Achieving a Zero Central Line-Associated Bloodstream Infection Rate in 4 Critical Care Units in Lebanon

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ABSTRACT

Every health care facility aims to achieve and maintain a zero central line-associated bloodstream infection (CLABSI) rate. Infections can be costly for institutions of any size and are often not covered by health insurance. The interventions put in place in this quality improvement project were implemented in 4 phases: (1) develop a new standard of care for central lines and give nurses full responsibility for the care and handling of these lines (including blood sampling); (2) revise policy and provide educational sessions to support nurses; (3) document compliance with the new policy; and (4) document CLABSI rates. The project took place during a 15-month period between January 1, 2016 and March 30, 2017, in 4 critical care units in a university medical center in Lebanon. The results revealed a reduction in CLABSI rates from a maximum rate of more than 17 per 1000 catheter days to zero per 1000 catheter days, which was sustained for 10 months. Nurse compliance with the new policy after 3 months ranged from 95% to 99%.

Key words: bundles, central line-associated bloodstream infection, CLABSI rates, critical care, CVAD, intensive care unit, Lebanon, nursing

Central line-associated bloodstream infections (CLABSIs) in critical care units are often associated with increased mortality and morbidity, long-term hospitalization, and increased health care costs.[1-6] In 2008, the Centers for Medicare & Medicaid Services discontinued reimbursement of costs associated with nosocomial infections because they were deemed preventable.[7] Despite this, an estimated 35 000 CLABSIs occur annually, with about half of them in critical care units at a cost of $46,000 per case and billions of dollars in added costs to the US health care system.[8] A major risk factor for the development of a bloodstream infection is the presence of a central vascular access device (CVAD). CLABSIs most commonly occur when CVADs are not inserted correctly or are not properly maintained.[5] To reduce CLABSI rates, care bundles have been created that involve a set of evidence-based practices to monitor the delivery of clinical care processes to all patients consistently, which have been proven to improve patient outcomes.[9-11] A recent study in South Korea[12] found that nonadherence to the bundle significantly increased the risk of CLABSIs, especially in critically ill patients. A meta-analysis involving 79 studies reported a significant association between the implementation of central line insertion and maintenance bundles and a significant reduction of CLABSI rates. This review found that CLABSI rates decreased from a median of 6.4 per 1000 catheter days to a median of 2.5 per 1000 catheter days.[13]

CLABSI is defined by the Centers for Disease Control and Prevention (CDC) National Healthcare Safety Network as a primary bloodstream infection (BSI) in a patient who had a central line within the 48-hour period before the development of the BSI without definite evidence of another infection.[14] Although several organizations, such as the CDC, the Joint Commission, and the Infusion Nurses Society, published recommendations to reduce CLABSI rates,[10,15] the most commonly implemented guidelines are outlined by the Institute for Healthcare Improvement (IHI).[16] These recommendations include 5 evidence-based guidelines: (1) hand hygiene; (2) the use of chlorhexidine-containing skin

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The authors have no conflicts of interest to disclose.

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DOI: 10.1097/NAN.0000000000000335

antiseptics; (3) maximal sterile barrier precaution during catheter insertion; (4) optimization of catheter site selection; and (5) daily review of the line with timely CVAD removal.

Although these strategies were implemented at an institution in Beirut, Lebanon, the CLABSI rates in the institution's other adult critical care units were higher compared with the rates reported by the International Nosocomial Infection Control Consortium (INICC),[6,17] (Figure). This was attributed to several factors, including limited adherence to the implementation of the IHI guidelines in clinical practice, lack of a standardized approach for CVAD blood sampling, and variations in the methods that physicians use to draw blood. Although these problems have been reported in previous studies,[18,19] there was an urgent need to address this problem, with the objective of decreasing and containing CLABSI rates in comparison with INICC rates. The objective of this quality improvement (QI) project was to decrease CLABSI rates, expressed as the number of CLABSI episodes per 1000 catheter days. Two outcomes were measured: the primary outcome was the number of CLABSIs per 1000 catheter days after the intervention, and the secondary outcome was the percentage of nurses who complied with the new policy. The new policy covered care and maintenance of CVADs by nurses and observation of physicians by nurses for compliance with CVAD insertion practices.

METHODS

Data for this QI project were collected before and after interventions were implemented between January 2016 and March 2017. The study was conducted at a university medical center in Lebanon, a 420-bed tertiary care center providing inpatient and outpatient services to the people of Lebanon and the Middle East. The hospital is accredited by Joint Commission International and has been awarded the Magnet Recognition designation by the American Nurses' Credentialing Center. The medical center provides medical, surgical, and specialized services and admits approximately 35 000 patients annually. The average age of nurses employed at the institution is 31.7 (±6.5) years, with an average of 6.84 (±3.2) years of experience. More than 92% of nurses hold a bachelor's degree, 15% hold a master's degree, and approximately 40% are men. No temporary nurses or agency nurses are employed. In the 4 critical care units where data was collected, there are 28 beds and 92 registered nurses (RNs). The ratio of RNs to patients is 1:1 or 1:2 depending on the acuity of patients. Practical RNs provide patient care at a ratio of 1 nurse to 3 patients. The 4 adult critical care units include the coronary care unit, the intensive care unit, the respiratory care unit, and the neurology intensive care unit. At the time of the project, the CVADs used at the hospital were either peripherally inserted central catheters or nontunneled internal jugular and subclavian catheters. The catheters were multilumen, with antimicrobial surfaces of chlorhexidine and silver sulfadiazine. The same type of catheter was used before and after the intervention. All physicians who insert CVADs are required to pass a 1-time mandatory online course and must repeat and pass a refresher course every year. To determine competency assessment, physicians are supervised by a senior medical staff member during CVAD insertion until 5 insertions are deemed successful. A certificate is printed and sent to the chief of staff's office for inclusion in a list of personnel eligible for CVAD insertion.

Data Collection

For the primary outcome, CLABSI rates were documented by the infection control unit before and after intervention based on the CDC guidelines,[17] which included documenting the following: the number of patients with CVADs, the number of patient days, the number of CVAD days, any positive peripheral blood culture results, and any positive blood cultures obtained through the CVADs (all blood cultures

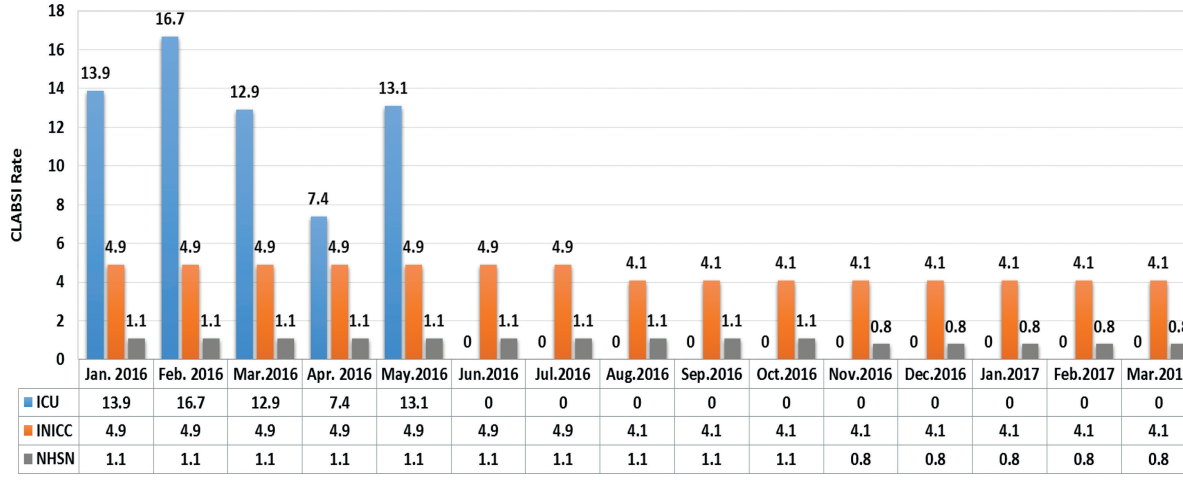

Figure. CLABSI infection rates before and after the intervention. *Abbreviations: AUBMC, American University of Beirut of Medical Center; CLABSI, central line-associated bloodstream infection; ICU, intensive care unit; INICC, International Nosocomial Infection Control Consortium; NHSN, National Healthcare Safety Network.* [a]Data from the INICC[6] and the NHSN.[17]

are drawn simultaneously—1 from the CVAD and 1 from a peripheral venipuncture—at a maximum of 15 minutes apart). The same data were collected before and after the intervention. CLABSI rates were reported per 1000 central line days. Blood cultures (1 through the CVAD and 1 through a peripheral venipuncture) were drawn by nurses based on suspected infection and sent to the laboratory. Positive blood cultures were sent to the infection control department for confirmation of a CLABSI in consultation with an infectious disease specialist. All CLABSIs were defined using the CDC criteria: a recognized pathogen cultured from ≥1 blood culture on 2 separate occasions and the organism cultured from blood is not related to an infection at another site or ≥1 instance of fever (>38°C), chills, or hypotension and positive laboratory results that are not related to an infection at another site or from a common skin contaminant (ie, diphtheroids [*Corynebacterium* spp], *Bacillus* [not *B. anthracis*] spp, *Propionibacterium* spp, coagulase-negative staphylococci [including *S. epidermidis*], viridans group streptococci, *Aerococcus* spp, or *Micrococcus* spp).[19]

For the secondary outcome, compliance rates by RNs were assessed by daily point prevalence observations defined as the number of times RNs complied with the new policy. This was completed in 2 parts, by observing physicians inserting CVADs and by auditing each RN's compliance with CVAD care and maintenance. Physicians were observed inserting the CVAD using a checklist that included the following: hand hygiene before the procedure, full draping of patient, correct use of personal protective equipment, use of chlorhexidine swabs for skin antisepsis, allowing complete drying of the chlorhexidine solution before venipuncture attempt, covering of ultrasound probe with a sterile cover, appropriate site selection, and specifying the reason why a femoral site was selected. If a physician did not comply with any of the above, the RN had the right to stop the procedure.

For CVAD care and maintenance, RNs were audited by the nurses managers, the clinical nurse specialists (CNSs), and the clinical nurse educators (CNEs) for the following: use of needleless connectors on access ports and 3-way stopcocks as specified by policy, use of multilumen y-site extensions, limiting the number of 3-way stopcocks on administration sets, disinfecting access ports and needleless connectors with alcohol swabs 30 seconds with every access of the CVAD, and keeping the system as a closed unit.

Ethical Considerations

This study was exempt from review by the internal review board of the university because the information collected could not be associated with individual patients.

PROJECT IMPLEMENTATION

The project consisted of 4 phases: preintervention (baseline), intervention (completed in 2 phases), and postintervention.

Phase 1

The preintervention phase took place between January 1, 2016, and February 28, 2016. The nurse mangers, CNSs, and CNEs audited and documented all vascular access device (central and peripheral) insertions by physicians and audited care and maintenance by RNs. Based on their observations and input from the bedside RNs, 3 recommendations were suggested.

The first recommendation was to develop a new standard of care for blood sampling from the CVADs and arterial catheters, because this standard was not consistently applied by physicians and RNs. The new standard was based on the latest evidence in the literature,[20,21] with a recommendation supported by the chief medical officer, that gives nurses full ownership of handling, caring, and sampling blood from CVAD and arterial catheters in the adult critical care units. The second suggestion was to place needleless connector devices on all CVAD ports (except for the port used for hemodynamic monitoring) to minimize disconnections, add a multilumen y-site extension to administer high-alert drugs, and eliminate the use of multiple 3-way stopcocks. The third recommendation was to revise the existing policy on CVAD insertion for physicians, as well as care and maintenance practices for nurses, to ensure infection control adherence that included detailed step-by-step instructions to guide the nurses in their practice. These steps included:

1. Assembly of an administration set including the use of multilumen y-site extensions and needleless connector devices to maintain a closed system, ensure proper blood sampling, and minimize handling of the administration set for hemodynamic monitoring. Frequency for changing administration sets, with special considerations for different types of intravenous therapies and medications was included.
2. CVAD site assessment including the confirmation of the number of sutures, presence of CVAD stabilization, and recognition of signs of infection or thrombophlebitis. For CVADs inserted in the chest and neck area, nurses were instructed to assess the patient's arm, shoulder, neck, and chest on the same side as the catheter insertion site for signs of pain, swelling, or tenderness. For femoral catheters, nurses were instructed to check the patient's leg size and assess for signs of pain, swelling, or tenderness on the same side as the catheter insertion site.
3. Description of the dressing types with documentation on the frequency for dressing changes. A focus on the importance of not using gauze dressings except under special conditions was included, because gauze may harbor moisture and promote infection. Examples of such conditions included diaphoretic patients, blood oozing from a catheter insertion site, or an open dressing for patients with extensive burns or skin exfoliation. If a gauze dressing had to be used, nurses were instructed not to remove the dressing unless signs of complications or infections were noted or if the gauze was dry. Nurses were to assess the area for

redness, pain, swelling, tenderness, or purulent drainage. Gauze dressings were to be converted to a transparent dressing as soon as diaphoresis ceased or hemostasis was achieved at the insertion site, because transparent dressing allows for easy visual inspection of insertion site.
4. Promotion of the use of 2% chlorhexidine solution to disinfect CVAD insertion site (except if clinically contraindicated for specific patient population, eg, patients allergic to chlorhexidine and infants younger than the age of 2 months).
5. Medication management for high-alert drugs using multilumen y-site extensions and a protocol for CVAD flushing and locking for unused lumens depending on the patient's infusion care needs.

Phase 2

Part 1 of the intervention phase took place between March 1, 2016, and April 30, 2016. The CNSs and the CNEs shared the new policy with the critical care clinical practice council following the shared governance model for the hospital and obtained their feedback. This feedback became the basis for creating educational sessions for all of the RNs in the adult critical care units. The education was provided through workshops, hands-on training, and competency validation and testing. The education provided to physicians was not changed from the preintervention educational plan. However, the new policy included a checklist for nurses to monitor physicians while inserting a CVAD to ensure that they adhered to the policy. The new policy also included a detailed description for CVAD care and maintenance by nurses.

Phase 3

Part 2 of the intervention phase took place between May 1, 2016, and May 31, 2016. The CNSs and the CNEs, along with the assistance of the nurse managers and the clinical nurse coordinators, provided support to all of the RNs working in the 4 critical care units in assessing patients with CVADs, auditing compliance, identifying breaks in compliance, and implementing action plans for improvement specific to the unit or patient population. In addition, the CNSs and the CNEs conducted daily rounds to assess compliance with the new policy; this assessment was completed in 3 months.

Phase 4

The postintervention phase took place between June 1, 2016, and March 30, 2017. Every new incident of a CLABSI identified by the infection control officers was reported to the unit nurse managers and the clinical nurse coordinators. Each new incident was documented and assessed to determine the possible cause of the infection, and an action plan was developed accordingly.

RESULTS

For measuring and evaluating the primary outcome, the results indicated a decline in CLABSI rates that ranged from 5.4 to >17.0 per 1000 catheter days in the 4 adult critical care units to a rate of zero (Figure). For the secondary outcome, nurse compliance rates after initial implementation of the new policy ranged from 50% to 70%. After 3 months, this rate reached 95% to 99%. Based on the results, a venous access device handling and care course was developed. The course was submitted to American Nurses' Credentialing Center and recognized as a nursing skill competency program. This course is now part of the annual mandatory nurse training for adult critical care nurses at the American University of Beirut Medical Center.

DISCUSSION

This study documented a sustained reduction of CLABSI rates in adult critical care units when nurses were given full responsibility of CVAD care and maintenance. The success of the intervention could also be attributed to the detailed policies and education of nurses on all of the adult critical care units, along with audits and monitoring of the new policy for implementation and engagement of direct care nurses with continuous feedback. CLABSI rates dropped to zero in 3 months and were sustained for 10 months. These results are congruent with several earlier studies that have shown reductions of 20% to 75% in CLABSI rates in adult critical care units, which can be attributed to education, CLABSI rate data collection, the identification of committed nurse champions, and the support of the administration.[9-11] The education of nurses on all of the adult critical care units, along with feedback and observation, was particularly helpful in decreasing the CLABSI rate. In addition to the education of all nurses, the availability of an easily accessible online training course facilitated compliance with the new policy. The success of this intervention can be attributed to limiting access, CVAD care and maintenance, and blood sampling to nurses. Implementation of the new policy minimized the risk of developing CLABSIs and demonstrated the benefit of empowering nurses to affect a practice that decreases CLABSI rates.

LIMITATIONS

Limitations of this study included other factors not assessed that may have contributed to the decline in CLABSI rates, such as the introduction of needleless connector devices and multilumen y-site extensions. Other factors that may have affected the results, such as patient acuity, were also not assessed.

CONCLUSIONS

This multimodal intervention included evidence-based education for nursing staff. Nurses monitored physicians during CVAD insertions and scrutinized details for CVAD care and maintenance, while also monitoring CLABSI rates.

Physicians transferred the responsibility of CVAD care to nurses, which resulted in a sustainable reduction in CLABSI rates to zero. The key result of this QI project is the fact that a zero CLABSI rate was achieved and maintained by an institution in a middle-income country that has far less resources than high-income nations. This study also demonstrated the capacity for nurses to own a project and successfully maintain a zero CLABSI rate over an extended period of time. Because CLABSIs prolong hospitalizations and increase the risk of patient morbidity and mortality, this QI project is worth replicating in larger hospitals and in other countries worldwide.

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