The Impact of Quality Improvements Initiatives on Reducing the Prevalence of Central Line-Associated Infection: an Integrative Review

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Abstract

Aim: This review aims to assess the effect of quality improvement initiatives on reducing the rate of CLABSI.

Method: This study used Whittemore and Knafl's method to enable researchers to systematically and organize a search for studies. Whittemore and Knafl's integrative approach structure consists of five stages (problem recognition, literature search, data assessment, data interpretation, and presentation). The empirical literature on quality improvement projects and initiatives on reducing the rate of CLABSI was reviewed and analyzed based on Whittemore and Knafl's framework to draw an overall conclusion about what is effective over the quality improvement projects in the infection rate.

Finding: Nine articles fit the study inclusion criteria 7 were Q.I., and two were a mixed method. The nine articles' findings were classified into two themes: (1) Central line bundle care and (2) Education on CLBSAI insertion and maintenance.

Conclusion: This review found quality improvement projects decrease the incidence of CLABSI, improve patients' mortality, and reduce hospitalization days. Therefore, care bundles should be performed as a routine protocol. To be more successful, bundles of care should concentrate on these risks. During the catheter insertion, compliance with barrier precautions is desirable to minimize the probability of infections. Staff education and training positively impact the prevalence rate, utilizing maximal sterile obstacle safety measures that include sterile full-body drapes, sterile gloves, sterile gowns, masks, and caps, all central venous catheters are placed.

Keywords: Quality improvements; CLABSI prevalence

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Introduction

CLABSIs cause mortality and morbidity in ICU patients. CLABSI rates have been successfully reduced in ICU settings in many Q.I. (quality improvement) studies; however, there is still significant variability in practice due to poor adherence to evidence-based CLABSI preventive steps [1-4].

CLABSI is a common infection in the critically ill population, accounting for 10%–20% of all HCAIs. Its prevention has played a significant role in infection control measures for a long period [3]. Although CLABSIs are largely preventable, they continue to be associated with increased morbidity, risk of death, length of stay, and hospitalization costs [5]. Recent research indicates that quality improvement initiatives can help reduce CLABSI rates; however, clinicians frequently struggle to follow evidence-based preventive practices [6-8]. Certain organizations are more responsive to infection control and prevention strategies than others [9-16]. Changing clinical behavior is a difficult task; thus, it is necessary to understand better the behavioral influences on implementing CLABSI prevention measures (Young et al. 2006). Additionally, it has been emphasized that implementation studies must consider or quantify the potential impact of context on quality improvement efforts aimed at facilitating practice changes [9].

There is also a lack of knowledge about how and why those active Q.I. strategies work; some are more effective than others at lowering CLABSI rates. The novel risk factors among PICU patients include >80 CVC accesses three days before CLABSIs and acute behavioral health essentials. In these high-risk populations such as PICU patients, interventions concentrated on these factors can minimize CLABSI. The application of multiple central venous catheters in pediatric intensive care units (PICU) for an extended period at once is the major risk issue for CLABSIs.

Along with increased healthcare costs and lengthened hospital stays, CLABSIs are associated with an increase in attributed mortality from 4% to 37%, even though central venous catheters are required in PICUs [13]. CLABSI rates vary between developing

and developed economies.

The rates of central venous catheterization in developing and developed economies are 6.5 and 1.2 cases/1000 central venous catheters, respectively (CVC).

In adult populations, risk factors for CLABSI include the type of dressing used and whether aseptic insertion techniques are used, the presence or absence of immunosuppression, the severity scores, the absence or presence of underlying health conditions, the duration of CVC use, and the location of CVC insertion.

To identify novel infection prevention targets, we examined modifiable and novel risk factors for CLABSIs.

The purpose of this paper is to assess the effect of quality improvement projects on reducing bloodstream infections associated with central venous catheters.

Research Method

To find studies focusing on the Q.I., the authors conducted a systematic analysis using an integrative approach based on Whittemore and Knafl [17]. This method enabled researchers to include studies that used various study designs, including experimental and non-experimental research, to understand the effect of Q.I. projects on CLABSI rate. When doing an integrative study, Whittemore and Knafl's [17] integrative approach structure consists of five stages (problem recognition, literature search, data assessment, data interpretation, and presentation). The empirical literature on quality improvement projects and initiatives on reducing the rate of CLABSI was reviewed and analyzed based on Whittemore and Knafl's framework to draw an overall conclusion about what is effective over the quality improvement projects in the infection rate.

Search strategy

We conducted a broad search in multiple databases. Our research focused on the quality improvement projects and study, which

had the primary goal of reducing the infection rate. The following steps were adopted: organization of a topic; establishing a guiding question; establishing inclusion and exclusion criteria; outline information to be extracted from the selected studies; critical assessment of studies; and interpretation of results. The search was conducted using (PUBMED, Science Direct, and Saudi digital library), using the terms "quality improvement," "catheter-related infections," "Health associated infection," "prevention," prevalence," and "central venous catheter rate." The first stage used each descriptor in isolation, associating each to filters available in the Database, such as language and date of publication. Papers titles and abstracts, and keywords were read to select the ones that indicated the use of intervention or project to reduce the CLBSAI rate. The next step was adopting the following exclusion criteria: Diagnostic studies; studies were addressing nurse's knowledge; experiments with skin antisepsis agents; and studies addressing hemodialysis catheters. Following that, papers that did not address quality improvement were excluded. Finally, inclusion criteria were: papers published from 2011 to 2021; available online; written in English only; studies addressing quality improvement project or intervention; describing the use and assessing the intervention's impact on CLBSAI rate. The flowchart **(Figure 1)** presents the search process and the number of selected papers. The search produced 37 articles. Around 21 articles were excluded due serval reasons regarding the language, publishing date, or the study designed. Only nine articles fit the study inclusion criteria 7 were Q.I., and two were a mixed method. Studies summer presented in **Table 1.**

Finding

The nine articles' findings were classified into two themes: (1) Central line bundle care and (2) Education on CLBSAI insertion and maintenance**.**

Central line bundle care

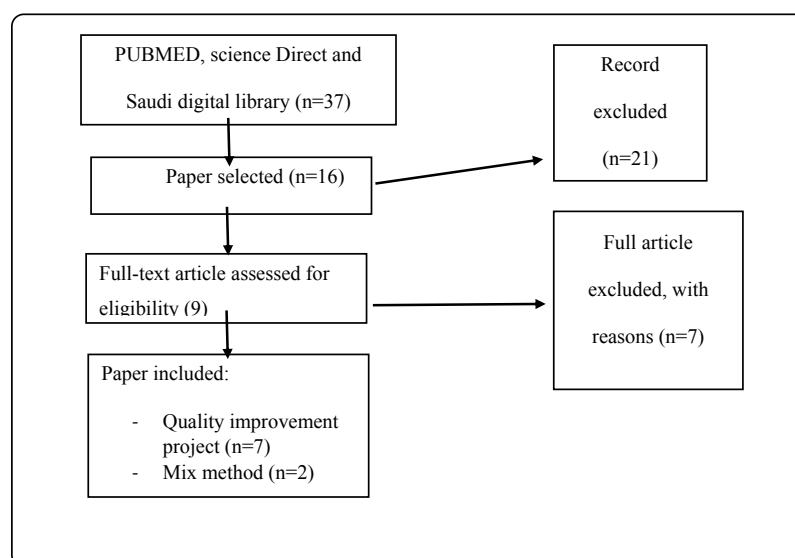Arrieta et al [1] findings can encourage the implementation of CLABSI prevention methods like the Catheter Group

Figure 1 Flowchart of the search strategy.

Table 1 Studies Summary.

Author, year	Study design	Objective	Intervention	Main finding
Ceballos et al [6]	Quality improvement project	Decrease infection level below benchmarks.	• A computer-based NICU CLABSI educational module	• Decrease hospital days • Cost savings • Reduction in central line days
Piazza et al [11]	Clinical practice recommendations	Recognize the significance of prevention practices on CLABSI.	• Monitoring compliance, with Hub scrub • Sterile tubing change	• Reduction on CLABSI by compliance on (Hub scrub compliance and Sterile tubing change)
Arrieta et al [1]	Quality improvement project	Quality important to reduce the rate of CLABSI in several countries.	• Implementation of bundles of care for the insertion and maintenance of C.L.s,	• Reduce the rate of CLABSI • Reduction in central line days
Yaseen et al [14]	Quality improvement project	Decrease CLABSI to achieve zero CLABSI incidence.	Central Line Bundle are • Hand hygiene • Maximal barrier precautions • Chlorhexidine skin antisepsis • Optimal catheter site • Use subclavian vein as the preferred site for CL • Daily review of CL necessity	• Reduce the rate of CLABSI to zero achieved after 4 years.
Cruz-Aguilar et al [7]	Mix method	This study intends to increase the body of evidence regarding catheter hub caps' effectiveness in preventing CLABSI.	• Use of antiseptic barrier cap (ABC)	• The control and antiseptic barrier cap (ABC) did not affect the infection rate reduction.
Balla et al [2]	Quality improvement project	To study aim to assess (Q.I.) initiative impact on reducing (CLABSI) rates.	• Hand hygiene • Central line bundle	• Reduce the rate of CLABSI • Reduction in central line days • Improve compliance on the guideline • Reduce the mortality rate
Inchingolo et al [8]	Mix method	Evaluate the effectiveness of educational and port protector interventions on rate CLABSIs.	• Educational program • Port protector	• Education had a significant impact on reducing the CLABSIs rate. • Port protectors had a significant impact on reducing the CLABSIs rate.
Muñoz et al [10]	Quality improvement project	Decrease CLABSI rates in hospitalized newborns in the neonate intensive care unite	A bundle consisted of • Hand hygiene • CL installation procedure • CL maintenance procedure • CL documentation • A sterile TPN change	• Bundle implementation has shown positive results in decreasing the rate of CLABSIs.
Taylor et al [12]	Quality improvement project	Decrease CLABSI from its current level.	A bundle consisted of • checklists for insertion • daily maintenance	• Reduce the rate of CLABSI

establishment to standardize CVC insertions, maintenances, and withdrawals [1]. Besides, these findings can offer guidelines on the cautious applications of central venous catheters and the significance of complications with and help with harmonized procedures for care with a catheter. Another unusual approach recommended by these studies is the knowledge integration into the hand-washing practice that shall minimize the infections in general and the bloodstream infection prevalence [14]. Because there are differences in the stay lengths and, subsequently, the CVC use duration among types of ICUs that cause differences in infection rates associated with invasive protocols, it is considered vital to conduct specific investigations with diverse ICU types. Considerations need to be put on cases involving factors that present relative risks for CLABSIs with numerical significance [12]. For pharmacological interventions, such scenarios can be candidates for CLABSIs prevention, like catheter blockage with ethanol or antibiotics, the applications of catheters saturated with antibiotics, and dressing saturated with antiseptic.

The research purposed to utilize PDCA (plan-do-check-act) method and model to minimize the central venous catheter infection incidences applying the management in central venous

catheter maintenance in people on hemodialysis to routine care. The pilot studies of [6] suggested that PDCA (plan-do-check-act) method and model can effectively minimize central venous catheter-related infections and enhance life quality and satisfaction in people on hemodialysis. In the labs, the PDCA model and methods can be effectively used to minimize the error occurrences and improve the processes' capacity to improve labs' effectiveness and efficiency.

From the baseline rates of 31.70 to 3.50 per 1000 line-days, the quality improvement accomplished 89% reductions in CLABSI. From 7.30 to 2.30 per 1000 patient-days, the bloodstream infections decreased. During the intervention period, the overall mortalities indicated a reduction from 2.90% to 1.70% [2]. There were great improvements in adherence to CLABSI and hygiene protocols. This research showed that simple measures involving the care bundle approach strengthening and hand hygiene through quality improvements could greatly minimize the CLABSI rates and bloodstream infections.

To improve quality, nurses and other healthcare practitioners are primary in hospital efforts [11]. Using nurse leaders in improvement activities helps empower staff to participate in and move the Q.I. initiative forward because nurses are important to hospitalized patients' care. Nursing Q.I. leaders were effective since they could raise collective expectations and awareness for practices in the NICU. In this NICU, these accountability expectations resulted in substantial culture changes that enabled sustained and real improvements in patient outcomes. The collaborative team processes for enhancing patient outcomes also improved the bedside nurse's sensitivity to remind providers about communication, bundle elements, and improved mutual respect. Training improved accountability, communication, respect, and empowerment among all NICU team members through these Q.I. methods and these interventions [11]. This culture change process has promoted various other NICU care improvements because personnel is adaptable and flexible to bedside practices changes.

Impact of education on CLBSAI

The training of practitioners responsible for catheter insertions and maintenances is one of the CLABSI prevention strategies [12]. The skin preparations with 0.5% chlorhexidine and maximum precaution barriers during insertions are also important methods. Especially in developing economies, the pediatric information on CLABSIs risk factors is limited. This is because the education levels are irregular, and healthcare practitioners-to-patient ratios are lesser than those in developed economies. Only 38% of the nursing professionals in these studies acquired continual training on central venous catheters' maintenance. No statistical relationships were noted between CLABSI occurrences and the catheter handling by practitioners who had not or had obtained continual training to prevent CLABSI or between the practitioners who inserted the catheters and CLABSI occurrences [14]. Continuous training is considered some kind of practical and theoretical education associated with the prevention of CLABSIs.

Because in the literature, continual training plans have already been analyzed as factors to enhance infection preventions, these

findings are shocking [8]. Biases in the outcomes may cause a small number of individuals in education. Examining the need for all catheters in many PICU is part of the day-to-day routines. Nevertheless, the final decisions to remove the lines majorly rely on the hospital and nursing staff. During multidisciplinary visits, day-to-day evaluations of the need for central catheter maintenances and discussions of these needs are vital in enabling the removals of CVCs no longer required. The duration of central venous catheter application in our research were risk factors for CLABSIs in PICUs. According to the multivariate analyses, the likelihoods of the patients presenting with CLABSIs when the applications of central venous catheters are prolonged by one day [12]. To minimize the need for multiple venous access devices and shorten the CVC application duration, future investigations need to evaluate systematic interventions.

Discussion

CLABSIs cause mortality and morbidity in ICU patients. To identify novel targets for infection prevention strategies, we examined available evidence about the impact of some quality improvement project on the infection rate.

Most of the studies showing that bundle care and the educational program showed interesting results were CLABSIs, in-hospital mortalities, and central line placements. The Q.I. project's objectives were to eradicate prevalent HAIs in the ICU through education and bundled intervention implementation. Implementing CL-specific prevention bundles effectively, in conjunction with an improvement methodology, can significantly reduce CLABSI. Studies conducted as part of great collaborative efforts have revealed similar trends in terms of outcomes when using a care bundle approach and strengthening with Q.I. principles [10,12,14].

Other elements of care bundles, like hand hygiene, maximal sterile barrier precautions (MBPs), and nurse observation and evaluation at the bedside, are also critical for CRBSI prevention. Although some studies have shown that compliance with barrier precautions reduces CRBSI rates [11,14], another study found that it does not affect infection rates [17].

As the multifaceted quality improvement programs currently executed by healthcare facilities on a gradually large scale worldwide, the programs are likely to reduce the economic cost of CLABSI in healthcare facilities. Awareness among healthcare providers and doctors about the benefits of the programs would include their implementations. The implementation of these programs can greatly minimize economic costs, morbidities, and mortalities related to CLABSI. Combined with improvement methodology, reliable implementations of neonatal-specific prevention bundles can greatly minimize VAP and CLABSI rates. Bundled interventions offered healthcare practitioners structures of ensuring systematic processes for improvements. Organizations can utilize checklists to educate healthcare practitioners about interventions that hold accountable for care offered and minimize HAI [12].

Nursing leadership and personnel support implementing practice changes established mechanisms for care concentrated on

accomplishing free and high-quality infections. NICU personnel felt empowered and involved in patient safety initiatives by fostering bedside nurses as Q.I. ambassadors, enabling for sustained improvements. Having VAP increased personal ownership and compliance, and healthcare practitioners effectively execute interdisciplinary Q.I. programs to minimize CLABSI was cost-effective and eventually improved patient outcomes and practice.

Nurses who have been trained effectively can provide effective nursing care and sound advice to patients, reducing their uncertainty and apprehension when confronted with clinical problems. Additionally, training nurses can significantly improve patients' satisfaction and alleviate their anxiety during hospitalization. These beneficial effects may be explained by the fact that uniform training can help standardize nurses' operations and equip nurses with sufficient knowledge about CVC nursing, enabling them to provide detailed responses to patients' questions and perform all care bundle components during catheterization. These proactive interventions have been shown to help patients overcome their feelings of vulnerability [6,8].

Incremental cost-effectiveness ratios and central line-related bloodstream infections are prevented through the methods discussed above. Deaths are averted because central line-related bloodstream infections are avoided. Probabilistic sensitivity analyses were carried out. The programs are minimized bloodstream infections and deaths at no extra costs as compared with current practices. The analyses indicated that there are virtually 80% probabilities that the programs minimize economic costs of infections and bloodstream infections to healthcare facilities.

Implications

Different lessons were learned from these projects. First, the biggest obstacle to the bundle implementation was the reluctance of healthcare practitioners to apply subclavian sites for insertions of central lines. The team's persistence to persuade the practitioners with scientific evidence and consistent feedback on the CLABSI local rates ultimately worked, and the healthcare professionals changed their practices. Secondly, to gain collaboration and buy-in of all players, all of the stakeholders must be included in the process. It is significant to share the

results with stakeholders to engage and enlist the support of staff members. To support the project's success, management should support them, guided by measures, led by stakeholders, and endorsed by science. Having these excellent results in this research, maintaining excellent compliance, and implementing CL Bundles are the key.

Controlled machine learning involves the applications of education data set to generate functions that can predict categorized outcomes. Controlled machine learning applications have been greatly correct for different predictions, including the healing of burn wounds and surgery outcomes. Applications of machine learning ideas to the intensive care units have also proven important for predicting clinical deteriorations and discerning medically suitable alarm signals. A team of investigators utilized infection severity comorbidities and scores for training artificial intelligence classifiers in these studies. For predicting mortalities and CLABSIs, the classifiers were greatly accurate.

According to the authors, these findings demonstrated the ability to utilize machine learning tools to easily develop predictive models for CLABSIs applying readily available variables of patients. In ICU protocols, integrating such predictive models can further reduce hospital-acquired infections by timely identifications of people at risk for these preventable complications. Further research areas include designing adaptive algorithms that can be utilized to improve patients through their stay at the ICUs. The models can precisely predict events of CLABSIs even before they take place.

Conclusion

The papers made potential deeper analyses of the effect of a quality improvement project on reducing central venous catheter-associated bloodstream infections. This review found quality improvement projects decrease the incidence of CLABSI, improve patients' mortality, and reduce hospitalization days. Therefore, care bundles should be performed as a routine protocol. To be more successful, bundles of care should concentrate on these risks. During the catheter insertion, compliance with barrier precautions is desirable to minimize the probability of infections. Staff education and training positively impact the prevalence rate, utilizing maximal sterile obstacle safety measures that include sterile full-body drapes, sterile gloves, sterile gowns, masks, and caps, all central venous catheters are placed.

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