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Implementing an Updated Evidenced-Based Maintenance Central Line Bundle (CLB) Policy: Monitoring Adherence and Central Line Associated Blood Stream Infections (CLABSIs) in a Medical Intensive Care Unit (MICU).

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IMPLEMENTING AN UPDATED EVIDENCED-BASED MAINTENANCE CENTRAL LINE BUNLDE (CLB) POLICY: MONITORING AHDERENCE AND CENTRAL LINE ASSOCIATED BLOOD STREAM INFECTIONS (CLABSIs) IN A MEDICAL INTENSIVE CARE UNIT (MICU)

by

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Abstract

Purpose: The purpose of this project was to update the current policy of CLB maintenance of CVCs by incorporating the latest recommendations from the literature, providing education and disseminating the new policy. Outcomes were measured by evaluating the effect on policy adherence and incidence of CLABSIs in a medical intensive care unit (MICU). Policy adherence was defined by the completion of CLB maintenance components.

Methods: This study included a pre- and post-interventional design utilizing a retrospective chart review to evaluate adherence to CLB maintenance interventions and incidence of CLABSI rates pre and post-implementation of a new CLB maintenance policy that included a brief educational intervention.

Results: 26 MICU nurses participated in the educational intervention. The mean bundle adherence score of the pre-intervention was 83.1 and the mean bundle adherence score of the post-intervention was 97.45, indicating an increase in bundle adherence ($p = <.001$). No CLABSIs were reported during the project period.

Conclusion: An updated evidence-based CLB maintenance policy with educational intervention increases adherence to CLB maintenance interventions among nurses. There was a statistically significant increase in adherence to CLB interventions after the new CLB maintenance policy was published with educational intervention ($p = <.001$). No CLABSIs were reported during the project's time frame. Future research could be performed by a retrospective analysis for a longer duration of time to evaluate the incidence of CLABSIs that may show a relationship between adherence and CLABSIs.

Keywords: central line associated blood stream infection, bundle, CLABSI, ICU

Implementing an Updated Evidence-Based Maintenance Central Line Bundle (CLB) Policy to Reduce Central Line Associated Blood Stream Infections (CLABSIs) in a Medical Intensive Care Unit (MICU)

Background

Patients in the Intensive Care Units (ICUs) often require central venous catheters (CVCs) for the management and treatment of critical conditions. CVCs are used for hemodynamic monitoring, administration of high-volume intravenous fluids, parenteral nutrition, or caustic drugs, hemodialysis, and massive blood transfusions; all of which require the use of CVCs (Reyes, Bloomer & Morphet, 2017). Despite the benefits, patients are at high risk for developing central line associated blood stream infections (CLABSIs). Most institutions use the Centers for Disease Control and Prevention (CDC)/National Healthcare Safety Network (NHSN) criteria for defining a CLABSI: a laboratory-confirmed bloodstream infection (LCBI) where a CVC was in place for more than 2 days on the date of event (DOE), with day of line placement being day 1 and CVC was in place on the DOE or the day before (National Health Safety Network, 2017).

A LCBI must meet one of three criteria, but since the third criteria only applies to neonates, it will be disregarded since the population of interest is adults. The first criteria is a recognized pathogen cultured from one or more blood cultures and is not related to an infection at another site. The second criteria requires that the patient has at least one of the following signs or symptoms: fever (>38.0 C), chills, or hypotension and the same pathogen is identified from two or more blood specimens drawn on separate occasion (National Healthcare Safety Network, 2017). It is estimated that 200,000-400,000 episodes of CLABSIs occur annually in U.S. hospitals, resulting in increased length of stay, cost, and patient morbidity and mortality (Merrill,

Sumner, Linford, Taylor & Macintosh, 2014). In the ICUs, 80,000 episodes of CLABSIs occur annually (Stango, Runyan, Stern, Macri, & Vacca, 2014).

The consequences associated with CLABSIs include: mortality rates between 12% and 25%; an excess length of stay up to 24 additional days; and an estimated annual cost associated with treatment exceeding $2 billion (Merrill et al., 2014). The prevention of CLABSIs is critical to the improvement of patient outcomes and reduced medical costs (Jeong, Park, Lee, Song & Lee, 2013). Centers for Disease Control and Prevention (CDC) implemented a set of guidelines to prevent CLABSIs: "Guidelines for the Prevention of Intravascular Catheter-Related Infections, 2011." In these guidelines, a central line insertion and maintenance bundle is composed using best evidence-based practices, structured for improving the processes of care and patient outcomes, and known to demonstrate decreased rates of CLABSIs (Salama, Jamal, Al & Rotimi, 2016). The Institution for Healthcare Improvement (IHI) also support the central line bundle (CLB) and are based on five strategies: hand hygiene, maximal use of barrier precautions during insertion, chlorhexidine skin antisepsis, daily review of CVC necessity and prompt removal of lines, and site selection that avoids femoral veins in adults (Jeong, Park, Lee, Song & Lee, 2013).

Problem Statement

Despite the CDC and IHI guidelines for preventing CLABSIs, the occurrence in the ICUs still remains. Multiple factors can contribute to CLABSI rates, including needleless connector use, poor infection control practices, location of the catheter insertion site, types of infusions, flushing practices, patient population, and duration of catheterization (Wallace & Macy, 2016). Needleless intravenous (IV) connectors were developed in part to reduce the risk of needle stick injuries to health care providers; however, reports of sudden increases in CLABSIs occurred

after the implementation of the needless IV connectors (Wright et al., 2013). Compliance associated with CLB use and the reduced rates of CLABSIs varies among studies. After catheter insertion, maintenance bundles have been proposed to ensure optimal catheter care. More data are needed to determine which components of the maintenance bundle are essential in reducing risk (Marschall et al., 2014).

At the project facility, maintenance CLB interventions have been introduced and implemented at various intervals. However, a comprehensive and evidence-based CLB maintenance policy has not been published and proper education has not been provided to nursing staff. In an effort to promote a CLB maintenance policy, thereby reducing the number of CLABSIs, the facility planned to integrate an official policy with an educational intervention. Current literature demonstrates that policy implementation with an educational intervention is effective in reducing CLABSIs (Lin, W. et al.; Ista et al., 2016). It was reported by Sacks et al. (2014) a decrease in the incidence of CLABSIs by 68%, preventing 12 CLABSIs, 2.5 deaths, and saving $198,600 annually after implementing a CLB with an educational intervention.

The following are additional CLB interventions that has demonstrated a reduction in CLABSIs in ICUs: utilization of alcohol disinfectant caps, chlorhexidine gluconate (CHG) bathing cloths and CHG dressings used on the insertion site, and positive displacement caps (PRN adapters). Alcohol disinfectant caps reduce microbial contamination and prevents microorganisms from entering the bloodstream (Stango et al., 2014). The disinfectant cap is placed onto IV needless connectors and CVC ports which bathes the connectors in 70% isopropyl alcohol (Voor in ’t holt et al., 2017). The single-use antiseptic barrier cap remains in place until the next catheter access; this design allows for direct safe access to the hub when the barrier cap is removed (Voor in ’t holt et al., 2017). The use of disinfectant caps has

demonstrated a decrease in the incidence of CLABSIs in ICUs by at least 30% (Martino et al., 2017; O'Grady et al., 2011; Patel et al., 2017; Ramirez et al., 2013; Stango et al., 2014; Sweet al., 2012; Voor in 't holt et al., 2017). Merrill et al. (2014) reported the incidence ratio for implementing the disinfectant caps was statistically significant (.577, P =.004), indicating that the rate of CLABSIs decreased by >40% (Merrill et al., 2014). DeVries, Mancos and Valentine (2014) found that implementing the alcohol disinfectant cap resulted in the blood stream infection rate decreasing to 50% for central lines (P < .00037).

It is recommended that adult patients in the ICU be bathed daily with a 2% CHG wipe as part of daily hygiene and CHG dressings are to be used on the insertion site of CVCs (quality of evidence: I) (O'Grady et al., 2011). The use of CHG wipes for daily skin cleansing and the use of CHG dressings did eliminate CLABSIs after 15 months according to Jock et al. (2016) and a burn ICU was able to sustain zero CLABSIs for three years (O'Grady et al., 2011; Sood et al., 2017). It is recommended that needleless connectors or positive displacement caps (PRN adapters) are to be changed at least every 72 hours or according to the manufactures' recommendations for reducing infection rates (category II evidence) (O'Grady et al., 2011). When PRN adapters are changed at least every 72 hours, it reduces the rate of CLABSIs by at least 50% (O'Grady et al., 2011; Oto et al., 2011; Tabak et al., 2014; Wallace & Macy, 2016).

Theoretical Framework

The Iowa Model, an evidence-based practice (EBP) model, was used to translate the evidence into clinical practice. The Iowa Model is represented as an algorithm with decision points and feedback loops and is applicable in a wide variety of specialty areas, most remarkably acute care (Schaffer, Sandau & Diedrick, 2013). There are six steps in the Iowa Model: (1) Identify practice questions (problem-focused or knowledge-focused), (2) Determine whether or

not the topic is an organizational priority, (3) Form a team to search, critique, and synthesize available evidence, (4) Determine the sufficiency of the evidence (if insufficient, conduct research); (5) If evidence is sufficient and change appropriate, pilot the recommended practice change; and (6) Evaluate pilot success and if successful, disseminate results and implement into practice (Schaffer, Sandau & Diedrick, 2013). The key features include: decision-making flowchart, uses problem-solving steps and feedback loops to guide change process, includes a trial of the practice change before implementation occurs, and designed as an interdisciplinary approach. Ongoing evaluation of the change and dissemination of results are further components of the Iowa Model (Schaffer, Sandau & Diedrick, 2013).

Using the Iowa Model as a framework for the project, the first step identified a problem-focused question: For hospitalized adult patients in the MICU, does an updated evidence-based CLB maintenance policy compared to current practices, increase CLB maintenance adherence and reduce the incidence of CLABSIs? The second step determined that updating the current CLB maintenance policy is an organizational priority. There has been a steady increase in CLABSIs over the last two years at the facility. The interim Chief Nursing Officer (CNO) and infection control nurse asked ICU nurse managers to provide CLABSI education to their nurses. A mandatory CLABSI education class was created by the ICU nurse managers in response and CLABSI reduction has been a focus for the ICUs. The third and fourth steps involved the literature review and finding sufficient evidence to support the practice change. The latest recommendations from the literature to reduce rates of CLABSIs are not included in the current policy for the care and maintenance of CVCs and the supporting evidence was brought to the policy and procedure committee and the nursing research and evidence-based practice coordinator. The fifth step involved implementing the new CLB maintenance policy, providing

education, and looking at adherence to the policy. The sixth step was evaluation of the project, dissemination of the findings and making further adjustments to the policy based on the results and findings after putting the new policy into practice.

Purpose and Objectives

The purpose of this project was to update the current CLB maintenance policy of central venous catheters by incorporating the latest recommendations from the literature and providing education on the new policy to MICU nurses to evaluate its' effect on adherence and incidence of CLABSIs in a medical intensive care unit (MICU). It was expected that the educational intervention implemented for this project would:

1) Increase CLB maintenance interventions adherence.
2) Decrease the incidence of CLABSIs.

Intervention

The intervention consisted of updating the current CLB maintenance policy by incorporating the latest best evidence-based practices for CVC maintenance and care and providing education on the new CLB policy to nurses in a medical ICU. The CLB maintenance policy incorporated evidenced-based interventions that demonstrated reduced rates of CLABSIs in ICUs. The following CLB maintenance interventions were incorporated into the new policy: (1) Use chlorhexidine gluconate (CHG) wipes around CVC sites and for baths daily, (2) place alcohol disinfectant caps on all unused connectors on CVCs and intravenous tubing and change every seven days, (3) change CHG dressings every 7 days, and (4) change protective caps (PRN adapters) on CVCs every 72 hours. The educational intervention was created using a 'read-and-sign' binder, which was a competency requirement for all nurses in the MICU. The 'read-and-

sign' binder was a mandatory education that discussed the background and clinical significance of CLABSIs, what is already known about central line care, the current CLB maintenance interventions on the policy, and the new interventions that are to be added to the policy. The following are the six CLB maintenance interventions included in the new policy: (1) change CHG dressings every 7 days; (2) replace IV tubing every 96 hours; (3) change PRN adapters every Monday and Thursday; (4) document a daily need to continue CVC(s); (5) use CHG wipes around CVC sites and for daily baths; and (6) change SwabCaps every Thursday.

The IRB Chair/Vice-Chair reviewed the submission and determined the project did not meet the "Common Rule" definition of human subjects' research. Therefore, the project did not require IRB review. When using protected health information, the HIPAA Privacy rules were applied. Institutional guidelines on patient privacy were followed.

Measures

Patient Factors

Patient factors were considered in the analysis of incidence of CLABSIs. Variables such as age, APACHE II scores, and the number of CVC(s) in place were reviewed. The Acute Physiologic Assessment and Chronic Health Evaluation II (APACHE II) score is the most widely used ICU mortality prediction score. It is a point-based score upon initial values of 12 routine physiologic measurements, age, and previous health status. The scores range from 0 to 71, with a higher score indicating a higher expected mortality. The APACHE II score has a specificity of 93.4% and a sensitivity of 74.5% in a MICU population (Godinjak et al., 2016).

CLABSIs

The second measure that was analyzed was the rate of CLABSIs. CLABSI rates were defined using the CDC/National Healthcare Safety Network (NHSN) criteria and the data was collected from the project facility's infection control nurse. For the project, inclusion and exclusion criteria for CVCs were applied for better control of the CLABSI outcome data. The inclusion criteria for CVCs for this project were: CVC must be inserted in the ED or in the MICU at the project facility and it had to be in place for greater than 24 hours. Exclusion criteria for CVCs were: midline catheters, and ports or PICC lines from home or other facilities.

Adherence to Policy

The third measure that was analyzed was the nurses' adherence to policy which was evaluated by conducting retrospective chart review. The principal investigator audited the central line charting in the facility's EHR, Cerner. Each component that was appropriately charted was collected. If all six components were charted on a CVC, CLB maintenance policy adherence was considered to be 100%.

Methods

Setting

The study was performed at a large tertiary hospital in downtown Louisville, Kentucky. The hospital is a 462-bed facility that provides care to patients in Kentucky and Southern Indiana. It offers a vast number of specialty care and services, including five organ transplantations (e.g. heart, lung, liver, kidney and pancreas), hand transplantation, extracorporeal membrane oxygenation (ECMO), ventricular assistive device (VAD), and specialty vascular interventions. There are five ICUs in the hospital, each one specialized to care for patients with certain critical illnesses. The project and data collection occurred in the Medical

Intensive Care Unit (MICU) which is a 16-bed closed medical/surgical unit with 24-hour intensivist coverage from two different intensivist groups. The community-based MICU cares for a wide range of adult medical/surgical patients with multiple comorbidities.

Study Design

A retrospective interventional design in the form of a pre- and post-intervention was used to assess adherence to CLB maintenance of central venous catheters among MICU nurses. An educational intervention was provided in the form of verbal and written demonstration. A retrospective design examined patient factors that were obtained from the electronic health records secured on Cerner, the electronic health record used by the hospital.

The incidence of CLABSIs and CLB maintenance adherence was gathered retrospectively during the pre- and post-intervention period. Adherence to policy was evaluated by performing chart audits in the electronic health record, Cerner.

Sampling and Population

The target population consisted of 26 nurses employed in the MICU at the project facility. Inclusion criteria were medical ICU trained registered nurses who work full-time, part-time or PRN. Float or agency registered nurses were excluded because they did not receive the educational intervention. All 26 MICU nurses completed the education training on the new CLB maintenance policy. The pre-intervention period was 3 months prior to the intervention (January 1 – March 31) and the post-intervention period was 3 months after the intervention (April 1 – June 30). Additional information was gathered by retrospective chart review which included acute physiologic assessment and chronic health evaluation (APACHE) II scores, number of CVC(s), and number of days the CVC(s) remained in place. These factors were reported because

of their potential influence CLABSI rates.

Patient information included in the data analysis were from patients aged 18 – 90 years who had a CVC during the study period, from January 1, 2019 to June 30, 2019. All CVCs were examined during the study period. Inclusion criteria for patients with a CVC included: CVC had to be inserted in the ED or MICU at project facility and length of stay (LOS) had to be greater than 24 hours in the MICU. Exclusion criteria included: midline catheters, ports or PICC lines from home or other facilities, and LOS less than 24 hours in the MICU.

Data Collection

This study included nurses from the MICU and adherence to CLB maintenance interventions were compared 3 months prior to and 3 months after the educational intervention to assess the effect of the educational intervention. Adherence to CLB maintenance interventions were evaluated by retrospective chart review; all six interventions had to be documented for each CVC to compute a 100% adherence rate. Patient records were accessed using the Cerner database and CVC(s) for patients who met the inclusion criteria collected during the study period were examined. The incidence of CLABSIs in the MICU were reported by the infection control nurse at the project facility.

Data Analysis

Adherence to the CLB maintenance interventions were collected during the pre- and post-intervention period. All six CLB maintenance interventions had to be charted on a single CVC: (1) CHG dressing changed at least every 7 days; (2) IV tubing changed every 96 hours; (3) PRN adapters changed every Monday and Thursday; (4) daily need to continue the CVC; (5) daily CHG bath; and (6) SwabCaps changed every Thursday. Each intervention was evaluated for

every CVC; the lowest adherence score was 0% (0/6 interventions) and the highest adherence score was 100% (6/6 interventions). Using SPSS, each intervention was labeled as nominal and marked as a 1 (1 = yes) for completed or 2 (2 = no) for not completed. Descriptive statistics using frequencies computed an adherence score for each intervention. The mean adherence scores pre- and post-intervention was examined using a paired sample t-test.

Incidence of CLABSIs as defined by the CDC/NHSN criteria were collected during the pre- and post-intervention period. CLABSIs were reported to the principal investigator by the infection control nurse at the project facility.

Results

Adherence to CLB Maintenance Policy

There were 20 CVCs that met inclusion criteria in the pre-educational intervention group and there were 20 CVCs that met inclusion criteria in the post-educational intervention group (N = 40). Table 1 shows the mean score and standard deviation for both the pre- and post-intervention. The mean score of the pre-intervention was 83.15 and the mean score of the post-intervention was 97.45. The increase in the post-intervention mean score indicates an increase in CLB maintenance policy adherence after updating the CLB maintenance policy with the educational intervention. Statistical significance was determined using a paired sample t-test with $p = <.001$, representing a statistically significant increase in CLB maintenance policy adherence after establishing an updated policy and providing education.

The most frequently missed CLB maintenance interventions during the pre-intervention period were CHG dressing change and replacing IV tubing. In the post-intervention period, CHG dressing change adherence increased by 30% and replacement of IV tubing adherence increased

by 27%. Documenting a daily need to continue a CVC had an adherence of 100% during both pre- and post-intervention period.

Incidence of CLABSIs

There were no CLABSIs reported during the project period, from January to June 2019. There were three CLABSIs reported for the unit between July to December 2018.

Patient Factors

Table 3 shows the patient factors collected during the project. The mean patient age was 57 (range 24 – 88), mean number of CVC(s) was 1.5 (range 1 – 3), mean number of indwelling catheter days was 5.8 days (range 0 – 23), and the mean APACHE II was 21.5 (40% mortality) (range 5 – 34).

Discussion

Study Objectives

One of the objectives for the study was met; a noted increase in CLB maintenance policy adherence among nurses after providing an updated CLB maintenance policy with the educational intervention, as evidenced by the higher mean adherence score for the post-intervention when compared to the pre-intervention mean adherence score. There were no CLABSIs reported during the project period. This study reflects current literature that a comprehensive and current evidence-based CLB policy for the maintenance and care of CVCs with educational intervention can lead to an increase in policy adherence among nurses. A relationship between an increase in CLB policy adherence and reduction in CLABSIs cannot be established since no CLABSIs were reported during the project period.

Limitations

There were limitations in this study. First, during the second half of the interventional period of the study, the nurse manager of the MICU started an accountability movement to ensure all CLB maintenance interventions were completed. The charge nurses reminded the staff nurses to complete a CLB maintenance intervention if it has not been documented by the end of the shift. Second, the results of this study are not generalizable as it had a small sample size, was conducted at a single site, and included a very specific patient population. Third, the project time frame only took place during a 3-month period, so adequate following of CLB maintenance policy adherence and its potential relationship with CLABSIs on the unit could not be identified.

Recommendations for Practice

The updated evidence-based CLB maintenance policy with education increased adherence among the MICU nurses for completing the CLB maintenance interventions for CVCs. The CLB maintenance policy and CLABSI information should be incorporated into annual competencies for nurses who care for patients with CVCs to increase knowledge and adherence.

Recommendations for Future Practice

The incidence of CLABSIs was not reported during the study. In order to determine if there is a change in CLABSI rates pre- and post-intervention, the data collection period needs to be for a longer duration of time in order to compare a large sample. This study did not evaluate barriers to CLB maintenance policy adherence. Barriers could be assessed by a survey or questionnaire sent to the staff nurses. Addressing the barriers to policy adherence could potentially increase adherence further.

Conclusion

Patients in the ICUs often require CVCs for the management and treatment of critical conditions. Despite the benefits of having a CVC in place, it places patients at risk for developing CLABSIs. The consequences associated with CLABSIs include increased mortality, excess length of stay, and cost associated with treatment. The prevention of CLABSIs is critical to the improvement of patient outcomes and reduced medical costs. To reduce the risk of developing CLABSIs, the CDC and IHI developed guidelines for the insertion and maintenance of CVC, known as CLB. Compliance with the CLB varies among studies. To promote CLB maintenance policy adherence in an effort to reduce CLABSIs, integrating an official CLB maintenance policy with an educational intervention has been examined.

This study implemented an updated evidence-based CLB maintenance policy with an educational intervention among nurses who care for patients with a CVC in a MICU in a large tertiary hospital and compared the adherence to CLB maintenance interventions 3 months pre- and post-intervention. There was a statistically significant increase in adherence to CLB interventions after the new CLB maintenance policy was published with educational intervention ($p = <.001$), but this could have been influenced by the increased surveillance by the unit leadership No CLABSIs were reported during the project's time frame, although it is not clear if this was related to the educational intervention or the increased surveillance by unit leadership. This A retrospective analysis for a longer duration of time could include enough CVCs and time to evaluate the incidence of CLABSIs that may show a relationship between adherence and CLABSIs.

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Table 1. *Comparison of adherence pre- and post-educational intervention (N=40)*

	Pre-education Mean (SD)	Post-education Mean (SD)	*p*
Adherence (%)	83.15 (9.275)	97.45 (6.228)	< .001

Table 2. *Comparison of pre- and post-educational intervention on CLB maintenance components*

		CHG dressing changed (*q 7 days*)	**Replacing IV tubing (< *96 hrs*)**	**PRN adapters changed (*q Mon & Thurs*)**	**Daily need to continue a CVC**	**Daily CHG bath**	**Swab Caps changed (*q Thurs*)**
Pre	Yes No	60 40	73.3 26.7	93.3 6.7	100	93.3 6.7	80 20
Post	Yes No	90 10	100	100	100	95 5	100

Table 3. *Descriptive statistics on patient factors*

	Minimum	Maximum	Mean
Patient age	24	88	57.03
Number of CVC(s)	1	3	1.49
Number of CVC days	0	23	5.83
APACHE II Scores	5	34	21.50

Figure 1. *Comparison of pre- and post-intervention CLB maintenance Adherence Rates*