

The Effect of Central Venous Catheter Maintenance Bundle Implementation on Central Line Associated Infection Rate in the Intensive Care Unit

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Abstract Background: Central venous catheters (CVC) play an important role in the treatment of hospitalized critically ill patients. To improve patient outcome and to reduce healthcare costs, there is considerable interest by healthcare providers in reducing the incidence of Central line associated blood stream infections. **OBJECTIVE:** This study aims to evaluate the efficacy of the implementation of CVC bundle to all patient admitted in intensive care unit with central line on the reduction of the rate of central line associated blood stream infection. **SETTINGS/DESIGN:** Quasi-experimental before and after study design conducted in intensive care unit of King Abdullah Medical City, Makkah. **SUBJECTS AND METHODS:** This study was targeting all patient with central line in intensive care unit. At the time of central line insertion bundle was initiated and maintained until the removal of central line over 12 months period started on December-2018 and ended on December-2019. **RESULTS:** Study result show a significant reduction (77%) of CLABSI rates, before and after CVC maintenance bundle implementation, which show the effectiveness of bundle implementation on ICU patient and also there is improvement in site selection, subclavian site selection has been increases to 27% during post bundle period compare to 9.5% before pre bundle period, so this improvement may have some impact on the result of CLABSI. Despite study intervention there was slight improvement in insertion bundle compliance rate increase from 89% to 96% over twelve months during study period. **CONCLUSION:** The study found the effectiveness of central line bundle implementation on ICU patient; this result been achieved with presence of high compliance to the element of bundle by ICU nurses. Looking to CLABSI cases before and after bundle implementation, variable which been observed were close to each other.

Keywords: intensive care units, central line bundle, central line-associated bloodstream infection, central venous catheter

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1. Introduction

Central venous catheters (CVC) play an important role in the treatment of hospitalized patients especially critically ill patients. Intensive care units (ICU) employ measure such as diagnostic procedures and invasive devices that may trigger complications such as health care -associated infections. Central line-associated bloodstream infection (CLABSI) is the primary complication of central venous catheters. In this sense, there is a concern over the risk of infections to which patients are exposed, the incidence of CLABSI, the need to improve care concerning the implantation and maintenance of CVCs, and the adoption of evidence-based measures to ground the care provided by the health staff [1,2]. Three out of four quasi-experimental

studies also found statistically significant reduction of CLABSI when maintenance bundles were implemented [3].

An infection is considered as Healthcare-associated Infection (HAI) if the date of event of the site-specific infection criterion occurs on or after the 3rd calendar day of admission to an inpatient location where day of admission is calendar day one [4]. Therefore, systematized care defined by evidence-based guidelines confers safety and quality onto the care provided by the intensive care team and can effectively reflect decreased HAI rates [1].

To improve patient outcome and to reduce healthcare costs, there is considerable interest by healthcare providers in reducing the incidence of these infections. This effort should be multidisciplinary, involving healthcare professionals who order the insertion and removal of CVCs, those personnel who insert and maintain intravascular catheters,

infection control personnel, and healthcare managers including those who allocate resources and patients who are capable of assisting in the care of their catheters [5]. A systematic approach on a daily basis using daily goals sheet, nurse-driven protocols, electronic reminders, or multidisciplinary catheter rounds are possible interventions [6]. The simultaneous implementation of insertion and maintenance bundles has a positive impact on the reduction of catheter-related bloodstream infection [7].

1.1. Aim of the Study

This study was aimed to identify evidence-based care to prevent central line-associated bloodstream infection among adult patients hospitalized in intensive care units by implementing CVC maintenance bundle checklist. Such bundle is not currently implemented in the ICU, which warrant the conduction of this study.

1.2. Subjects and Methods

This study was Quasi-experimental before and after study design conducted in King Abdullah Medical City in the Intensive care unit, which is a 26-bed medical surgical ICU. The study sample was all patient with central line in intensive care unit. Before the data collection procedures department educators provided education and competency assessment for the ICU staff nurses on the use of the maintenance bundle. At the time of central line insertion, the primary nurses were initiated bundle for patients and terminates it and submit it for data collection when the central line is removed or when the patient is transferred out of the intensive care unit. Charge nurses were monitoring the completeness every shift and the overall compliance would review by the head nurse on monthly basis. The per-shift entry would be considered complete if all the fields would fill with either "yes" or "no". Bundle forms submitted for data collection would keep in a folder inside the head nurse's office, which secured with a lock. Central line-associated bloodstream infection is defined as a laboratory-confirmed bloodstream infection (LCBI) where an eligible blood stream infection (BSI) organism is identified and an eligible central line is present on the date of the (LCBI) or the day before [8]. The CLABSI rate per 1000 central line days is calculated by dividing the number of CLABSIs by the number of central line days and multiplying the result by 1000 [9]. CLABSIs were recorded according to the Centers for Disease Control definitions. The Central Line Utilization Ratio is calculated by dividing the number of central line days by the number of patient days [10]. This calculation is done by the infection control department.

The infection control department was done the calculation for the CLABSI rate after ensuring that the cases of CLABSI meet the criteria of the CDC definitions and the laboratory confirmation. The study was utilized historical CLABSI rate data to compare it with the rates after the intervention. In this study, the researchers would measure the following outcomes: The percentage of compliance to the CVC maintenance bundle, The changes in the CLABSI rate after introduction of the CVC maintenance bundle and Baseline CLABSI rate before bundle introduction is 8.4/1000 CVC days, and expected rate after bundle introduction is 3.7/1000 CVC days. With power of 70 % (being a preliminary study) and X for 2-sided test = 0.1; 2400 CVC days are needed before and after.

2. Results

Table 1 show details of type of catheter and insertion site majority of catheters were triple lumen (74.5%) and most common site for insertion was Internal Jugular (49.2%), compared to 481 triple lumen central catheter and 134 dialysis catheter inserted for 410 patients during twelve months prior intervention period with total of 2857 days.

Table 2 shows that CVC maintenance bundle implemented in that patient over the period of study with slight improvement in the compliance from the starting of intervention until the end of study with overall compliance of (93%).

Figure 1 shows that Despite study intervention was focus on maintenance bundle only but still there was slight improvement in insertion bundle compliance to raise from 89% over twelve months prior study period to 96% over twelve months during study period.

Figure 2 shows that CVC maintenance bundle implemented over the period of months study with slight improvement in the compliance monthly rate from the starting of intervention until the end of study.

Figure 3 shows that the central vascular access utilization mean was 38% of patient pre-bundle implementation and it became 43% post bundle implementation, which show slight increasing of central vascular access utilization per patient.

Figure 4 shows that CLABSI rate Pre and Post bundle implementation from the starting of intervention until the end of study.

Table 3 shows that during study period 5 patients out of 424 were having CLABSI with mean of 1.6/1000 device days, Compared to 21 cases during 12 months pre-bundle with median of 7.1 /1000 device days, which show significant reduction of 77% of CLABSI cases post-CVC maintenance bundle implementation.

Table 1. Describe the Number of Lines and Site of Insertion

Line Category	Pre-Bundle		Post -Bundle	
	No	%	No	%
Number of patient where have triple lumen central line or HD catheter insertion during ICU admission	410		424	
Total number of central vascular access inserted for ICU patents (Triple lumen or HD catheter)	615		636	
Total Number of triple lumen catheter	481		474	
Subclavian triple lumen Access	46	9.5%	128	27%
Internal Jugular triple lumen access	310	64.4%	233	49.2%
Femoral triple lumen Access	125	25.9%	113	23.8%
Hemodialysis catheter	134		162	
Internal Jugular HD catheter access	110	82.1%	133	82.1%
Femoral HD catheter Access	24	17.9%	29	17.9%

Table 2. Details of Monthly Compliance for CVC Maintenance Bundle

Month	Total Audit Sample	Compliances	Non-compliances	Percentage
Dec-18	271	232	39	86%
Jan-19	213	195	18	92%
Feb-19	207	186	21	90%
31-Mar	172	146	26	85%
19-Apr	126	122	4	97%
May-19	97	92	5	95%
19-Jun	129	121	8	94%
19-Jul	233	212	21	91%
19-Aug	107	100	7	93%
19-Sep	166	166	0	100%
19-Oct	316	316	0	100%
19-Nov	162	153	9	94%
Total	2199	2041	158	93%

Table 3. Show Comparison of CLABSI Rate before and after Bundle Implementation

Comparison of CLABSI rate details Pre - bundle implementation (Dec-2017 to Nov-2018) and Post - bundle implementation (Dec-2018 to Nov-2019)		
	Pre-bundle	Post-bundle
CLABSI Rate	7.1	1.6
Number Of cases with CLABSI	21	5
Number Of devices Days	2857	3226

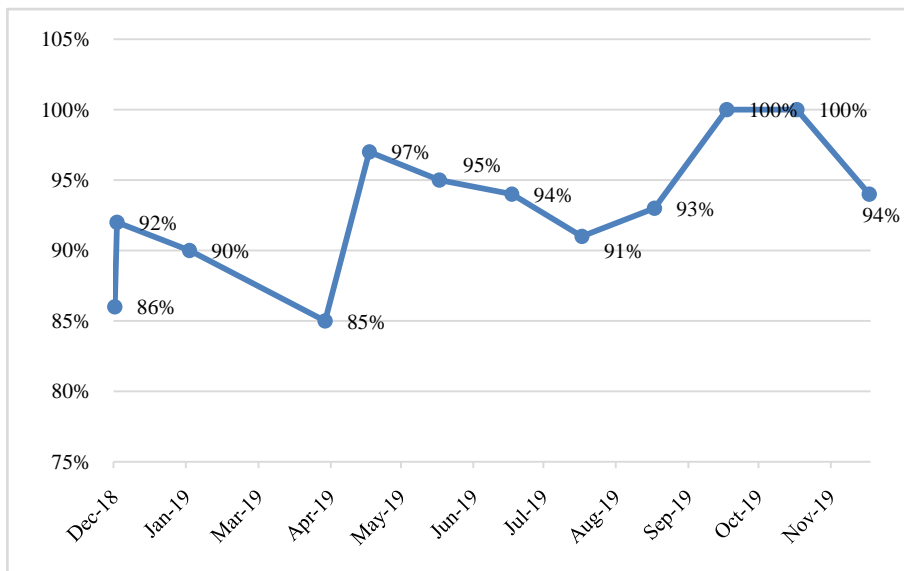


Figure 1. Description of monthly compliance of CVC maintenance bundle

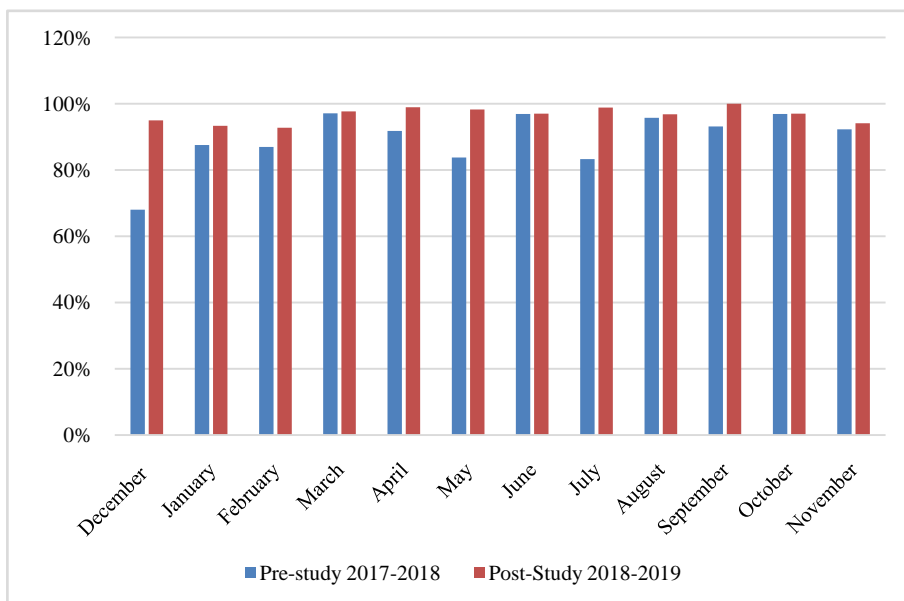


Figure 2. Compliance to insertion bundle Pre and Post bundle implementation

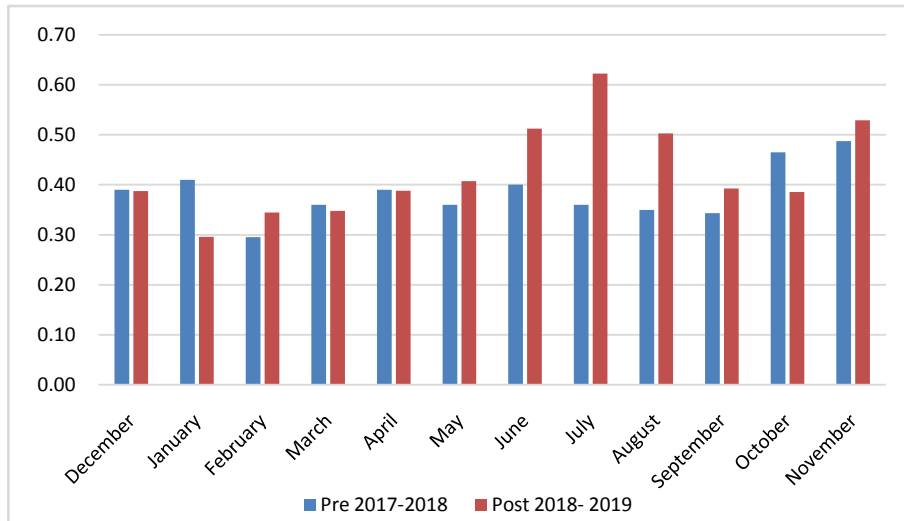


Figure 3. Show CVC utilization comparison before and after study period

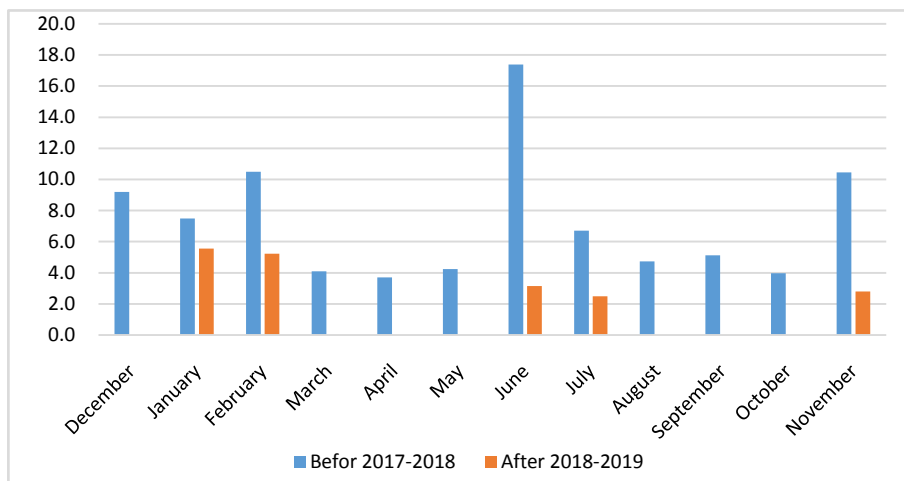


Figure 4. CLABSI rate Pre and Post bundle implementation

3. Discussion

This quasi-experimental before and after study design, been conducted in medical surgical ICU with capacity of 26 beds, over 12 months started on December-2018 and ended on December-2019, CVC maintenance bundle been used based on different element supported by evidence show reduction on CLABSI rate, six element of bundle were present in CDC CLABSI prevention checklist and three other elements been added with considering using new technology for CLABSI prevention, such as using split Septum Device and prefilled syringes. A systematic review of 584 ICUs suggests that quality improvement interventions contribute to the prevention of CLABSIs and implementation of care bundles and checklists appear to yield the strongest risk reductions [11].

At the beginning of implementation we conducted education sessions about bundle element and implementation over two months period for all ICU nurses, then all ICU nurses implement CVC maintenance bundle for all patient who is been admitted with central vascular access or inserted after admission to ICU, charge nurses were conducting auditing on bundle implementation three times a week, all used bundle will be kept in one folder after patient discharge from ICU, at the end of each month, we calculated the overall compliance of the bundle. Some

studies supporting that the trained nurses can provide effective nursing measures and proper advice to patients and reduce the uncertainty and difference in dealing with clinical problems [12,13]. Training of nurses can also dramatically improve the patients' degree of satisfaction and alleviate their anxiety during hospitalization [13]. In addition, the use of hands-on, simulation-based training in proper CL insertion as a supplement to didactic lectures also contributes to lowering CLABSI rates [12].

All other relevant data related to our study been collected from ICU registry program at the end of study then been analyzed as per study needs, to make compare for population and sample before and after study. Study result show a significant reduction by 77% of CLABSI cases, before and after CVC maintenance bundle implementation, which show the effectiveness of bundle implementation on ICU patient, this result been achieved with presence of high compliance to the element of bundle by ICU nurses. A meta-analysis of the incidence of CLABSI in adult ICUs, neonatal ICUs, and pediatric ICUs showed that care bundles can significantly reduce the incidence of CLABSI across all age ranges [14]. Another meta-analysis of CLABSIs in neonatal units also showed a significant reduction in the incidence of CLABSI following the implementation of care bundles [15]. This study result also showing improvement in site selection,

subclavian site selection been increases to 27% during post bundle period compare to 9.5% before pre bundle period, so this improvement may have some impact on the result of CLABSI, however the percentage of CLABSI cases in subclavian access before and after maintenance bundle not less than internal jugular or femoral site. These result also consistence with those of the previous studies where, the differences in the proportions of catheter insertion sites between the case and control groups were not statistically significant, and the proportion of the femoral vein approach was lowest in both groups. Thus, the use of the femoral insertion site had fewer negative impacts on care bundles [16]. Another study also supporting that the catheterization duration was longer and femoral access was more frequently observed in patients with CLABSIs. CLABSI rates decreased with use of the care bundle [17].

Looking to CLABSI cases before and after bundle implementation, variable which been observed were close to each other before and after except for catheter stay duration, post bundle show longer catheter stay period to reach 31 days compared to 10 days pre bundle period, which gave additional impact for CVC maintenance bundle in increase catheter stay prior getting infection, furthermore analysis showed CLABSI event before and after study were more in ICU long stay patients with average length of stay 42 in pre bundle period and 38 in post bundle period. There are several other studies published about CLABSI prevention in Saudi Arabia. All of these studies were pre- and post-intervention design. Most implemented the bundle with varying rates of success. The total number of Central line days was 87,842, with the highest reported (24,238) [18]. The overall bundle compliance improved from 69% to 95% (an increase of 26%), Reporting the greatest improvement (63%) [19]. The average rate of CLABSI decreased from 6.5 to 2.8/1000 CL days, and the biggest improvement was reported [20].

4. Conclusion

The study found the effectiveness of central line bundle implementation on ICU patient; this result been achieved with presence of high compliance to the element of bundle by ICU nurses. Looking to CLABSI cases before and after bundle implementation, variable which been observed were close to each other. In conclusion, central line maintenance bundle were found to be an effective in reduction in the CLABSI rate at our institution and also reducing central line days. Therefore, maintenance bundles should be performed as a routine protocol.

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Conflicts of Interest

There are no conflicts of interest.

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