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Risk of Developing Central Line-Associated Bloodstream Infections in Integrated Health Care System of Pakistan-A Meta-Analysis

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Abstract

Studies regarding the prevalence of CLABSIs in Pakistan are limited. However, it is known that healthcare-associated infections are a concern in many low- and middle-income countries, including Pakistan. The present study is aimed to identify the relative risk of developing CLABSIs in the hospital care setups of Pakistan. The risk of biases in included studies was assessed using Cochrane tool parameters. Analysis of results revealed a relative risk of getting CLABSIs is 1.78 ($p<0.001$) among patients admitted in the hospitals for greater than 72 hours. This shows that the chances of getting infected at the central line site were more than 50% among patients admitted to ICUs in Pakistan. It has been concluded that the relative risk of CLABSIs in the integrated healthcare system of Pakistan is high.

Keywords

Healthcare system, Hospital-acquired infections, Risks

Introduction

Central Line-Associated Bloodstream Infections (CLABSIs) are a type of Healthcare-associated Infection (HAI) that occurs when bacteria or other germs enter the bloodstream through a central line[1-2]. Central lines are medical devices inserted into a large vein, usually in the neck, chest, or groin, and are used to give fluids, blood products, or medications or to monitor a patient's blood pressure[3]. CLABSIs can be severe and even life-threatening and are a significant concern in healthcare settings. The global prevalence of CLABSIs varies depending on the setting and population[4]. In healthcare settings such as hospitals and long-term care facilities, the prevalence of CLABSIs can be relatively high[5-6]. According to a systematic review and meta-analysis published in the Journal of Hospital Infection in 2016, the global incidence of CLABSIs in hospitalized patients has been estimated at 5.1 cases per 1,000 central line days[7].

However, the prevalence of CLABSIs can also be influenced by factors such as the type of central line used, the patient population, and the infection control practices in place[8]. For example, CLABSIs can be higher in intensive care units and patients with weakened immune systems[9-10]. Many organizations prioritize the prevention and control of CLABSI, such as the World Health Organization, the Center for Disease Control and Prevention, the European Centre for Disease Prevention and Control and the National Health Service in the UK, among others[11]. They have been promoting the implementation of evidence-based guidelines and interventions to reduce the incidence of CLABSIs. Studies regarding the prevalence of CLABSIs in Pakistan are limited. However, it is known that HAIs such as CLABSIs are a concern in many low- and middle-income countries, including Pakistan. Various factors, including a lack of infection control measures, limited access to healthcare, and a high burden of other infectious diseases[12], can influence the prevalence of CLABSIs in these countries.

In Pakistan, the healthcare system faces multiple challenges, such as inadequate infrastructure, a shortage of healthcare professionals, and a lack of infection control measures. These factors can contribute to a higher risk of HAIs, such as CLABSIs1[3].

In order to reduce the risk of CLABSIs and other HAIs, it is crucial for healthcare facilities in Pakistan to implement evidence-based infection control measures, such as proper hand hygiene, adherence to central line insertion and maintenance guidelines, and regular monitoring and reporting of infections[14].

It is also important to note that data on the prevalence of HAIs, including CLABSIs, in Pakistan may be limited and may need to accurately reflect the actual burden of these infections in the country[15]. Therefore, the present study is aimed to identify the relative risk of developing CLABSI in the hospital care setups of Pakistan.

Methodology

Electronic Databases and Searching Strategies

Numerous databases such as Google Scholar, PeDro, MEDLINE, Cochrane Library, EMBASE and Web of Science were searched by two independent reviewers using the MeSH terms like "CLABSIs", "Hospital Infection", "Venous Catheter" to obtain studies on the desired topic.

Criteria for Eligible Studies and Participants

Inclusion criteria comprised for induction of all those studies in which the relative risk of CLABSIs was determined among the patients admitted in intensive care units of tertiary care hospitals of Pakistan, and their stay was extended for greater than 72 hours. All studies meeting the inclusion criteria and conducted from 2009 to 2022 were included. The meta-analysis was performed on the guidelines of Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) illustrated in the form of flow chart1[5-16] (Figure-1).

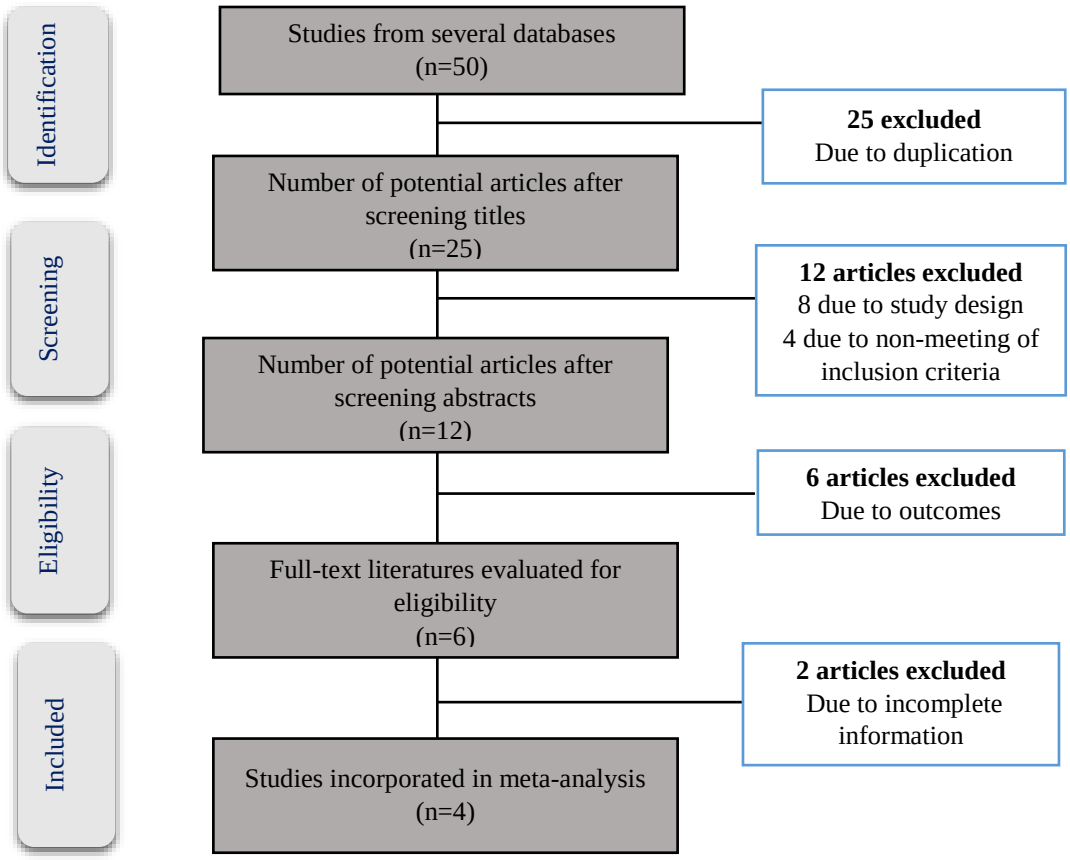

Figure-1 Flow chart based on guidelines of PRISMA

Studies based on determining HAIs other than CLABSIs site and all evidence that were not available in English language and studies for which open accesses were not reachable even after emailing the corresponding authors were excluded from this meta-analysis. Additionally, a data mining form was designed for extracting study information, such as author name, publication year, targeted population, and treatment duration, represented in Table-1.

Table-1 Description of studies incorporated for the purpose of Meta-Analysis

Author & Year of Publication	Total Sample Size (n)	Patient developed CLABSIs (n)	Duration of Hospital Stay
Hussain et al 2021[17]	613	45	2 to 68 days
Sayeed et al 2020[18]	138	80	13.3 days
Babar et al 2020[19]	137	78	3 days
Farooqi et al 2013[20]	174	29	12 days

Assessment of Risk of Bias

The risk of biases in included studies was assessed using the risk of a bias assessment tool for observational study[21]. Risk of bias assessment was performed on the following criteria: Selection Bias, Information Bias, Measurement Error, Confounding and other errors.

Quantitative Analysis

For quantitative analysis, MedCalc Statistical Software version 20.112 was employed. Continuous Measure Analysis calculated the pooled impact based on Standardized Mean Difference (SMD) at 95% confidence intervals. The effect size was assessed using Cohen's rule of thumb, which classified an effect size based on three parameters: small if the values of SMD are between 0.2 and 0.5, moderate if the values are between 0.5 and 0.8, and large if the values are more than 0.8. The I^2 number was used to evaluate the amount of heterogeneity based on the random and fixed effect models (I^2=50 Fixed effect, I^2>50 Random effect).

Results

Study Flow

A total of 1062 participants included in the four studies were analyzed to determine the relative risk of developing CLABIs among patients admitted in ICUs of the integrated healthcare system of Pakistan. Study flow was based on the initial retrieving of articles that were 50, for which 25 studies were excluded due to duplication. After further screening, 21 more studies were excluded that were not meeting the inclusion criteria. Finally, 4 studies were included that were further analyzed to fulfill the objective of this meta-analysis.

Estimating Relative Risk of developing CLABSIs among patients admitted in ICUs

The analysis of the finding revealed a high relative risk (RR) of CLABSIs among patients admitted to the ICUs of integrated healthcare systems in Pakistan. Analysis of results revealed a Relative Risk of getting CLABSI is 1.78 (CI 1.34 to 2.37) $p<0.001$ among patients admitted in the hospitals for greater than 72 hours. This risk shows that the chances of getting infected at the site of the central line were more than 50% among patients admitted to ICUs in Pakistan. Individual study data, along with pool effect and graphical representation in the form of forest plot, as illustrated in Table-2, Figure-2.

Table-2 Relative risk of getting infected at the site of central line

Study	Exposed	Unexposed	RR	95% CI	z	P	Weight (%)	
							Fixed	Random
Hussain et al 2021[17]	31/301	14/312	2.295	1.246 to 4.228			6.69	14.96
Sayeed et al 2020[18]	33/37	47/101	1.917	1.512 to 2.430			44.36	35.64
Babar et al 2020[19]	78/137	59/137	1.322	1.038 to 1.683			42.84	35.33
Farooqi et al 2013[20]	29/174	12/174	2.417	1.275 to 4.579			6.11	14.06
Total (fixed effects)	171/649	132/724	1.699	1.424 to 2.028	5.886	<0.001	100.00	100.00
Total (random effects)	171/649	132/724	1.784	1.340 to 2.375	3.968	<0.001	100.00	100.00

Test for Heterogeneity	
Q	7.23
DF	3
p-value	0.06
I^2 inconsistency	58.56%
I^2 95% of CI	0.00 to 86.21

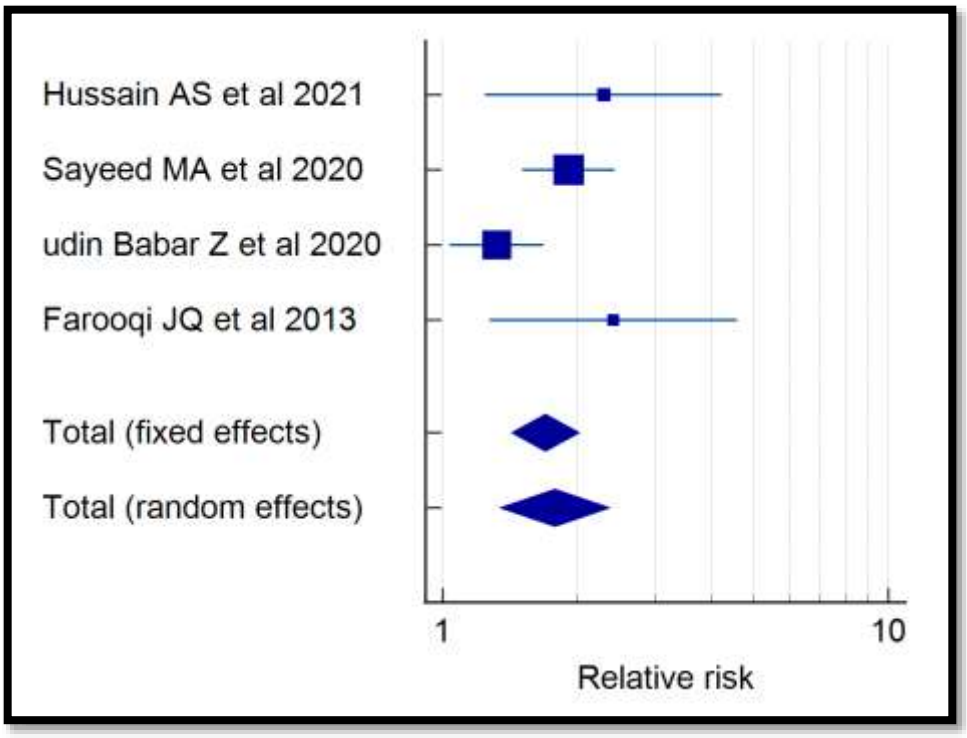

Figure-2 Forest Plot illustrating RR of CLABSI in health care system of Pakistan

Further application of Egger's and Begg's test suggested that the studies incorporated for analysis had shown no publication bias p=0.41, hence extending strong support for a high rate of CLABSI in the hospitals of Pakistan (Table-3).

Table-3 Identification of Publication biases	
Egger's Test	
Intercept (95% of CI)	1.93 (-6.18 to 10.05)
p-value	0.41
Begg's Test	
Kendall's Tau (p-value)	0.00 (1)

Risk of Bias Assessment

The risk of bias analysis was based on the author's judgment. It was guided according to the guidelines for analyzing the bias risk in an observational study and was illustrated in Table-4.

Selection Bias

The selection bias analysis suggested that all four studies revealed a low risk of bias[17-20].

Information Bias

All studies under this parameter revealed a low risk of information bias, per the author's judgment[17-20].

Measurement Errors

Two studies[17-18] considered the low risk of measurement error, whereas two studies[19-20] reflect unknown risk.

Confounding

As per the author's understanding, none of the studies showed any biases on a confounder risk factor.

Other Errors

Other errors were estimated based on lead time bias, and ecological fallacy and all four studies reflected a low risk of bias[17-20].

Table-4 Assessing Risk of Bias using a Cochrane Collaboration's Tool

Studies	Selection Bias	Information Bias	Measurement Errors	Confounding	Other Errors
Hussain et al 2021[17]	+	+	+	+	+
Sayeed et al 2020[18]	+	+	+	+	+
Babar et al 2020[19]	+	+	?	+	+
Farooqi et al 2013[20]	+	+	?	+	+

–, bias at high risk
+, low risk bias
? , unknown risk of bias

Discussion

This study's finding provided evidence that Pakistan's integrated healthcare systems bear a high risk of developing CLABSIs among patients admitted to intensive care units of hospitals for more than 72 hours. Studies have provided evidence that the risk factors for CLABSIs include; prolonged use of a central venous catheter, poor catheter maintenance and hygiene, and contamination of the catheter or the patient's skin during insertion[22]. Other risk factors include; being in an intensive care unit, having a weakened immune system, having a history of previous infections, and having a catheter placed in a non-sterile environment. However, studies identifying the relative risk of CLABSIs in an integrated healthcare system are not well-established. Some studies have suggested that these systems, which integrate primary care and

specialty care, may have lower rates of CLABSIs due to improved care coordination and better communication among healthcare providers[23]. However, other studies have not found a significant difference in CLABSIs rates between integrated and traditional healthcare systems. It is important to note that many factors, such as the quality of care, the training of the staff and the organizational culture, the use of evidence-based guidelines for the insertion, maintenance, and removal of central venous catheters, and the use of infection prevention and control practices can influence the CLABSIs rates. It is also important to note that an integrated healthcare system may include primary and specialty care and telehealth, home health care, and long-term care facilities. Evidence is available that supports the fining of our study, particularly of developing CLABSIs in hospitals setups of developing countries in which the authors had come to the findings that several factors, such as 1) Limited access to healthcare: In many developing countries, healthcare resources are scarce, and access to primary medical care is limited. This can lead to overcrowding in hospitals, inadequate staffing, and poor infection control practices 2) Limited infrastructure and equipment: Developing countries may have inadequate or outdated medical equipment and facilities, which can increase the risk of infections 3) Limited education and training: Healthcare workers in developing countries may have limited education and training on infection control practices, which can lead to poor practices and increased risk of infections 4) Socio-economic factors: Socio-economic factors such as poverty, malnutrition, and poor living conditions can also increase the risk of infections in developing countries and 5) Limited surveillance and reporting: Developing countries may have limited surveillance and reporting of healthcare-associated infections, which makes it difficult to assess the actual risk of CLABSIs accurately leads to the increase in relative risk of developing infection[24-25].

Conclusion

Hence based on the findings of the current meta-analysis, we have concluded that the relative risk of CLABSIs in the integrated healthcare system of Pakistan is high and based on the findings of available evidence, the causes of high RR of CLABSIs in health care setups of developing countries are due to limited access to healthcare, limited infrastructure and

equipment, limited education and training, socio-economic factors, and limited surveillance and reporting.

Authors Contribution

Nasir A: Conception, design and drafting.

Khawaja F: Drafting and data acquisition.

Khan GN: Critical revision.

Declaration of Interest

None.

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