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A Prospective Study of Epidemiology of Central Line Associated Bloodstream Infections at aTertiary Hospital Makkah Saudi Arabia

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ABSTRACT

Background and Objective: *The epidemiology of central line-associated bloodstream infections in Al Noor Hospital Specialist Hospital has not previously been reported. We sought to describe time-trends in central line-associated bloodstream infections rates, etiology, and responsible pathogens for the period January 1, 2016-December 31, 2018.* ***Materials and Methods:*** *All 120 patients age 18 years and older admitted to all departments of a Tertiary Hospital who had double lumen catheters inserted during the study period were followed up and monitored for central line-associated bloodstream infections.* ***Results:*** *From 120 patients who had a central venous catheter inserted, 20 developed blood infections. The catheterization duration was significantly longer with approximately 11 days among the infected against 6 days in non-infected. The most frequently isolated organism was Klebsiella pneumonieae. The infection rate recorded were 30.67, 23.06, and 16.39 per 1000 catheter days in 2016, 2017, and 2018 respectively. The overall rate for the 2 years of study was 24.06 per 1000 catheter days.* ***Conclusion:*** *Keeping the catheter beyond the period required increases infection rate while avoiding femoral catheter site insertion leads to reduction. If the Line Care Protocol of best practices and education of staff regarding the protocol are implemented infection rates will reduce.*

Keywords: Catheter related bloodstream infections, Central-venous-catheter, Isolated microorganism, Al Noor Specialist Hospital

INTRODUCTION

Central Line Related Blood Stream Infections (CLABSI), defined as the presence of bacteremia originating from an intravenous catheter, accounts for 11% of all healthcare-associated infections [1]. According to the Centre for Disease and Drug Control (CDC), CLABSI is one of the leading causes of death and disability among patients with end-stage renal failure [2]. Studies have further confirmed that a single episode of CLABSI can independently increase hospital stay from 7 to 21 days and healthcare-related cost from $4,000 to $56,000, putting a substantial economic burden on the healthcare resources of a country [3,4]. CLABSI rate in a hospital is therefore an important quality indicator to assess its healthcare standards [5]. These bloodstream infections among hemodialysis patients are potentially preventable and their prevalence in a healthcare setting can be significantly reduced through evidence-based infec-

tion prevention and control measures such as practicing hand hygiene, adherence to aseptic techniques, use of PPE, and chlorhexidine dressings; collectively referred to as "CVC Care Bundle". Nevertheless, there exist individual risk factors that can independently increase the rate of CLABSI among hemodialysis patients even in the face of best infection control strategies. These risk factors include the type of central venous catheter, operator's experience, presence of neutropenia, duration of catheterization, and lengthy hospitalization before insertion of catheter [6,7]. This study assesses the rates of CLABSI among patients admitted in Al-Noor Specialist Hospital, determines the incidence of central line-related bloodstream infections among patients, identifies the commonest organisms responsible for CLABSI among patients, and documents the predisposing factors among patients leading to an increase in the risk of acquiring CLABSI. Knowledge gained through this study will allow the Infection Prevention and Control Department to implement evidence-based practices in the Hospital regarding the care of patients with a central line to ensure better and improved outcomes.

MATERIAL AND METHODS

This is a prospective observational study conducted between January 2016 to December 2018. In total, 120 patients admitted to a Tertiary Hospital in various departments who had double lumen catheters inserted mainly for hemodialysis (and few patients who had plasmapheresis through it) and with CLABSIs were included. Patients were then followed up and observed for signs of infection including fever, redness, or any pus discharge from the catheter site, rising white-blood-counts, and culture positive. Other causes of infection were excluded. Data were collected using a standard form to gather the information that included patient characteristics, potential underlining factors predisposing patients to CLABSI, CVC access site, and type, and microorganisms isolated through blood cultures. Central line-associated bloodstream infections were defined according to the CDC as the presence of clinical signs of infection, for example, culture growth of the same bacteria from blood extracted from peripheral vein, catheter tip, or blood from catheter of any patient with no other source of infection apart from the catheter [8]. The study included all patients aged 18 years and older admitted to this Tertiary Hospital that requires central line insertion. Those that got transferred to the hospital but had their catheter inserted outside were excluded.

Statistical Analysis:

Statistical analyses were performed with SPSS 20.0 for Windows software (SPSS Inc., Chicago, IL, USA). Data are presented as mean ± SD, median (range), and frequency in percentage (%). Frequencies were compared using the chi-square test. A p-value of <0.05 was considered significant. The CLABSI rate is calculated per 1,000 catheter days. Ethics approval: This study was first approved by the Institutional Review Board of Al-Noor Specialist Hospital, Ministry of Health. Written consent was obtained from the patient to participate in the study.

RESULTS AND DISCUSSION

Characteristics of patients in this study are shown in Table 1. In total, 120 patients who had a CVC placed from various departments of the hospital were prospectively followed during the study period (January 2016-December 2018) out of which 20 developed CLABSIs. Out of the total patients, 64 (53.3%) were male while 56 (46.7%) were female with a mean age of 60 years (Table 1). Eighty (66.7%) patients had a femoral catheter insertion site. Indication for catheterization in the majority 112 (93.3) was for hemodialysis while the remaining 8 (6.7%) had it due to other clinical conditions. The catheterization duration was significantly longer in patients with a CLABSI ($p=0.003$) with a duration of approximately 11 days among the infected while in non-infected it was 6 days.

Table 1 Characteristics of patients

Characteristics	Mean/No (%)	Sig.
Age		
Mean age	60	0.494
Gender		
Male	64 (53.3)	0.413
Female	56 (46.7)	
Total	120 (100.0)	
Nationality		
Saudi	68 (56.7)	0.869
Non Saudi	52 (43.3)	
Total	120 (100.0)	
Indication for Central Line (CL)		
Hemodialysis (HD)	112 (93.3)	0.743
Non HD	8 (6.7)	
Total	120 (100.0)	
Past History of CLABSI		
Yes	13 (10.8)	0.003
No	107 (89.2)	
Total	120 (100.0)	
Site of catheter		
Lt femoral	26 (21.7)	0.462
Rt Femoral	54 (45.0)	
Not specified	40(33.3)	
Total	120 (100.0)	
Types of catheter		
Temporary	119 (99.2)	
Permanent	1(0.8)	
Total	120 (100.0)	
Catheter Length of Stay (CLS)		
Mean CLS (infected)	10.85	0.003
Mean CLS (non infected)	6.14	

Table 2 presents the type of microorganism isolated among those infected. Type ranges from *E.coli* MRSA, *Staphylococcus aureus*, *Stenotrophomonas,* and *Klebsiella pneumonieae*. The most frequently (35%) isolated organism was *Klebsiella pneumonieae*.

Table 2 Types of microorganism isolated among infected patients

Organism	No.	%	Sig.
E.coli	1	5	<0.001
Klebsiella pneumoniae	7	35	
MRSA	1	5	
Staphylococcus aureus	1	5	
Stenotrophomonas	1	5	
No growth	9	45	
Total	20	100	

Table 3 displays the CLABSI rates per year throughout the study period of January 2016 to December 2018. The highest rate 30.67 per 1000 catheter days occurred in 2016, followed by 23.06 in 2017 and declined significantly to 16.39 in 2018. The overall rate for the whole year of study 2016 to 2018 was 24.06 per 1000 catheter days.

Table 3 Infection rate per the year 2016-2018

Year	Catheter infected	Length of stay	Infection rate per 1000
2016	5	163	30.67
2017	14	607	23.06
2018	1	61	16.39
All	20	831	24.06

DISCUSSION

Central Line-Associated Bloodstream Infection Rates

Our study results showed that the CLABI rate overall between 2016 and 2018 was 16.39 per 1000 catheter days. The rates were 30.67, 23.06, and 16.39 in 2016, 2017, and 2018 respectively per 1000 catheter days. These rates though higher than those obtained in countries such as US rate variation like these findings were reported in the WHO South-East Asia Region. For example, such as found in a study carried out by Singh et al., in India, a rate of 0.48 CLABSIs per 1000 CL days who found [9]. Similarly, other studies in the Region such as Chopdekar et al., found CLABSI rates of 27.065, and Singh et al., also found 16.0,66 CLABSIs per 1000 CL days [10,11]. A recent systematic literature review and meta-analysis carried out by Ling et al., also in the South-East Asia Region showed the pooled incidence density of CLABSI to be 4.7 per 1000 catheter-days (95% CI, 2.9-6.5) [12]. Correspondingly, the results in the Eastern Mediterranean WHO Region were similar or higher than obtained in our study. In Iran, the study by Johnson et al., showed 29.3 CLABSIs per 1000 CL days and that of Askarian et al., was 147.3 CLABSIs per 1000 patient-days [13,14]. Findings in the previous study in Saudi Arabia by Balkhy et al., was 8.2 CLABSI rate per 1000 CL days which is similar to the 10.0 rate found by AlTawfiq et al., also in Saudi Arabia [15,16]. The rates in our present study were similar to two studies from Tunisia conducted by Ben Jaballah et al., who found the CLABSI rates per 1000 CL days to be 15.3 and 14 respectively [17,18]. However, in the European WHO Region, the CLABSI rates were lower. For example, in Turkey rates varied ranging from 2.8 CLABSIs per 1000 CL found Tutuncu et al., and 3.8 found by Yalaz et al., days [19,20]. Other studies in the Region such as that of Huang et al., and Dogru et al., reported 7.69 and 11.8 respectively [21,22].

CLABSI Causative microorganism

In our study, we found a common statistically significant (p=0.000) causative organism to be *Klebsiella pneumoniae* (35%) of all isolated microorganisms. Others are the *E.coli*, MRSA, *Staphylococcus,* and *Stenotrophomonas*. Other studies found coagulase-negative *Staphylococci*, *Staphylococcus aureus*, *enterococci*, and *Candida spp.* to be the most frequently reported causative pathogens [23]. In CLABSIs reported to CDC by Gaynes R, Edwards, Gram-negative bacilli accounted for 19% while it accounted for 21% Surveillance and Control of Pathogens of Epidemiological Importance (SCOPE) database, respectively [24,25]. Methicillin-resistant *Staphylococcus aureus* (MRSA), *Klebsiella pneumoniae,* and *E. coli* isolated are very important due to their antimicrobial resistivity [24].

Intrinsic Risk Factors (non-modifiable characteristics of patients)

These factors include the patient's age, underlying diseases or conditions, and patient's gender. In our study, no statistically significant difference was found in any of these factors except those who had a previous history of CLABSI (p=0.003). Other studies also found no significant relationship between CLABSI and age, sex, or APACHE II scores of the patients [11]. However, we found most patients who had the catheter to be patients on hemodialysis. Among these patients, infection is the most common cause of morbidity, and the second most common cause of death [1]. These infections are numerous and costly as found by a study in 2008 estimated 37,000 BSIs among hemodialysis patients with central lines [2]. Another study a long time ago estimated the cost to treat 1 Bloodstream Infection (BSI) as a result of *Staphylococcus aureus* to be $24,034 [3]. The implication of this can be understood better when one considered another estimated incidence of sepsis in end-stage renal disease patients found to be up to 100 times higher than

in the general population [4]. These risks are prone to increase considering the suggested estimate that the number of patients with end-stage renal disease may increase to 150% by 2020 [1]. Centres for Disease Control and Prevention (CDC) has therefore labeled the challenge as a national priority5 and leading authorities in the field to conclude and the body suggested a more proactive prevention procedure to be part of all routine patient care [6].

Extrinsic Risk Factors (potentially modifiable factors associated with CVC insertion or maintenance) These factors include the prolonged hospitalization before CVC insertion, Multiple CVCs, Parenteral nutrition, Femoral or internal jugular access site, Heavy microbial colonization at the insertion site, Multilumen CVCs, Lack of maximal sterile barriers for CVC insertion, CVC insertion in an ICU or emergency department. In our study, the site commonly used for CVC insertion was femoral. The recent evidence-based prevention of CLABSI advice emphasizes avoiding femoral veins among others known as prevention bundles [8-10]. Previous studies by Lorente et al., and Frasca et al., reported increased infection and complications when the insertion site was either femoral or internal jugular [8,9]. A more recent study also found more frequent infection rate increased when the catheter was inserted through a femoral route ($p = 0.015$) [9].

RECOMMENDATION AND CONCLUSION

This study concludes that strict infection control practices with an emphasis on optimum hand hygiene, use of CLABSI prevention bundles, and avoiding femoral CVC insertion site will drastically reduce the incidence of CLABSI.

DECLARATION

Significance Statement

The occurrence of bacteremia intravenous catheters is a serious healthcare issue. Our study found the history of CLABSI to cause reoccurrence while the most causal organism is *Klebsiella pneumoniae*. It is suggested that the catheter be promptly removed after use

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Authors' contributions

MMA designed the study and interpreted the results. AHA (corresponding author) designed the study tools, performed the preliminary statistical analysis, interpreted the results, prepared the manuscript for publication, and submitted the final manuscript. HK performed final statistical analysis. ZH drafted the study protocol and collected data and critically revised the methodology. DA coordinated data collection and performed data entry. SA drafted the initial study design and reviewed the initial results. NAM participated in data collection. All authors read and approved the final manuscript.

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