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Prevalence and Predictors of Central line Associated Infection in Jordanian Adult Patients hospitalized in Intensive Care Units

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Abstract

Background. *Central line associated blood stream infection is one of the main oncerns worldwide. Reduction of this problem is the main goal of nurses working in intensive care units to improve patients' safety and quality of care. Little is known about the endemic burden of this problem in developing countris.*

Aims and Objectives. *This study aimed to estimate the prevalence of central line associated bloodstream infection in adult patients hospitalized in intensive care units, in Jordan. Moreover, the study aimed at identifying significant predictors of central line associated bloodstream infection.*

Methods*. A retrospective design was used. The setting of this study was a University affiliated hospital in northern Jordan. Data from 300 medical records for adult patients hospitalized in intensive care units of the selected hospital, during the period from 1st January 2014 to 1st December 2015 were retrieved and recorded using researchers developed tools.*

Results. *The prevalence of central line-association bloodstream infection in intensive care units was 17.7 per 1000 central line days. Smoking, respiratory related disorders, blood transfusion, femoral site of central venous catheter significantly predicted the infection.*

Conclusion. *Assessment for risk factors contributing to infection in patients hospitalized in intensive care units is essential to build nursing care strategies targeting risky groups. Furthermore, establishing a national-wide surveillance programs at hospitals of*

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national and regional levels to prevent such infection in intensive care units are required.

***Key words**: Central line associated infection, Intensive care units, Jordan, Predictors and Prevalence*

1. Background

Central Venous Catheters (CVCs) or Central Lines are essential in every day medical practice, especially in Intensive Care Units (ICUs). In the United States (US), there are fifteen million CVC days for patients hospitalized in the ICUs [1]. Despite its benefits, CVCs are associated with many complications including CLABSI [2]. The CLABSI has been defined by the Centers for Disease Control and Prevention as a laboratory-confirmed primary bloodstream infection in patients who had a central line for at least 48 hours, which is not related to an infection at another site [3]. The infection should not be present at the time of admission to a health care facility [4].

In US, about 84.0% of primary bloodstream infections occurred ICUs [5]. According to the National Nosocomial Infection Surveillance System of the CDC [6] the rate of catheter-related bloodstream infection in ICUs range from 1.8 to 5.2 per 1000 catheter-days. Approximately, 90,000 new CLABSIs develop annually in the US hospitals [7] In Malaysian ICUs the incidence of CLABSI was 6.4 per 1000 catheter days [8]. In Saudi Arabia, the pooled CLABSI's rate was 10 per 1000 catheter days [9]. In India, the prevalence of CLABSI was reported as 14.59 per 1000 catheter days [10].

Another study indicated that the device associated infections are considered as greatest threat to the patient safety [11]. Data associated with the CLABSI and the catheter associated infections was analyzed along with the profiles of micro- organisms. The results of this study showed that the prevalence rates of CLABSI in Shanghai are more than in US. The research study also concluded that the infection control programs conducted for infection surveillance can improve the patient safety since these surveillance programs can implement guidelines to reduce the prevalence rates of infection and improve patient safety. This study has indicated that the prevalence rates of CLABSI are not only high in the US but have also affected the healthcare sector of other regions. Due to massive spread of CLABSI infections globally, this disease has become an important concern and priority of the healthcare sector, for which the efforts are being made in designing effective strategies [12].

In brief, CLABSI is a worldwide health problem that causes serious incremental increase in mortality rate, length of stay and depletion of health care resources. It was demonstrated that prevalence rates of CLABSI in ICUs patients is more in limited resource countries as compared to high income countries. Moreover, the limited number of studies about CLABSI prevalence and related risk factors in limited resources countries has also increased the significance of this study. As mentioned previously, there are no studies conducted specifically to identify the prevalence of CLABSI and related risk factors in ICUs patients in Jordan. Therefore, the identification of prevalence and contributing risk factors for CLABSI is essential to build an infection control program to prevent CLABSI.

Aims and Objectives

The aims of this study were to:

• Estimate the prevalence of CLABSI among adult patients hospitalized in ICU.
• Identify the significant predictors of CLABSI among adult patients hospitalized in ICUs.
• Based on the previous aims the following research questions were formulated
• What is the prevalence of CLABSI among adult patients hospitalized in ICUs?
• What are the significant predictors of CLABSI among adult patients hospitalized in ICU.

2. Literature Review

The World Health Organization (WHO) reported that CLABSI was the most frequent cause of healthcare acquired bloodstream infections [13]. The CLABSI related death rate in ICUs patients, ranges from 14% to 45.7% [14] [15]. The overall hospitalization period has been reported to be increased by a mean of 7.5 to 25 days [16].

The annual cost of treating CLABSI has been reported as $2 billion [17]. The economic burden of CLABSI has become a problem in countries with limited finance resources, including Jordan. Several risk

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factors for CLABSI in ICUs have been identified. These risk factors include CVCs, prolonged hospitalization, low nurses patients ratio, break in sterile technique during catheter insertion [18]. The administration of total parenteral nutrition, chemotherapy, tissue plasminogen activator, the use of open infusion container instead of closed infusion containe,18 invasive procedure such as tracheostomy, and neutropenia [18], [19], [20],[21], [23].

Although CLABSI is a serious condition and it can be prevented by identification of risk factors [24]. Identification of risk factors is essential to establish and promote infection control programs to reduce morbidity, mortality and health care costs. Different studies reported inconsistent findings about many risk factors [25]. In a study, the insertion site, jugular or femoral veins vs. subclavian vein and duration of catheterization were found to be significant risk factors for CLABSI [26]. Another study found no significant relationship between CLABSI and the catheter insertion site; or the duration of catheterization [19]. [27]. Moreover, other risk factors which related to economic status, insufficient resources, incompliance with hygiene practices and malnutrition, may be the determinants of hospital acquired infection in low and middle-income countries, but not in high-income countries [28]

Nurses have critical role in the prevention and control of CLABSI [29]. Central venous catheters are inserted by doctors and nurse specialists, but caring for CVCs is predominantly the responsibility of nurses [30] Therefore, the rate of CLABSI is considered as one of the most important nurse-sensitive patient outcomes [31] and a strong indicator for safety and quality of healthcare services provided for the patients [16]

In limited resources countries, CLABSI prevalence is expected to be higher than in the US,28 ranging from 1.6 to 44.6 per 1000 central line days in adult and pediatric ICUs, and have a significant impact on mortality since the developing countries have no adequate resources, skilled workforce, and proper medical equipments on general [32] A previous Jordanians study supported this notion in a way that they demonstrated that infection control guidelines and hand hygiene practices among healthcare providers were poorly followed [33]. In limited resources countries, the magnitude of CLABSI problem is even more serious, since there is scarcity in national established statistics [34]. Moreover, In Jordan there are no specific studies conducted to identify the prevalence of CLABSI in ICUs.

A study was conducted to compare the risk of CLABSI between the Peripherally Inserted Central Catheters (PICCs) and Central Venous Catheters (CVCs). For this purpose, a systematic review and meta analysis of previous studies was performed [35]. In this systematic review, twenty eligible studies indicated that the PICCs are associated with lower risk of CLABSI as compared to CVCs, but these lower risks are observed in outpatients. According to this study, in hospitalized patients, an association of CLABSI with CVCs and PICCs was found to be similar. This study has provided stronger evidences that Peripherally inserted Central Catheters and Central Venous Catheters can cause CLABSI.

Another study was conducted to determine the reasons behind the increased prevalence rates of CLABSI [36]. This study has reported that among hospitalized patients, children were the common victims of CLABSI. The results of the study indicated that those children who were younger or suffering from underlying metabolic and malignant condition or those who have insertions of PICCs in the lower extremities suffer from CLABSI. The authors concluded that the administration of parenteral nutrition for the treatment via PICC, pediatric exposure to ICUs and lengthy dwell time of catheters are the major risk factors that contribute in the development of CLABSI. This study has also indicated that the careful assessment of risk factors is important for preventing CLABSIs and reducing its prevalence rates specifically in hospitalized patients. The results of the first study were aligned with the results of the second study that also indicated increased prevalence rates of CLABSI in hospitalized patients [36]. Moreover, the latter study discussed some major points related to the high prevalence rates in limited resource countries. The study indicated that limited resource countries provide fewer facilities and poor quality of care services [32]. In addition, unavailability of educational programs and less awareness about the significance of hand hygiene also contributed to the progression and

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increased prevalence rates of CLABSI. The results of the study indicated that the prevalence rates of CLABSI ranged from 1.6 to 44.6 cases/ 1000 central line days in pediatric and adult ICUs and from 2.6 to 60.0 cases/ 1000 central line days in neonatal ICUs. The prevalence rates in limited resource countries were more than the benchmark rates of US National Healthcare Safety Network. This study has indicated that poor self hygiene increase the chances of infection transmission and decreased educational programs resulted in reduced awareness about CLABSI and its transmission sources. This study has reflected that the rates of CLABSI prevalence can be reduced by promoting information or making the society aware about the CLABSI facts and by maintaining proper hygiene.

3. Methods

In this study, a retrospective cross-sectional design was used. The three researchers extracted the required data from medical records of patients hospitalized in ICUs. The setting of this study was a University-affiliated hospital in northern Jordan. This hospital provides health care services for more than one million inhabitants in four governorates in northern Jordan. This hospital has 683 beds and 5 adults' intensive care units; neurosurgical ICU with capacity of 9 beds, medical ICU containing 12 beds, surgical intensive cardiac care unit of 10 beds and intermediate cardiac coronary care unit of 10 beds, and cardiac coronary care unit (CCU) of 12 beds.

Sample Size, Inclusion and Exclusion Criteria

Accessible population was the medical records of adult patients who had CVCs and admitted to ICUs of the selected hospital. A convenience sampling technique was used. Medical records of Jordanian patients who were 18 years old or greater and admitted to the adult ICUs, from 1st January 2014 to 1st December 2015 and had CVC were included in the study. However, Medical records of patients with preexisting CVC at the time of admission to the hospital and those patients who used the central line as arterial line or for renal dialyses were excluded. The sample size was calculated using the following formula (50+ 8*numbers of variables). To achieve statistically significance predictors of CLABSIs at alpha level less than 0.05 and beta level 0.20, a sample size of 298 medical records was selected.

Instrumentation

The following instruments were used to obtain the required information:

• Socio-demographic characteristic: seeks information about age, gender, marital status insurance of the participants.
• Clinical characteristics: including body mass index, smoking status (smoker or non-smoker), unit of hospitalization, Medical ICU, surgical ICU, general ICU, CCU, IMCU or SCICU, admission diagnosis, associated health disorders.
• Rank of CVC (the first CVC or more), site of CVC (subclavian, jugular, femoral, or peripherally inserted central venous catheter) and setting of insert CVC in ICUs settings or non-ICUs setting such as operating room, radiology unit, cardiac catheterization lab).

Dependant Variables

The dependent variable is the presence or absence of CLABSI, which had been identified from the registry of infection control unit and based on the physicians' diagnoses. The diagnosis of CLABSI must meet one of the following criteria:

• Patients had a recognized pathogen cultured from one or more blood cultures and the organism cultured from blood is not related to an infection at another site.
• Patient has at least one of the following signs or symptoms- fever, body temperature >38°C, chills or hypotension.
• The signs and symptoms and the positive laboratory results are not related to an infection at another site.

The CLABSI cases have been considered as ICU related infection if they were detected at least 48 hours after admission to the unit or less than 48 hours after discharge from the unit and the CVC should be inserted in hospital and should not be present on admission.

Data Analysis

Statistical package for Social Science (SPSS) for windows version 19.0 was used for data analysis.

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Descriptive statistics such as frequency, percentage, means and standard deviation were used to describe the socio-demographic and clinical characteristic of the sample, and to estimate the prevalence rate of CLABSI. In addition, binary logistic regression with odd ratio was employed to identify significant predictors of CLABSIs in adult patient who were hospitalized in ICUs.

Ethical Consideration

The Institutional Review Board of Jordan University of Science and Technology approved the study. Permission from the director of the selected hospital was obtained to use the electronic database and paper medical records. The obtained information was confidential and used for research purpose only. As far as the protection of the data is concerned, the data collected from the field is kept safely out of reach of inappropriate persons or institutions. The recorded data is stored using secure hardware, which is further protected by passwords. Only the identified research assistants are allowed to access the information.

4. Results

The researcher screened 825 medical records of patients who were admitted between 1st January 2014 and 1st December 2015 to adult ICUs and had central line during their hospitalization period to identify eligible patients. Only 425 medical records of the patients met the inclusion criteria. One hundred twenty five files were excluded; 80 files had incomplete data about CVC, 20 files of patients showed that the central line was used as arterial line by their physicians, 6 files of patients showed that their CVCs were used as dialysis catheters by their physicians and 19 file of patients indicated that the patient arrived to the hospital with already inserted CVC. Therefore, the final sample was 300 medical records.

Socio-demographic Characteristics of the Sample

As shown in Table 1, the sample (n=300) was older adult, more than two thirds of the sample were married, and more than half of the samples were male. However, only 14% of the sample did not have health insurance.

Table 1: Socio demographic characteristics of the sample (n=300).

Variable	CLABSIs Patients N (%)	Non-CLABSIs Patients N (%)	Total sample N (%)
Age M(SD)	56(20.14)	49.3(18.23)	49.9(18.47)
Gender			
Male	18(66.7)	162(59.3)	180(60)
Female	9(33.3)	111(40.7)	120(40)
Marital status			
Married	22(81.5)	192(77.1)	214(77.5)
Single	5(18.5)	57(22.9)	62(22.5)
Insurance			
Ministry of healt	9(33.3)	104(38.1)	113 (37.7)
Prime minister	7(25.9)	57 (20.9)	64 (21.3)
Royal court	3(11.1)	39 (14.3)	42 (14.0)
Other insurance	4(14.8)	35 (12.8)	39 (13.0)
No insurance	4(14.8)	38 (13.9)	42 (14.0)

Clinical Characteristics

As shown in Table 2, the most common admission diagnosis of the patients was circulatory system related disorders, neoplasms and endocrine related disorders followed by traumatic injury. Almost half of the sample had hypertension as associated health disorder, followed by Diabetes Mellitus. There are 51 patients who had malnutrition, about 11% had respiratory system related disorders or renal failure, and only 7 patients had neutropenia.

Table 2: Clinical characteristics of the sample (N=300).

Variables	CLABSIs N=27 N(%)	Non-CLABSIs N=273 N(%)	Total N=300 N(%)
Diagnosis			
Circulatory system related disorders	7(25.9)	93(34.1)	100(33.3)
Neoplasm's, endocrine	4(14.8)	76(27.8)	80(26.7)

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Variables	CLABSIs N=27 N(%)	Non-CLABSIs N=273 N(%)	Total N=300 N(%)
related disorders			
Traumatic injury	4(14.8)	38(13.9)	42(14)
Digestive, musculoskeletal related disorders.	2(7.4)	36(13.2)	38(12.7)
Respiratory system related disorders	3(11.1)	22(8.1)	25(8.3)
`Nervous system related disorder.	4(14.8)	7(2.6)	11(3.7)
Renal failure	3(11.1)	7(2.6)	10(3.3)
Health associated disorders			
Having hypertension	18(66.7)	123(45.1)	141(47)
Having DM	19(70.4)	94(34.4)	113(37.7)
Having malnutrition	21(77.8)	30(11)	51(17)
Having respiratory related disorders	11(40.7)	23(8.4)	34(11.3)
Having renal failure	12(44.4)	27(9.9)	33(11)
Having neutropenia	5(18.5)	3(1.1)	7(2.3)

As shown in Table 3, majority of patients were non-smoker, overweight. More than the half of the sample had more than two invasive tubes or received immunosuppressive drugs (corticosteroids or cyclosporine) during their CVC insertion period. Less than half of the sample received blood products via CVCs. Fifty patients reported other infection (ventilator associated pneumonia, urinary tract infection and surgical site infection) during CVC insertion period and before blood culture. About 12% had undergone invasive procedure. More than two thirds of the CVCs were inserted for the first time before blood culture. Surgical ICU is the most common unit in which half of the patients were hospitalized. On the other hand, the settings of insertion CVCs were non-ICU (operation room, cardiac catheterization lab and radiology lab) and ICUs (medical ICU, surgical ICU, CCU, general ICU, IMCU). The most common site of CVCs was the jugular vein, and subclavian vein. However, only (15%) were inserted via femoral vein, and (8%) via peripheral veins (PICC).

Table 3: Other clinical characteristics of the sample (N=300).

Variables	Patients with CLABSIs N (%)	Patients without CLABSIs N (%)	Total sample N (%)
BMI M(SD)	27.34(6.06)	27.35(5.49)	27.35(5.53)
Smoker	15(55.6)	68(24.9)	83(27.7)
Undergone surgery	13(48.1)	208(76.2)	221(73.7)
Having other infection	20(74.1)	30(11)	50(16.7)
Invasive procedure	14(51.9)	23(8.4)	37(12.3)
blood transfusion	22(81.5)	120(44)	142(47.3)
Received Corticosteroid or cyclosporine	20(74.1)	143(52.4)	163(54.3)
Number of invasive tubes	26(96.3)	160(58.6)	186(62)
-More than two tubes	1(3.7)	113(41.4)	114(38)
- Two tubes or less			
No of days in ICU before CVC	13(48.1)	212(77.7)	225(75)
- Zero day	14(51.9)	61(22.3)	75(25)
-One day or more			
Rank of CVC			

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Variables	Patients with CLABSIs N (%)	Patients without CLABSIs N (%)	Total sample N (%)
- First	14(51.9)	213(78)	227(75.7)
-Second or more	13(48.1)	60(22)	73(24.3)
Unit of hospitalization			
- Surgical ICU	11(40.7)	144(52.7)	155(51.7)
- SCICU	3(11.1)	65(23.8)	68(22.7)
- Medical ICU	8(29.6)	30(11)	38(12.7)
- IMCU or CCU	2(7.4)	18(6.6)	20(6.7)
- General ICU	3(11.1)	16(5.9)	19(6.3)
Settings of insert CVC			
-Operation room	4(14.8)	134(49.1)	138(46)
-Cardiac Catheterization lab	3(11.1)	69(25.3)	72(24)
- Medical ICU	9(33.3)	35(12.8)	44(14.7)
- Surgical ICU	4(14.8)	16(5.9)	20(6.7)
- CCU	2(7.4)	9(3.3)	11(3.7)
- Radiology lab	1(3.7)	7(2.6)	8(2.7)
- General ICU	3(11.1)	2(0.7)	5(1.7)
- IMCU	1(3.7)	1(0.4)	2(0.7)
Site of CVC	7(25.9)	126(46.2)	133(44.3)
- Jugular	5(18.5)	93(34.1)	98(32.7)
- Subclavian	14(51.9)	31(11.4)	45(15)
- Femoral	1(3.7)	23(8.4)	24(8)
- PICC			

SCICU: surgical cardiac intensive care unit, CCU: coronary care unit, IMCU: intermediate care unit, PICC: peripherally inserted central venous catheter. The definition of CDC for CLABSIs was used to calculate the prevalence of CLABSIs in ICUs patients. During the study period, there were 1525 central line days and 27 patients with CLABSIs. The rate of CLABSIs was 17.7 per 1000 central line days.

Predictors of CLABSIs in ICUs

The results of binary regression analysis showed that being smoker, having a respiratory system related disorders, received blood transfusion, received corticosteroids or cyclosporine and the femoral site of insertion were significant predictor of CLABSIs. Patients who were smoker, having respiratory system related disorders, having femoral CVC, received blood transfusion, received corticosteroids or cyclosporine were (3.53), (4.21), (8.11), (5.63), (9.33) folds more likely than their counterparts to develop CLABSIs respectively. Significant predictors of CLABSIs in ICUs are shown in Table 4.

Table 4: Significant predictors of CLABSI in ICUs

Variable	OR	*P*	95%CI
Being smoker	3.53	0.03	11.03-1.13
Having Respiratory system related disorders	4.21	0.02	14.59-1.22
Blood transfusion	5.63	0.01	20.73-1.53
Femoral site of the CVC	8.11	0.00	29.84-2.20
Receive corticosteroids or cyclosporine	9.33	0.00	38.31-2.27

Prevalence of CLABSI in Adult Patients in Intensive Care Units. High prevalence of CLABSI in adult patients in ICUs was reported in the current study (17.7/ 1000 CL days). This result is consistent with Rosenthal (2009), who reported that the prevalence of CLABSI was ranging from 1.6 to 44.6 in limited resource countries and congruent with an Indian study results (Kaur et al. 2015) which indicated that the rate of CVC-BSI was 14.59 per 1000 catheter days. However, the prevalence rate of CLABSI in the current study is greater than the results of other studies (Hu et al. 2013 & Sulong et al. 2011). In Sulong and colleagues' study (2011) that conducted in Malaysian ICUs the prevalence rates of CLABSI were 6.4 per 1000. In addition, in a Chinese study (Hu et al. 2013), the prevalence of CLABSI was 7.66/1000 CL days. The difference in CLABSI rate may be related to the utilization of different surveillance methods, diversity of CLABSI diagnosis criteria and availability of infection control programs.

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Predictors of CLABSI in ICUs

Being smoker, having respiratory system related disorders, received blood products, femoral site of CVC, received corticosteroids or cyclosporine are significant predictors for CLABSI. This result is congruent with those studies that showed that these variables can significantly predict CLABSI. Using femoral vein as insertion site of CVC can significantly increase the risk for developing CLABSI compared to using non-femoral insertion site (e.g. subclavian vein, jugular vein, peripheral vein). Many other studies showed significant difference in CLABSI rate based on the insertion site (Smith et al. 2011 & Haga et al. 2013). On the other hand, the conclusion of Marik, Flemmer & Harrison's.(2012). systemic review is incongruent with the current study's findings. The later study indicated that there were no significant differences between femoral, jugular or subclavian insertion sites in the rate of CLABSI.

The association between CLABSI and smoking is rarely described. Smoking has a negative impact on the immune system, because prolonged inhalation of tobacco alters many immunological functions which predispose patients to infection (Anderson & Stämpfli, 2009).

Using CVC for blood transfusion makes the catheter good media for growing and multiplication of microorganisms. Krause and colleagues (2013) reported that administration of blood product via CVC was a major risk factor for CLABSI. This is consistent with the finding of this study which has showed that the patients who had blood transfusion via CVC were significantly more likely to develop CLABSI than patient who had not.

The immune depressive effects of corticosteroids and cyclosporine may explain the significant increase in likelihood of developing CLABSI in patients who has received these medications in the current study. There are no studies that have investigated the association between CLABSI and receiving corticosteroids or cyclosporine. However, Al-Rawajfah and his colleagues (2009) found that patients who received corticosteroids were more likely to develop nosocomial bloodstream infection. Management of chronic respiratory related disorders required patients to use corticosteroids for long period of time and increase the susceptibility of having microbial infections (Juhn, 2014). This result may explain the results found in this study, which indicated that, patients with respiratory related disorders can significantly predict the development of CLABSI.

5. Limitations

The current study had some limitations which should be considered in a thoughtful manner in future studies. The current study was conducted in one hospital with convenient sampling technique, which may affect the representativeness of all ICU patients with CLABSI in Jordanian hospitals. The sample size was small which limits the generalizability of the current study's findings.

6. Conclusion

This study revealed a high prevalence of CLABSIs among intensive care unit patients in Jordan compared to reported prevalence rates in developed countries. Moreover, the study showed important risk factors for CLABSIs among ICUs' patients in Jordan such as; smoking, femoral site insertion, respiratory system related disorders, received corticosteroid and cyclosporine therapies or blood transfusion.

7. Recommendations and Nursing Implications

Implication for Education

The continuous education program must focus on educating nurses about CLABSI risk factors and effective prevention and management strategies. Appropriate education can give nurses the confidence and power to play their role in prevention of CLABSI while dealing with patients who had CVC. The curriculum should be based on universal guidelines, with consideration of patient's health status and the available infection control resources.

Implication for Practice.

The high prevalence of CLABSI among ICU patients (revealed in the current study) has created a need for comprehensive assessment of patients with CVC from the date of CVC insertion until the date of discharge, to identify the most vulnerable patients. This assessment should be unified using a comprehensive tool based on evidence-based guidelines.

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Implication for Research. More studies are needed to assess the prevalence of CLABSI in ICU and non-ICU patient among various regions of Jordan. Additional studies are also needed to examine the effectiveness of applied infection control program on the incidence of CLABSI using randomized control trials design.

8. Conflict of Interest

We, the authors of this study declare that we have no propriety, financial, professional or other personal interest of any nature in any product that could be construed as influencing the review of the manuscript "Prevalence and Predictors of Central line Associated Infection in Jordanian Adult Patients hospitalized in Intensive Care Units".

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