application of chlorhexidinegluconate 2% antiseptis, using of barrier precautions (gloves, gowns and eye shields) during central vascular catheter care, insertion sites known to have lesser complications should be chosen, and immediate removal of central line if not necessary.Nurses' hands are prone to horizontal infection transmission, thus emphasizing the importance of hand hygiene compliance to control this crucial issue [29].The results of the current study showed that neglect of hand hygiene predisposed patients to bloodstream infection.

Studies have shown the association between non-adherence to hand hygiene guidelines and the increase of pathogens transported on nurses' hands which is evidently common in intensive care units [30]. Promoting hygienic behaviors resulted in an improved compliance with hand hygiene protocols from 65% to 88%, as seen from Huang'sprospective observational study that was performed on 258,436 hand disinfection events from January 1st to December 31st 2008 in a university hospitals' 27 bed intensive care unit in the Netherlands [31].

Among the two hospital-wide studies on nosocomial BSIs, the results showed great variation, related to many factors but primarily to non-availability of antiseptic solution (chlorhexidine 0.2%); it was found that one hospital had an elevation of BSI rate greater than the other.

A observational study by Climo & Wong aimed to discover if daily bathing with chlorhexidine-impregnated washcloths significantly reduced the risks of acquisition of MDROs and development of hospital-acquired blood-stream infections [32]. The advantage of chlorhexidine bathing was noted in a reduction in the rate of bloodstream infections due to coagulase-negative staphylococci, also it was consistent with several earlier studies concluding that chlorhexidine bathing may be a simple and effective measure for some hospitals to prevent infections [32]. Concerning the using of personal protective equipment, it was found in this study that all of the staffs were compliant with the application of this equipment as the proper utilization by nurses of personal protective equipment is vital in infection prevention and has an effect on nurses' safety. Mitchell and his partner performed an observational study in 11 hospitals participating in the Canadian Nosocomial Infection Surveillance Program between January and March 2011. Observers recorded nurses donning and removing personal protective equipment and performing hand hygiene upon entry into the rooms of febrile, respiratory illness, patients [32]. It was concluded that overall adherence with appropriate personal protective equipment use in health-care lowered the transmission rate between intensive care unit patients, as of this current study results that coincide with previous research findings but have no significant statistical difference because nurses followed the personal protective equipment guidelines. In regard to this factor, checking the necessity of central vascular catheters was emphasized to health care workers during the present study, as the majority of the evidence based research showed a reduction in central line associated bloodstream infection when daily catheter necessity was reviewed and it was removed as soon as it was deemed possible [33].

Tannous emphasized the major effect of best practices during insertion, and of focusing on the daily review of central line necessity through prospective surveillance for central line associated bloodstream infection in intensive care unit, there were a total of 564 central lines inserted in intensive care unit and were reviewed for daily necessity; the overall compliance with the central line bundle was 61.6%, is the recommendations were to exert more efforts in central vascular catheter maintenance and care which is pertinent to the present research although, it had no significant statistical differences (table 4)[34]. Regarding the relationship between site selection and bloodstream infection, results showed the increased rate of bloodstream infection in jugular and femoral sites rather as opposed to the subclavian site.

Deshpande and his colleague performed their epidemiologic, prospective, observational study between two groups of patients, wherein the first group were connected to a catheter at subclavian site, while the second groups' patients were connected to central vascular catheters at jugular or femoral sites. The study analysis showed that the incidence

of infection was less in the subclavian site group than at femoral and internal jugular site group which indicated a statistically significant difference in the average of infection and colonization among the three sites of insertion; the results in group 1 concurred with the present study results, which proved significant statistical differences (table 4)[35]. In addition, some barriers and facilitators to successful implementation of central line associated bloodstream infection prevention in ICU patients across hospitals were identified as an indicator for best practice performance and it considers as a key factor for future practice of infection control program, this has coincide with the present study [36].

CONCLUSION

The study analysis of results showed that implementation of central vascular catheter maintenance care bundle has statistical significant differences on bloodstream infection rate. This positive impact on central line bundles were for the sake of bloodstream infection prevention. In order to provide nurses with evidence based knowledge in the future to prevent bloodstream infection.

RECOMMENDATION

Based on the results of this study several recommendations would enhance the adherence to CVC maintenance care bundle those include, documentation of the importance of central vascular catheter maintenance care bundle, development of a written policy regarding the central vascular catheter maintenance care bundle and encouragement of the health care workers to adhere to it, education of healthcare workers regarding the importance of bundle implementation and central vascular catheter care and provision of prompt feedback on adherence to aseptic technique, empowerment of staff to stop non emergent central vascular catheter insertion if proper procedures are not followed, provision of recurring educational sessions on central line insertion, handling and maintenance, institution of an educational program for intensive care unit nurses caring for patients with central lines and provide them with opportunities to attend courses and workshops in relation to bloodstream infection prevention, Initiative of using facets strategies in which bundle is recommended to improve compliance with evidence-based practices, monitoring and evaluation of the catheter care practice as a part of the organizations program in quality management.

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