8-2023

Improving central line-associated bloodstream infection prevention bundle compliance to reduce infection rates in a pediatric cardiac intensive care unit.

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Improving Central Line-Associated Bloodstream Infection Prevention Bundle Compliance to Reduce Infection Rates in a Pediatric Cardiac Intensive Care Unit

by

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Paper submitted in partial fulfillment of the
requirements for the degree of

Doctor of Nursing Practice

School of Nursing, University of Louisville

August 6, 2023

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Acknowledgments

I would like to thank my family for their constant support and encouragement throughout my DNP program. You all never doubted my ability to succeed. I could not have done this without you all. I would also like to thank Dr. Lynn Roser for sharing her knowledge and passion for infection prevention with me. I appreciate your guidance and countless hours working through this process.

Abstract

Background: Central line-associated bloodstream infection (CLABSI) is the most common healthcare-acquired infection in pediatrics. In 2020, a pediatric acute care facility in Kentucky created a specialized care team in an effort to track CLABSI bundle compliance and reduce central line infections. However, staff adherence to current evidence-based policies and infection prevention interventions remains low. Rates of infection have decreased, but a significant number of infections are still occurring.

Purpose: To reach the facility's goal of zero central line-associated bloodstream infections, a quality improvement (QI) project was developed to improve staff knowledge of care and increase staff adherence to policy.

Methodology: To create the QI project focused on staff compliance with policy and reducing CLABSI rates, a literature review, and the Institute for Healthcare Improvement (IHI)'s Plan-Do- Study- Act (PDSA) model were used. This project was the first cycle of PDSA, a guide to future cycles with the data provided helping improve upon processes and indicate additional needs.

Intervention: Interventions included initiation of biannual CLABSI educational simulation, distribution of a monthly newsletter, and posting bundle elements at the bedside.

Results: A 2.25% increase in test score from pre to post-test was obtained and scores on many of the questions increased from pre- to post-test. Necessary additional areas for nurse education were identified based on the scores and most frequently missed questions. Audits allowed for the calculation of baseline compliance with the facility's Central Line- Associated Blood Stream Infection prevention bundle, as well as identified areas where compliance was not adequate. Assessment of the unit's CLABSI infections post-intervention illustrates that although the

quality improvement project's impact on rate of infection cannot truly be determined, the influence on nursing compliance with the CLABSI bundle resulted in a +32.27% of change.

Keywords: Bundle Compliance, Guideline Adherence, Nursing Interventions, Nursing Education, Infection Control, Simulation, Central Line-Associated Bloodstream Infection, CLABSI

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Improving Central Line-Associated Bloodstream Infection Prevention Bundle Compliance to Reduce Infection Rates in a Pediatric Cardiac Intensive Care Unit

Introduction

Healthcare professionals have an ethical responsibility to protect patients. Nurses, in particular, have the American Nurses Association (ANA) *Nursing scope and standards of practice* (2015) to guide their work. Within this text, nurses gain an understanding of their role in advocacy and patient safety (ANA, 2015). Harm, however, still occurs and often comes in the form of hospital-acquired infections (HAIs; (Woods-Hill et al., 2021). Central line-associated bloodstream infections (CLABSIs) are a life-threatening type of HAI that arise upwards of 30,100 times a year (Centers for Disease Control and Prevention [CDC], 2018). In children, CLABSIs are suspected to be the most common HAI to occur (Solutions for Patient Safety Network [SPS], 2019; CDC, 2018). In a meta-analysis to determine the approximate cost of HAIs, the Agency for Healthcare Research and Quality (AHRQ, 2017) determined that a CLABSI event on average costs an extra $48,108 in hospital costs. The risk of death from a CLABSI is approximately 150 excess deaths per 1,000 CLABSI events (AHRQ, 2017). As AHRQ (2017) indicated, this risk and cost are preventable.

Background/ Rationale

Efforts nationally and locally emphasize the great threat that antibiotic resistance poses to society's ability to treat many infections now and especially in the future. Antibiotic-resistant organisms are often causes of HAIs due to their abundance in the healthcare setting (CDC, 2021). According to the CDC (2019), their laboratories find a new resistant organism every 4

hours. Only through infection prevention can the rapid growth of drug-resistant organisms be slowed.

Infection prevention bundles are practice measures designed to be utilized within patient care to reduce the risk for harmful HAIs. While a necessary tool, many facilities become reliant on bundles to protect patients when other components, such as staff education, skill set, and compliance, all play an important role in CLABSI prevention as well (Harnage, 2012). A cross-sectional study of National Healthcare Safety Network (NHSN) hospitals by Furaya et al. (2011) indicated that CLABSI rates decreased only when an ICU had a policy, monitored compliance, and achieved greater than or equal to 95% compliance, suggesting that adherence by staff is a common issue and source of infection.

Bundle compliance data and CLABSI rates from a Kentucky pediatric acute care facility, as well as a needs assessment performed with the Vascular Access Team (VAT) manager and the Director of Patient Care Services, support the implementation of a quality improvement (QI) intervention in this pediatric acute care facility to increase staff knowledge of bundle components and central line dressing changes and increase staff adherence to policy. This facility reported 14 CLABSI occurrences in 2021, with three being mucosal barrier injury related, for a rate of 0.9 in the last half of 2021. While attempts to reduce CLABSI rates were made, a quality improvement initiative focused on hands-on nursing education, nurse knowledge, and compliance with the facility's evidence-based CLABSI bundle and policies had not been performed. This project was, thus, created to fulfill this gap in care related to staff compliance, knowledge, and competence with rationale supported primarily by facility needs, national goals for infection prevention, and a thorough review of literature.

Gap Analysis

The Kentucky pediatric acute care facility has many evidence-based initiatives in place to prevent CLABSIs. A CLABSI bundle designed by the Solutions for Patient Safety Network (2019), which consists of over 135 children's hospitals in the United States, was initiated in 2012 to reduce CLABSI harm to its patients. This CLABSI bundle is the leading component of prevention in the facility at this time.

Monthly bundle compliance data and infection occurrences are posted on a whiteboard in a central location on each unit for nurses to view. During orientation, nurses are required to attend classes that educate on policies for line care. In addition, the facility educates providers on the use of a central line insertion checklist, and 'swarm' evaluations are held when an HAI occurs to review protocols limiting potential opportunities for infection. Utilization of chlorhexidine-(CHG) impregnated dressings and Guardiva® discs (CHG-impregnated with antimicrobial and hemostatic properties) on central venous lines (CVLs) has also been implemented as a standard of practice. However, in 2018 and 2019 this facility averaged 19 CLABSIs, indicating a rate of 1.1 CLABSIs per 1000 line days (S. Flanders, personal communication, September 7, 2021).

In June 2020 a specialty care team, called the Vascular Access Team (VAT), was instituted for daily central line audits and dressing changes to increase standardization in care. This change has drastically lowered the CLABSI rate. However, compliance with the CLABSI bundle remains below the facility's desired percentage of 95% which reflects adequate compliance and CLABSI rate remains higher than desired as the facility supports CLABSIs to be an unacceptable event. With the initiation of VAT's daily CVL audits, a significant decrease in compliance was noted when a consistent approach to auditing was utilized. While the bundle

compliance percentages have since increased from 62% to 72% from the initial period of June 2020 -December 2020 to 2021; overall compliance remains below the desired threshold of 95%.

The specialty care team reduced CLABSI rates; however, knowledge of central line care and compliance with the central line bundle by nursing staff has diminished. Staff turnover, new hiring, and limited opportunity for practice have increased the number of staff who have limited knowledge, experience with central line dressing changes, and competence in caring for central lines. To achieve reduced CLABSI rates, consistency in care and knowledge, as well as increased awareness and competence to address noncompliance, must be achieved throughout the facility, not just with the specialized care team.

Conceptual definitions

Central venous line

A central venous line (CVL) is defined as a catheter placed in a large vein in the neck, groin, chest, arm, or leg that allows for the infusion of medications, fluids, and blood, as well as aspiration of blood depending on how large the catheter is (Kolikof et al., 2022). Peripherally inserted central catheters (PICC) are included in this definition. Central lines can also be called central venous catheters or CVCs (Kolikof et al., 2022). CVLs can be permanent (for extended therapy) or temporary (for short-term therapy).

Central line-associated bloodstream infection (CLABSI)

National Healthcare Safety Network (NHSN) and CDC guidelines (NHSN, 2022) were used to define and diagnose CLABSI. Temporary and permanent central lines were identified as lines under surveillance.

- Central line-associated bloodstream infection (CLABSI): A laboratory-identified, eligible bloodstream infection (BSI) organism in an eligible central line (NHSN, 2022).
- Eligible Central Line (CL): CL in an inpatient facility, that has been in place during the current admission, and that has been inserted for three days or more, having been accessed for use. An eligible CL remains so until the patient is discharged or until one day after removal (NHSN, 2022).
- Eligible BSI Organism: An organism that meets criteria for laboratory-confirmed bloodstream infection (LCBI) or mucosal barrier injury (MBI)-LCBI. This is also stated as any organism, other than an excluded pathogen in LCBI or MBI-LCBI criteria. These organisms may or may not be included on the National Healthcare Safety Network organism list (NHSN, 2022).

Mucosal Barrier Injury

A mucosal barrier injury (MBI) is a laboratory-confirmed bloodstream infection caused by injury to mucosal tissue. MBIs are often associated with chemotherapy use and prolonged neutropenia (NHSN, 2022).

CLABSI Rate

CLABSI rate is defined as occurrences of CLABSIs per 1000 central line days x1000. (NHSN, 2022).

Central line days

Central line days is defined as total days of indwelling central venous catheters. (NHSN, 2022)

Vascular Access Team

A vascular access team (VAT) is a group of nurses specialized in obtaining peripheral intravenous access for patients who may be difficult or have limited venous access, placing PICC lines, changing central line dressings, and are considered experts in venous access maintenance (central and peripheral) (Cincinnati Children's, 2023).

Healthcare-associated Infection

A healthcare-associated infection (HAI) is an infection that results from a healthcare complication. CLABSI is an HAI (NHSN, 2022).

Job Aid

A job aid is a guideline-based algorithm or workflow for nurses to follow when providing care (Harris, 2023).

Practice Environment

Clinical Agency

A formative assessment was conducted at a pediatric acute care hospital that is a leading provider of pediatric healthcare in Kentucky and Southern Indiana. This facility is a 300-bed hospital in a large metropolitan city in Kentucky. It is the area's only Level 1 Pediatric Trauma Center and freestanding pediatric hospital. The acute care pediatric facility provides care to Kentucky and Southern Indiana children regardless of their ability to pay. It is a teaching hospital affiliated with the metropolitan state university in the city.

Patients in this facility vary in age and acuity. Ages often range from birth to 21 years. Staff varies greatly in years of experience. Nurses are trained to a specific level of care and

specialty area, such as medical/surgical or intensive care unit, except for critical care float team nurses who are trained in all hospital units in the pediatric facility.

Setting

This QI initiative focused on nurses in the cardiac intensive care unit (CICU) for the initial intervention. This ICU was selected based on a needs assessment and discussion with the nurse managers about frequent occurrences of CLABSI on the unit. The CICU is a 17-bed unit responsible for providing critical care most often to patients recovering from heart procedures, including open heart surgery and heart transplants, or those who have heart failure or other complications requiring intensive heart care. This unit employs approximately 80 nurses educated from an associate degree to a master's degree. This unit reported the most incidences of CLABSI in 2021.

Target population

Nurses in the CICU were the target population of this QI project. The QI initiative focused on nurse education, simulation, and engagement to reinforce behavior changes that would successfully increase compliance, knowledge, and accountability of staff. These nurses ranged vastly in years of experience, but all are registered nurses.

Stakeholders

Care of central lines is provided by many individuals. A stakeholder assessment was performed to determine individuals involved and who may benefit from this quality improvement intervention to continue the facility's progress. The identified stakeholders included the Chief Nursing Officer, facility providers, the nurse manager of the CICU, the nurse

manager of the VAT members, assistant nurse managers, clinical nurse educators, bedside nurses, the Information Technology (IT) Department, CLABSI Committee, the Director of Patient Care Services, and the Infection Prevention Department. The Chief Nursing Officer, the CICU manager, and the Vascular Access Team Manager played a very important role in this project since their approval was required, and they approached the QI Team lead (DNP student) to implement the QI project.

In addition, bedside nurses were also stakeholders, although their authority for change was low. Building relationships, recognizing their responses, and listening to their input helped create successful change, enabling them as partners in the QI intervention and acknowledging the importance of their role. Each stakeholder had varying levels of control, interest, and participation, but all played an important part in helping to reduce CLABSI occurrences and creating better patient outcomes.

Personnel

The primary person involved in the implementation of this change was the DNP project lead. This DNP project lead is a bedside nurse cross-trained with the VAT, with the knowledge base and experience to implement this quality improvement initiative. The DNP project lead took full responsibility for implementation of the educational experience.

Barriers to change

Anticipated barriers to change included staff workload and prioritization and acceptance of the project. These were identified early on as the primary threats to the successful implementation of the QI project. Significant behavior changes and changes in perception of the role in infection prevention were also necessary for success in increasing compliance and reducing CLABSIs.

Approvals for the Project

This QI project had approval by the University of Louisville Institutional Review Board (IRB). Approval for the quality improvement project was also obtained from the Chief Nursing Officer and from the organization that operates the Kentucky pediatric acute care facility. This project aligned with the organization's values, goals, and facility needs.

Purpose and Specific Aims

The purpose of this project was to reduce the CLABSI rate in the CICU of a pediatric acute care facility in Kentucky by increasing CLABSI bundle knowledge and compliance. Outcomes including improved staff knowledge and competence in central line maintenance, increased compliance of CLABSI bundle elements as well as increased overall compliance with the CLABSI bundle. In addition, long-term outcomes included a decreased CLABSI rate in the CICU. Achievement of these aims were completed through targeted interventions to reduce knowledge gaps, support an environment of confident care, and increase staff compliance to policy and infection prevention bundles. This project aligned with the pediatric acute care facility's goal to reach zero healthcare harm to support the facility's safety statement 'We will eliminate preventable harm events and maximize patient outcomes.'

This QI project did not fall under research involving human subjects as the project did not seek to develop or generate new generalizable knowledge or test a hypothesis. The project proposal sought to outline an evidence-based intervention that would generate improvements in healthcare delivery in a specific hospital unit based on evidence-based practice guidelines. This project directly benefited the specific unit involved in the QI project based on gaps that were identified in healthcare delivery on the unit and appropriate interventions were designed to respond to the immediate needs of the unit through rapid-cycle PDSA. The project was not

within the research realm, as it did not seek to test a hypothesis, generate new knowledge, or answer a question beyond what is currently considered evidence-based practice. Quality improvement seeks to employ changes based on the needs of the unit, often using a rapid cycle PDSA approach with each cycle changing based on the results of the previous cycle. This project's intent was to review, improve, monitor, and evaluate current existing unit evidence-based policies and practices

Facilitators of this project included the engagement of staff, support of administration and management, congruence of the goals of the QI project with the facility's desired outcomes. The project was carried out in an environment where QI projects were regularly performed to improve the culture of safety and reduce harm.

Theoretical Framework

Donabedian's Theoretical Model of Healthcare

Donabedian's Theoretical Foundation (1980) is one of the oldest in healthcare quality management. This model was created by physician, Avedis Donabedian. Donabedian (1980) divides the healthcare system into three dimensions of care; Structure, Process, and Outcomes (Figure 1). Structure of healthcare refers to the factors which impact how care is delivered, including infrastructure, education, technology, and facilities (Donabedian, 1980). Processes of care are defined as the methods in which healthcare are carried out and delivered. Outcomes refer to the effects of care on patients including morbidity and mortality, infection, or quality of life. In creating quality improvement, it is essential to assess the healthcare system as it functions, not just to evaluate the outcomes. Thus, Donabedian's Theoretical Model of Healthcare served as the framework for this project.

Conceptual Framework

IHI Quality Improvement Model- Plan, Do, Study, Act (PDSA)

When considering QI of care delivered in central line management, the IHI Quality Improvement Model (Institute for Healthcare Improvement [IHI], 2022) was implemented as a practical approach for change and QI activities. The IHI model asks three questions: what are we trying to accomplish; how will we know that a change is an improvement; and what change can we make that will result in improvement (IHI, 2022). Through setting an aim, measures, and changes to be implemented these questions are answered and outcomes can be measured. The quality improvement (QI) model then rapidly cycles the Plan- Do- Study- Act (PDSA) process, created by Deming (1994). With constant evaluation and improvement, goals, objectives, and outcome measures help denote progress and success.

Plan

The Plan- Do- Study- Act (PDSA) cycle began with the initial ‘plan’ phase. Increasing staff knowledge and competency of CVL maintenance and CLABSI bundle components was intended to lower CLABSI rates.

A logic model was created to guide the project’s implementation based on facility needs, in conjunction with the project’s stakeholders (Figure 2). Based on a thorough literature review and facility needs, the inputs, activities, assumptions, and outcomes were created.

Do

The ‘do’ phase consisted of implementation of the simulation and dissemination of this information, ensuring staff were aware of the importance of each bundle element and their completion. This phase also built staff knowledge of maintenance of CVLs to reduce the burden on specialty teams and for when they are not available for assistance. To accomplish the aims of

this project, staff were asked to participate in a knowledge of central line management quiz and a required simulation was performed. In addition, laminated signs with bundle elements were hung throughout the unit as a reminder for staff to complete these tasks at shift change. A newsletter was also distributed via email and posted on staff bulletin boards, including pertinent deficiencies found in practice the prior month, percentages of bundle compliance, and research on bundle components. Approximately one month after participation in the educational intervention, participating nurses took the knowledge of CVL maintenance quiz again.

Study

The 'study' phase evaluated the nurse's growth or lack of knowledge using results from the pre- and post-tests, results of audits of patients' charts on the elements of the CLABSI bundle, and assessment of occurrence of CLABSi or other complications. Achievement of project objectives was evaluated frequently and consistently throughout the first cycle.

Act

The 'act' phase then adjusted implementation carried out in the 'do' phase based on information obtained in the 'study' phase and the success of meeting objectives. During this phase, the implementation of change necessary to continue bundle compliance and CLABSI rate improvement was carried out. This QI project only outlined the first cycle; however, successive cycles would begin after each completed PDSA cycle based on gaps identified in the previous completed cycle.

Evidence Review

Analysis of the literature indicated that while CLABSI bundles are abundant in practice, they are often not being carried out to the required levels of compliance for prevention of infection (Furaya et al., 2011; Azar et al., 2019; Balla et al., 2018). When compliance was

monitored and maintained at 95% or greater CLABSI rates greatly decrease (Furaya et al., 2011). While some studies focused heavily on CVL insertion compliance (Lee et al., 2018), more often studies (Styslinger et al., 2019; McMullan et al., 2013) suggested maintenance of central lines may be the most common source for CLABSI as most infections in the researched facilities occurred more than six or seven days after insertion. However, when staff did not feel engaged in this practice of infection prevention, safety, and quality of care decreased (Rosati et al., 2021).

Synthesis of Literature

Elements of the Kentucky pediatric facility's CLABSI bundle included hand hygiene performed before line care; an appropriate indication for the line; a dry, occlusive, dated, and timed dressing; lines dated and changed per policy; a needleless access device present on all indicated sites, labeled with the date and time, and changed per policy; 5-second hub disinfection visualized or Curos® disinfection cap in place on all access ports; a daily chlorohexidine gluconate bath performed every 24 hours; and oral care performed per policy on all oncology patients. These components and policies were created by the Solutions for Patient Safety Network (2019). Each bundle element is essential in reducing the potential for infection (Table 4).

Daily assessment of Need for Central Line

Central lines should be assessed daily for appropriateness of use (CDC, 2011, INS, 2016). Removal of the line, if not clinically necessary, is also important for reducing the risk of contamination. Indications for a CVL include patient instability or limited vascular access; chemotherapy administration to be carried out over three months or more; continuous or frequent infusion of vesicants, parenteral nutrition, or blood/ blood products; invasive hemodynamic monitoring; or long-term infusion therapy (CDC, 2011; INS, 2016; Lin et al., 2017).

Sutureless Securement Device

The use of a sutureless securement device is a suggested intervention widely used in infection prevention practice (Yamamoto, 2002; CDC, 2011; Ullman et al., 2016). Providing stabilization of the catheter prevents catheter movement, reducing the risk of phlebitis, displacement, and accidental line removal. As an alternative to sutures, this method prevents further disruption of the skin surface around the insertion site. Migration of skin flora or colonized bacteria into open areas of skin is thought to be the cause of CLABSI. Utilizing a sutureless securement device reduces micromovements of the catheter which increase the risk for introduction of skin flora and reduces the amount of infection susceptible entry sites.

Hand Hygiene

Emphasizing hand hygiene in the bundle helps to reduce contamination to and from CVLs. Hand hygiene should be performed before touching the line or the dressing, before entering the line, before building a new line, and after touching the line (CDC, 2011; Rinke et al.,2012; Dandoy et al., 2015; INS, 2016; Yuan et al., 2015; Lin et al, 2017).

Dry and Intact Dressing

To keep insertion sites of CVLs as clean as possible, the bundle includes the dressing must be clean, dry, intact, and changed per policy. Dressings should not be loose, soiled, or damp. Dressings should be changed every two days if a gauze dressing is in place and every five to seven days if a transparent semipermeable membrane dressing is in place (CDC, 2011; Rinke et al., 2012; Atilla et al., 2016; INS, 2016).

Infusion Sets and Needleless Access Devices

Infusion sets or lines and needleless access devices must also be maintained to reduce the risk of growth within the lines and decrease the risk of contamination. Recommendations for the

frequency of this care do vary, but minimally so. Most organizations chose to err on the side of caution. Lines should be changed no more than every 96 hours with two exceptions; lipids or albumin-containing fluids should be changed every 24 hours and propofol sets should be changed every 6 to12 hours (CDC, 2011; Rinke et al., 2012; Atilla et al., 2016; INS, 2016). In addition to line changes, needleless access devices should be changed with these same recommendations or generally every time the line is changed (CDC, 2011; Rinke et al., 2012; INS, 2016).

Disinfection of Hub of Infusion Lines and Central Line

Implementation of a 15-second hub disinfection before each line entry is considered an important and necessary element of any central line bundle. (CDC, 2011; Rinke et al., 2012; INS, 2016). The importance of utilizing only sterile devices to access the line is also noted (CDC, 2011; INS, 2016). To supplement this route of infection prevention, the use of alcohol caps on each entry point of the line has also been recommended (Rinke et al., 2012; Pavia & Mazza, 2016).

Daily Chlorhexidine Baths

The importance of standardized daily hygiene is another important element of the infection prevention bundle. The use of a daily chlorohexidine gluconate bath daily is commonly integrated into practice and strongly suggested (CDC, 2011; Dandoy et al., 2015; Lin et al., 2017). In addition to this element of hygiene, some research has suggested provision of oral care hygiene for those who are immunocompromised as the risk for mucosal barrier injury CLABSI is high in this population. Oral care should be provided twice daily including teeth brushing using either sodium bicarbonate or chlorhexidine mouthwash (Sarmiento et al., 2014; Best et al., 2016; Wittekamp et al., 2018).

Staff Engagement

Transparency with staff on issues occurring in the facility allows staff to recognize what facility leaders see as important to care. Informing staff and letting them be a part of change is essential to staff engagement as it awards them a higher level of situational awareness (Mobely & Bizzaro, 2017). Engaged staff represent satisfied, caring, and vigilant staff who want to provide better care. Eliciting staff opinions and allowing for discussion, especially between units, creates a constructive learning environment helping to standardize care throughout a facility with open communication (Azar et al., 2019; Savage et al., 2019; Thornton et al., 2019). This initiation and involvement in providing better care are what develop an improved culture of safety, helping staff understand that human error is bound to arise, but by making the issue with bundle compliance known, solutions can be created to prevent reoccurrence.

Staff Education and Training

Providing staff education on proper care and compliance increases staff knowledge and awareness of how to correctly complete tasks. Routine standardized education helps all staff to better understand why care is being provided, what is not compliant or correct, and how to safely provide care no matter who is caring for the patient or where the patient may go in the facility (Savage et al., 2019; Beaudry & ScottoDiMaso, 2020). Creating consistency in education and care is essential to reducing errors and decreasing patients' risk for CLABSI (Kim-Saechao et al., 2016; Wilder et al., 2016; Savage et al., 2019; Thornton et al., 2019). Education can be completed in a formal focused setting or at the bedside (Hugo et al., 2021; Kamity et al., 2021). In a culture of safety, it is important that nurses feel comfortable speaking up immediately when they notice errors and feel safe to educate staff on appropriate care to prevent potential harm (Hugo et al., 2021).

Providing dedicated time for educating staff on issues is crucial to providing competent central line use and maintenance (Beaudry & ScottoDiMaso, 2020). Gauntt et al. (2022) suggest providing this education in the form of a simulation. Adopting the 'practice makes perfect' ideology, the authors focused on both line maintenance and line access in biannual simulation. Providing this frequent education, Gauntt et al. (2022) ensured all the pediatric CICU nurses were exposed and given the opportunity to practice maintenance bundle elements regularly. Deliberate practice available through simulation of both central line maintenance and central line entry benefits both novice and familiar persons in a controlled setting increasing the opportunity for mastery of the task (Hebbar et al., 2015; Motola et al., 2013).

Simulation-based education should ideally be performed in small groups, less than eight individuals, and provide planned feedback (Motola et al., 2013). This improves the opportunity for real-time feedback on hands-on skills practice and allows for debriefing with each participant to ensure gaps in knowledge are addressed and discussed (Motola et al., 2013). While high fidelity simulation is preferred, it is costly (Motola et al., 2013). Significant to note, however, any hands-on simulation has been shown to result in significant behavior change and reduced CLABSI rates (Hebbar et al., 2015). Hebbar et al. (2015) compared a mobile, hands-on simulation and a PowerPoint educational presentation, finding that participants in simulation had notably higher percentages of compliance at three, six, and 12 months after training than their counterparts.

In addition to providing simulation-based education, increasing staff awareness and transparency of issues consistently is another learning opportunity (Mobely & Bizzaro, 2017). Both Wilder et al. (2016) and Santos et al. (2019) found success in disseminating information to staff with an emailed monthly newsletter. Including information such as the success of staff or

days-since infection, number of CLABSI occurrences, results of CLABSI event analysis, and progress of intervention and changes, staff were kept up to date on infection prevention and involved in the process. Presentation of real-life stories also creates the opportunity to learn from other's experiences and promotes discussion of other possible solutions to issues (Mobely & Bizzaro, 2017).

Cues and Checklists for Reminding Staff

Reminders at bedside and the involvement of families have also been noted to improve CLABSI rates (Kalamity et al., 2021; Thornton et al., 2019). Utilization of visual reminders for task completion hanging at the bedside ensures that staff are aware of expectations for CLABSI bundle compliance. A laminated card in the shape of a key, to represent keys to success, was used by Kalamity et al. (2021) to remind staff of bundle elements and to help families understand the importance of CLABSI prevention while illustrating staff's responsibilities to complete bundle cares. While families did not have a responsibility to learn or complete bundle elements, giving staff the opportunity to teach was shown to improve long-term knowledge about central line maintenance (Kalamity et al., 2021).

Recommendations for CLABSI rate reduction are numerous, ranging from dressing and specific device use to behavior changes and staff adherence to policy. The value of a multimodal approach is important to note (Hamza et al., 2021). Overall, discussion of frequent education and transparency with staff are recurrent in this literature review. Providing staff with recurrent and standardized hands-on education, keeping them active in change, and promoting engagement, builds a culture of safety.

In general, the fewer resources a system dedicates for improvement, the less improvement it will see (Nuckols et al., 2016). Financially, CLABSI prevention has a high net

savings, especially with interventions such as simulation-based education and increasing staff compliance, awareness, and transparency (Gauntt et al., 2022; Nuckols et al., 2016). With adequate funding, staff can come together, learn, and engage in bringing forth a safer stay for patients with CVLs.

Methods/ Interventions

To improve the CLABSI rate of the facility, the quality improvement initiative was implemented to increase staff knowledge and nursing staff compliance with bundles and adherence to policy. As a foundation for this initiative, the DNP project lead worked with nurse managers to require staff to participate in a simulation-based learning experience centered around CLABSI prevention. In addition to the educational experience, nurses were asked to participate in a nursing knowledge of CVL maintenance quiz.

Procedures

Phase 1

Initially, data from the two months prior to implementation of the QI project was requested from the Information Technology (IT) Department and initial compliance data was collected. Requested information included CLABSI occurrences and rates. Data collected included bundle component compliance percentages and overall bundle compliance percentages. Collection occurred over three times through bundle audits.

Phase 2

While on shift, nurses were required to join in small groups of two to four for a short, 10 minute simulation outside their patients' rooms. The nurses did not have to leave their assigned pods to participate. Before the simulation began staff were presented with a one-to-two-minute pre-brief by the DNP project lead to help them understand the scenario they were approaching.

They were also provided an educational handout. The hands-on simulation was conducted using a central line mannequin and infusion set on an IV pump rolled throughout the unit. Simulation was monitored by the DNP project lead and staff were expected to identify and correct deficiencies in real-time. It included a scenario on line entry, line use, and line maintenance. All nurses were also given the opportunity to change a central line dressing. Facility job aids were used as guides to staff per facility policy. Following this simulation, a two-minute debriefing occurred and provided time for staff to discuss gaps in care and address those who may not be competent. Multiple opportunities for each shift were provided over the course of two weeks. A list of active registered nurses who worked in the CICU was obtained from the nurse manager for the purpose of tracking participation in this required simulation.

Prior to participating in the simulation, staff were invited to complete a 15 question true or false quiz assessing their knowledge of CVL maintenance based on the facility's evidence-based bundle elements and policies. This optional quiz took approximately two minutes for staff to complete. This quiz was not a required component of the educational experience. Nurses willing to participate were instructed to enter a unique code at the end of the quiz. This was provided to staff using a QR code that linked to the quiz on SurveyMonkey.

With each quiz, the nurses were asked to enter the same unique code consisting of the last four digits of their cell phone number, the first initial of their mother's name, and the first initial of their mother's maiden name. This allowed for quizzes to be linked to each participant anonymously.

In conjunction with the educational activity, a computer background with bundle elements was to be set on each CICU computer. This was meant to serve as a reminder to complete all parts of the bundle each time the nurse logs on to the computer. The DNP lead was

responsible for creating and uploading the computer background. With facility technology restrictions, however, this background was unable to be uploaded. As an alternative, the checklist was laminated and placed strategically around the nurses' stations and around central line tubing preparation areas.

Phase 3

Approximately one month after participation in the educational simulation, participating nurses were again asked to take the knowledge quiz. Every day at huddle for one week, nurses were asked to complete this post-quiz by huddle leaders. The DNP project lead was also frequently present encouraging staff to take the post-quiz.

In addition, a newsletter was issued to supplement CLABSI information discussed at huddle. It was distributed via email and posted on staff bulletin boards, including pertinent deficiencies found in practice the prior month, percentages of bundle compliance, and research on bundle components. The DNP project lead was responsible for the creation and distribution of this newsletter.

After the two-week intervention period data collection began again. Bedside audits of central lines for bundle compliance occurred for six weeks after the implementation of the intervention. These audits were performed weekly by the DNP project lead.

Phase 4

CLABSI rates following the two-week intervention period to two months post-intervention were requested from the Information Technology (IT) Department. Data requested, again, comprised of information obtained from CLABSI tracking. This included CLABSI rate and CLABSI occurrences. At this time data analysis then began.

Measures

Instruments

Pre- and Post-Test

The knowledge of central line maintenance quiz was a 15-question true or false quiz developed based on the facility's evidence-based bundle elements and policies (Appendix A). The overall score of knowledge out of 15 possible points was analyzed.

The CICU nurses were asked to complete the quiz before the required educational simulation and one month after the intervention. The quiz was provided through the platform Survey Monkey. A QR code with a link to the quiz was available for nurses to scan using their phones. The quiz required two minutes to complete each time.

Achieving a high content validity was important in this scenario to ensure that this quiz was asking the right content for evaluation of staff knowledge. Questions were read and evaluated by the VAT nurse manager. This quiz evaluated the nursing staff's knowledge of central line maintenance.

Audit Tool

An audit tool was developed based off the existing CLABSI Bundle CVL Audit, adding additional elements of assessing for presence of securement device and separating the elements of using alcohol caps and 15-second scrub the hub. Compliance was assessed at the bedside of the patient at a singular point in time. This tool measured compliance by comparing the total number of audited patients to the total number of audit observations deemed compliant to attain a total percentage of compliance. Total compliance for the assessed patients best reflects the true compliance percentage as if one bundle element is not correct or compliant, neither is the bundle in its entirety. All elements of CLABSI bundles are meant to be complied with for successful

infection prevention. In addition, this audit tool measured compliance with each element by comparing the total number of audited patients for that element to the total number of audit observations deemed compliant with that element.

Outcome measures

- Pre- and post-knowledge of central line maintenance quiz
    - Staff knowledge of central line maintenance score before simulation (continuous level of measurement)
    - Staff knowledge of central line maintenance score after simulation (continuous level of measurement)
    - Staff participation in pre- and post-quiz percentage
- Audit data from after educational simulation intervention and knowledge assessment
    - CLABSI occurrences (continuous level of measurement)
    - CLABSI rate- infections per 1000 line days (continuous level of measurement)
    - Compliance with central line bundle elements- number of audits deemed compliant with the element divided by number of audits performed on that element (Percentage)
    - Overall bundle compliance- number of audits deemed compliant divided by number of audits performed (Percentage)

Process measures

Evaluation of project process was to be completed at the one- and two-month mark. At the one-month mark 100% of nurses should have participated in simulation and been offered the pre-quiz. At two months 100% of nurse should have participated in the simulation and been offered the pre-quiz and the post- quiz. This allowed for an evaluation of project progress on

staff knowledge. Ideally, staff knowledge of central line maintenance should have increased by 20%.

CLABSI bundle compliance, determined by percentage of correctly carrying out each or all elements, were also to be evaluated at this point. Ideally, percentages of compliance should have increased as tracked by the weekly, randomized, bedside central line audits. An increase in percent of compliance of 10% was desired at this time.

At two months, the above measures were to be analyzed again and, additionally, a CLABSI rate was evaluated. CLABSI are considered an event that should never occur and, as such, the facility desires rates to decrease to zero infections per 1000 line days. Bundle compliance percentages were expected to increase at this point as well, reaching an increase of 10% from the average compliance.

Data Collection

Data collection included asking CICU nurses to complete the optional knowledge quiz and bundle component compliance percentage and overall bundle compliance percentage determined through weekly CVL audits. With bundle audits, patient demographics including age, gender, location and type of central line, were also collected. CLABSI occurrences and CLABSI rates were requested from IT as the facility already track these.

Pre- and post-staff knowledge of central line maintenance quiz

The pre-intervention quiz total scores were compared to the post- intervention quiz total scores for an increase in knowledge score.

Facility rates prior to and after intervention

Collection of staff compliance with the implementation of all CLABSI bundle elements was performed using the modified bundle audit tool. Bundle component compliance measured

the percentage of each bundle element's compliance. The overall bundle compliance measured the overall percentage of bundle compliance. Bundle compliance from before and after intervention was collected for comparison.

Lastly, CLABSI occurrences were measured using the Centers for Disease Control and Prevention (National Healthcare Safety Network, 2022) guidelines which can be found in the operational definitions. CLABSI rate is the overall rate of CLABSI occurrence, measured per 1,000 central line days calculated by dividing the number of CLABSIs by the number of central line-days and multiplying the result by 1,000. CLABSI rates were requested from the information technology department and evaluated two months prior to and two months after the intervention. This analysis looked for any decrease in the overall rate and occurrences of CLABSIs.

Data Analysis and Evaluation

For analysis of data, each of the measures of staff knowledge, staff compliance, and CLABSI occurrences and rate were evaluated using measures of central tendency, percentage, percentage of change, and rate.

Due the nature of PDSA, evaluation of the project was an ongoing process. The success of process and outcome measures were regularly communicated with stakeholders. Suggestions and input from staff were welcomed and will be considered for future cycles. Results from data analysis were communicated and targeted areas of deficiency were identified to complete further cycles of QI.

Human Subjects Protection

The quiz and audit data were collected and kept by the DNP project lead in a password-protected laptop and did not include any staff or patient identifiers. Staff were asked to submit

the quizzes with a unique anonymous code before participating in simulation so that each submission could be identified but not linked to a specific individual. Electronic documentation of measures was also saved on a password-protected laptop. Measure results did not include any patient identifiers.

Project timeline

This project was conducted over the course of the years 2022 and 2023. Throughout this time, meetings were held with University of Louisville faculty, advisors to the project, and facility leaders. To begin, approval was sought and received from both the University of Louisville Institutional Review Board and the facility in which the project would occur. In Spring 2023, the quality improvement project was implemented, and data was collected. Throughout the Summer of 2023, collected data was analyzed, the final paper was written, and results were disseminated. This timeline can be seen in a Gantt chart (Figure 3).

Results

Pre- and Post-test

Initiation of the test and simulation were delayed by one week from the original timeline per CICU leadership request as February is designated Heart Month and events were occurring on unit for the majority of February. However, leadership did choose to make this DNP project the required March education for all nursing staff and regularly supported the facilitation of the project. From February 22nd to March 8th, 2023, CICU nurses were asked to participate in the Maintenance of Central Venous Line (CVL) Knowledge Assessment. Each nurse was shown a QR code with a link to the SurveyMonkey pre-test prior to the simulation-based education. QR codes were additionally posted around the unit in common spaces such as break rooms, nursing stations, and unit bulletin boards by the DNP project lead. Charge nurses also discussed taking

this quiz at shift huddles and an email was sent by the unit educator to all CICU nursing staff notifying them of their required participation in the simulation and optional participation in the knowledge quiz. The post-test was distributed using the same methods as the pre-test beginning two weeks after the intervention began. Nurses had two additional weeks to complete the post-test. The DNP project lead rounded regularly during this time to encourage participation. However, participation significantly declined when nursing staff was not required to participate in any other education along with the quiz. Both quizzes consisted of 15 true or false questions based on the Kentucky pediatric acute care facility's policies, consistent with the CLABSI prevention bundle. While 75% of staff participated in the pre-test, only 41% participated in the post-test.

Scores for all participating nurses on the pre-test averaged 89% and 91% on the post-test. When analyzed, these scores represented a percentage of change of 2.25% increase in average score from pre- to post-test. Additionally, a percentage of change was calculated for the average score of each question (Table 1). Results indicated that out of the 15 questions, an increase in score occurred in seven questions, no change occurred in three questions, and a slight decrease in score occurred in five of the questions.

Significant improvement was noted in the percent of change calculations for several questions after participation in the educational simulation. The first was a 29.79% increase in scores for the question "A transparent semipermeable (i.e., Tegaderm) dressing should be changed every 5 days and as needed (soiled, wet, or nonocclusive/ loose adhering) except for those patients in which the risk for dislodging the catheter outweighs the benefit of changing the dressing (i.e., neo-picc)." Initially, mean scores showed that 47% of participating nurses correctly chose "False" while 61% chose correctly after the education-based simulation.

Additionally, the question “The hub (Cap or NAD) should be scrubbed for 3 seconds before each line access,” resulted in an 18.06% percent of change increase from 72% of nurses correctly choosing “False” to 85% choosing correctly. This indicates that the education-based simulation had a significant impact on nursing staff’s knowledge of these topics.

Minor decreases were also noted in percent of change calculations for several questions. Decreases in scores ranged from -3% to -4.35% indicating that room for improvement or further education could be completed in these areas, including not re-enforcing CVL dressings, the importance of using sutureless securement devices, assessing for the need of each central line daily, and checking for line patency. On both the pre- and post-test questions number one, eight, and thirteen (Appendix A), nurses responded 100% correctly. These scores indicate that nursing staff’s knowledge base on these topics is adequate. Topics included hand hygiene, use of caps or NADs on all access ports, and evaluation of the CVL and lines at shift change.

This project had the aim of increasing nursing staff knowledge by 10%. While nursing knowledge of central line maintenance did not indicate a percentage of change increase to this extent, the initial percentage of overall knowledge was higher than anticipated at 89%. This information combined with results from the pre- and post-tests, helped to identify areas of central line maintenance that CICU nursing staff need further education and indicate that, along with a knowledge gap, other implementation issues may be causing noncompliance, both of which can be considered in future PDSA cycles.

Audits

Weekly audits were performed at the bedside of patients with a central line to assess compliance with the facility’s Central Line Associated Blood Stream Infection Prevention

Bundle. A total of 54 patients' central lines were audited using random selection. Audits were performed prior to the education-based simulation over three weeks, with six patients each week, to obtain a baseline of compliance. Although compliance percentages were being collected by the facility, audits missed several key elements of infection prevention. Audits then resumed after the education-based simulation for an additional six weeks, with six patients each week. Data obtained from these audits were analyzed to determine specific areas of non-compliance, to determine improvement after education, and to guide future PDSA cycles.

Average percentage of compliance before and after participation in the education-based simulation were calculated for each bundle element as seen in Table 2. Overall compliance was calculated based on adherence to each bundle element. When one element of the bundle was not adhered to the entire bundle is considered non-compliant as infection prevention bundles are intended to be completed in full for adequate infection risk reduction. In initial audits, compliance was noted to be lowest for hub disinfection, the use of Curos (alcohol) caps, and for sutureless securement devices. Overall compliance was also initially noted to be approximately 60.9%.

Notable improvement was noted in knowledge scores and compliance with hub disinfection. The nursing knowledge of the use of Curos (alcohol) caps remained 100% pre- and post-test and compliance improved by +17.11% of change. Conversely, a slight decrease of -4.29% in change did occur in nursing knowledge of sutureless securement devices although the percentage of compliance with sutureless securement devices increased by 10.08%. Important to note is that providers inserting lines determine initial line securement, sutures or Statlock, while dressing the newly inserted line.

While the audits did not result in >95% compliance, a significant increase in overall compliance from 60.9% to 80.55% did occur. This QI project aimed to increase overall compliance by 10%. With a +32.27% of change, this aim was met. Additionally, an increase in percentage of change was noted in each bundle element, apart from documenting an indication for each central line and presence of a needleless access device on each port which remained 100% compliant before and after the simulation. While eight elements of the bundle achieved satisfactory percent of compliance above 95%, three elements show room for improvement. These include hub disinfection, maintaining a clean, dry, and intact dressing, and use of a sutureless securement device. These percentages of compliance indicate room for improvement which can be targeted in future cycles of PDSA.

Demographics

While bundle audits were being performed, demographics of patients and central lines selected for randomized audit were collected (Table 3). Patients audited were nearly evenly split in gender with 55.6% male and 44.4% female. Age of patients varied significantly from birth to 18 years old. The majority of patients were considered infants with 55.6% of audited patients being from 29 days to two years old.

Evaluating line type and line location more significant findings results. At 83.3%, most central lines audited were inserted as temporary lines meaning that they were not intended to dwell for long periods of time. Additionally, insertion site was another predominately lead demographic with 72.2% of central lines audited being femoral lines. While the nursing staff has minimal influence over line type and insertion site, these factors do affect infection risk and should be evaluated in subsequent cycles.

Central Line Blood Stream Infections

CLABSI rates were requested from the information technology department for the Cardiac Intensive Care Unit. However, during the two months prior to and two months after the intervention no CLABSI events occurred. While this intervention was able to maintain the CLABSI rate of zero, with no previous events occurring in the analyzed time there is no way to evaluate if this intervention resulted in reduced CLABSI rates at this time. Future PDSA cycles may be able to widen the time of assessment, but for the sake of this project's timeline, this is not possible.

Discussion

This QI project, although some specific aims and goals were not met, was considered successful as it was always intended to be the first cycle of PDSA. Information obtained from the implementation of this project illustrates the staff's desire to learn and their knowledge in central line maintenance, several knowledge gaps of bundle elements and restraints for implementation of elements exist. Additionally, this project brought awareness of why each bundle element is essential to CICU nursing staff. While improvement in compliance did rise after this education, room for improvement still exists and barriers to implementation need to be further evaluated in future PDSA cycles. This project demonstrates the need for routine, thorough, evaluation of staff compliance and regular staff education. Results from this QI project indicate that even as staff knowledge was minimally increased, participation in education leads to notable improvement in compliance with policies. This served as a reminder to staff of the numerous infection prevention bundle elements and their importance resulting in a reduction of patient risk.

Limitations/ Challenges

While all aspects of the project that were intended to be implemented were carried out, several barriers to implementation did arise. The first was that the project was intended to begin in mid-February of 2023. However, management chose to delay implementation by one week to allow for planned activities in February for Heart Month. Management, still highly supportive of the QI project, did then make this project the dedicated education point of March.

Prior to project initiation, a discussion was also had with facility leaders to clarify the facility's hub disinfection before accessing the line policy. A discrepancy was found between recommended "scrub the hub" times in the literature and the facility's written policy. After significant discussion, it was determined that the nursing staff was required to scrub for a minimum of five seconds with a five-second dry time. Audits of hub disinfection were completed based on the evidence that a 15-second scrub and five second dry time were considered best practice. Additional information about proper hub disinfection was sent to a facility leader for discussion with the CLABSI prevention team.

Additionally, issues with reminders arose as the facility's policy for changing computer backgrounds prohibited the upload of the approved background. With approval from facility leaders and management, multiple attempts to escalate approval through IT and security were made, however, no progress was made. It was then decided, by the DNP project lead, with unit management approval, to hang printed and laminated reminders throughout the unit. This expense was incurred by the DNP project lead.

During implementation, the DNP project lead also had to change the intended plans of requiring participation of two to four nurses in each education-based simulation with four of the last nurses needing to participate. Reaching the last few CICU nurses during the implementation

period required the addition of half a week for implementation. With the help of the CICU nurse managers, the DNP lead was able to find the specific shifts these nurses would be working and be present during these additional times. However, many of these nurses were not working the same shifts. This resulted in several staff participating in the education-based simulation alone. Much of the difficulty locating these staff came from their scheduling (e.g. vacations, PRN status) and low unit census resulting in budgeting, cancellations, and pulls from their home unit. The DNP project lead made significant efforts and was able to reach all nursing staff, bringing the simulation to other units and accommodating to specific staff members' schedules.

Finally, this project was able to collect significant amounts of data that will benefit future PDSA cycles. It also found significant issues with being able to monitor some bundle components. Observing nursing staff scrub the hub without explicitly indicating observation was difficult. While several different methods, including randomly timed audits, audits at medication pass times, and audits based on randomly selected patients' scheduled medication times were attempted, success at observing scrub the hub opportunities were minimal. It is important to note that while all audits recorded in this data were accurate representations of actual nursing staff's compliance, with limited observations this data may be inaccurate in representing the compliance of the entire unit. An attempt was made to monitor more hub disinfection on randomly selected patients over an additional two weeks, but concern exists that this data may be biased since although patients were still randomly selected, specific medication pass times to each of these patients were monitored so nursing staff awareness of audits may have been heightened to what the auditor was looking for. Continued efforts to monitor hub disinfection may be more successful if monitored by multiple auditors on regular bedside rounds such as charge nurses and VAT members.

Recommendations

This QI project was successfully implemented with several modifications to the original plans. Accommodations included project implementation date changes, increasing project time to reach all 79 staff nurses, and changing the methods of staff reminders. Data collected in this project, however, will be invaluable in guiding future cycles of PDSA. In addition to data collection, this project also provides multiple suggestions for improvement of bundle implementation and risk reduction.

There was a minor increase in knowledge, but there was a more notable increase in compliance after the implementation of the QI initiative. While this could have served as a reminder to staff, their initial knowledge of central line management was higher than anticipated meaning that there are likely significant barriers to implementation of the bundle elements as they were not being completed even with a mean knowledge score of 89% in a majority of the CICU nursing staff. A suggestion would be to further evaluate barriers to bundle completion. Some noted during this project were that nursing staff do not initially dress or secure lines since lines are placed in other units such as the operating room or during cardiac catheterization, and that patients' acuity drives the nursing staff's time or prevents staff from being able to adhere to bundle elements.

Additionally, hub disinfection or scrub the hub audits were challenging to perform with significantly varying medication administration times, with many patients being on continuous medications, and without drawing attention to the fact that the nurses were being watched. One suggestion would be for nursing leadership, clinical educators, and VAT nurses to be tasked with trying to monitor hub disinfection. Having multiple people watching and ensuring completion would provide a more accurate representation of all nursing staff's compliance with the task.

Also important to note, in a review of the literature the DNP project lead noticed variation in recommended hub disinfection times, with consensus coming to a 10 to 15-second hub scrub and five-second dry time. This facility's current policy is for nurses to scrub for five seconds. Recommendation from this project would be to increase hub disinfection time.

In future cycles and continued audits, another recommendation would be to divide the facility's current audit tool further so that each element and more specific issues with compliance can be identified. The use of an audit tool facilitates assessment of compliance, but currently the facility's tool groups elements such as hub disinfection and use of alcohol disinfection caps, with labeling dressings that are clean, dry, and intact. The current bundle also does not include an assessment for dressing type or the use of a sutureless securement device. It is important to distinguish each of these elements of infection prevention individually because this allows auditors to specifically note the issue and reduces ambiguity as to what was actually done.

Finally, it is recommended that further evaluation be done on the choice of central line insertion sites with providers. Although this patient population is highly unique with complex congenital heart and vascular malformations, femoral central lines are the site associated with the highest risk of CLABSI (Haddadin et al., 2022). This site should be avoided when at all possible and with 72.2% of audited central lines being femoral, this site is being used at significantly higher rates than alternative sites in this unit.

As the first cycle of PDSA, this QI project was intended to meet its purpose of reducing infection risk associated with central lines, but also emphasized potential areas for improvement. Using evidence-based interventions, suggestions sought to further successful infection prevention and improve care of pediatric patients with central lines.

Implications

This project sought to improve patient safety through frequent education and transparency of issues to increase the knowledge and perception of nurses in their role of CLABSI prevention. Staff were encouraged to become care partners again after disengagement resulting from the implementation of a specialized care team. Improved staff engagement is reflected in the increase in bundle compliance. Staff participation creates 100% accountability of actions and protects patients from unintentional harm, resulting in a decreased risk of CLABSI.

Feasibility

While the Kentucky pediatric acute care facility's CICU does treat patients with a variety of cardiac diagnoses, it was primarily chosen for its occurrences of central line-associated bloodstream infection and the prevalence of central lines in its high acuity patients. The unit and facility also treat pediatric patients at a notably higher rate than any other acute care facility in the area. With significant support from the unit manager and leadership, it was decided implementation would be well received with significant buy-in from key stakeholders.

Implementation of this project was highly feasible. It was cost-effective, allowed nursing staff participation while on shift, and required minimal extra staff for implementation. Resources required for the education component of the project were already owned, recycled, or expired materials which were already expensed to the unit and education department. While simple, the interventions of this QI project resulted in significant improvement in staff compliance with the CLABSI prevention bundle.

Sustainability

From the planning period, the intent of this initiative was for this QI project to be the first PDSA cycle of multiple. For subsequent cycles, interventions will be selected and tailored based

on this initial cycle. The sustainability of this project is promoted by the utilization of the PDSA model. With each subsequent cycle, improvement in CLABSI risk prevention is expected by utilizing evidence-based interventions and suggestions to further improve patient care.

This QI project utilized evidence and interventions that are very generalizable to any pediatric acute care facility. Utilization of central lines is common in the acute care setting and the information this project provides could be useful in numerous acute care settings and patient populations. Sustaining this project will entail the implementation of future cycles and dissemination of results and information learned, regardless of each cycle's success.

Dissemination

Dissemination entails distributing the QI project's results from data analysis and distinguishing which interventions were successful and which were not. The identity of the Kentucky pediatric acute care facility will be protected in all forms of dissemination.

Results were shared with the facility in which the project occurred and with key stakeholders. This communication with the facility promotes the facilitation of future PDSA cycles. A poster presentation of the result will also be carried out by the DNP project lead for the University of Louisville School of Nursing. Through the distribution of this project's results, it is desired that other facilities and patients may benefit.

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Appendix A

Pre- and Post-Quiz

Maintenance of Central Venous Line (CVL) Knowledge Assessment

Please circle True (T) or False (f) for the following items. Your information is anonymous.

True or False…

T	F	1. Hand hygiene should be performed before and after line care or access to reduced potential contamination.
T	**F**	2. A transparent semipermeable (i.e., Tegaderm) dressing should be changed every 5 days and as needed (soiled, wet, or nonocclusive/ loose adhering) except for those patients in which the risk for dislodging the catheter outweighs the benefit of changing the dressing (i.e., neo-picc).
T	**F**	3. A dressing may be re-enforced if VAT or a manager are unavailable to assist with a dressing change.
T	F	4. Lines should be dated and timed, indicating a need for change at least every 5 days/120 hours and no more often than every 4 days/96 hours, except for lines infusing lipids, blood product (albumin), and propofol.
T	F	5. A needleless access device should be changed every 7 days if heparin locked or with continuous IV tubing changes, except for when blood products, lipids, or propofol have been given.
T	F	6. If a blood product or lipids have infused a needleless access device should be changed every 24 hours and if propofol has been given it should be changed every 12 hours.

T	**F**	7. The hub (Cap or NAD) should be scrubbed for 5 seconds before each line access.
T	F	8. On continuous infusion lines, alcohol disinfection caps should be in place on all access ports.
T	**F**	9. A patient with a central venous line will receive 2% chlorohexidine gluconate (CHG) bath every 12 hours unless otherwise contraindicated and documented in the EMR.
T	**F**	10. A sutureless securement device (Statlock) increases risk for infection.
T	**F**	11. Administration sets can be moved from peripheral to central lines and can be disconnected and reconnected from central lines for risk of contamination.
T	**F**	12. Nurses should not assess the need for central venous lines on daily rounds.
T	F	13. The nurse should check the entire infusion system, from the solution container to the CVL insertion site, when assuming care and as needed for system integrity, infusion accuracy, and expiration dates of the infuscate, dressing and administration set.
T	**F**	14. Patency of the CVL should not be assessed with cap and tubing changes.
T	F	15. CHG tegaderm should be used on all CVLs, excluding PICC lines less than or equal to 2F, Ports, Intracardiac lines, Arterial lines, lines that are bleeding, and those with documented CHG allergy.

_____ Total Knowledge Score (0-15)

Table 1

Peercent of Change in Pre- and Post-Test Percentage of Correct Responses of Nursing Knowledge of Central Line Infection Prevention Bundle

Item No.	Variable: Question Based on Bundle Elements	Pre-Test Mean Scores (n=60)	Post-Test Mean Scores (n=33)	Percentage of Change in Scores
1	Hand hygiene should be performed before and after line care or access to reduce potential contamination.	100	100	0.00%
2	A transparent semipermeable (i.e., Tegaderm) dressing should be changed every 5 days and as needed (soiled, wet, or nonocclusive/ loose adhering) except for those patients in which the risk for dislodging the catheter outweighs the benefit of changing the dressing (i.e., neo-picc).	47	61	+29.79%
3	A dressing may be re-enforced if VAT or a manager are unavailable to assist with a dressing change.	92	88	-4.35%
4	Lines should be dated and timed, indicating a need for change at least every 5 days/120 hours and no more often than every 4 days/96 hours, except for lines infusing lipids, blood product (albumin), and propofol.	97	94	-3.09%
5	A needleless access device should be changed every 7 days if heparin locked OR every 5 days with continuous IV tubing changes, except for when blood products, lipids, or propofol have been given.	95	97	+ 2.11%

Item No.	Variable: Question Based on Bundle Elements	Pre-Test Mean Scores (n=60)	Post-Test Mean Scores (n=33)	Percentage of Change in Scores
6	If a blood product or lipids have been infused, a needleless access device should be changed every 24 hours and if propofol has been given it should be changed every 12 hours.	98	100	+2.04%
7	The hub (Cap or NAD) should be scrubbed for 3 seconds before each line access.	72	85	+18.06%
8	On continuous infusion lines, alcohol disinfection caps should be in place on all access ports.	100	100	0.00%
9	A patient with a central venous line will receive 2% chlorohexidine gluconate (CHG) bath every 12 hours unless otherwise contraindicated and documented in the EMR.	90	97	+7.78%
10	A sutureless securement device (Statlock) increases risk for infection.	70	67	-4.29%
11	Administration sets can be moved from peripheral to central lines and can be disconnected and reconnected from central lines.	98	100	+2.04
12	Nurses should not assess the need for central venous lines on daily rounds.	100	97	-3.00%

Item No.	Variable: Question Based on Bundle Elements	Pre-Test Mean Scores (n=60)	Post-Test Mean Scores (n=33)	Percentage of Change in Scores
13	The nurse should check the entire infusion system, from the solution container to the CVL insertion site, when assuming care and as needed for system integrity, infusion accuracy, and expiration dates of the infusate, dressing and administration set.	100	100	0.00%
14	Patency of the CVL should not be assessed with cap and tubing changes.	100	97	-3.00%
15	CHG tegaderm should be used on all CVLs, excluding PICC lines less than or equal to 2F, Ports, Intracardiac lines, Arterial lines, lines that are bleeding, and those with documented CHG allergy.	70	76	+8.57%
16	Overall Scores	89	91	+2.25%

Note. Pre- and post-scores based on one point for each element and calculated by percentage correct

Table 2

Percent of Change in Audit Percentage of Compliance with CLABSI Bundle Before and After Education-Based Simulation

Item No.	Variable: Central Line-associated Blood Stream Infection Prevention Element	Before Simulation Mean Compliance (n=18)	After Simulation Mean Compliance (n=36)	Percentage of Change in Compliance
1	Indication for Central Line is Appropriate and documented	100.00	100.00	0.00%
2	Hand hygiene performed before touching line	94.00	96.00	+2.13%
3	CHG bath in last calendar day	88.70	100.00	+12.74%
4	Hub disinfection, 15 second scrub the hub	39.00 (n=8)	94.50 (n=15)	+142.31%
5	Curos (alcohol caps) in place on all IV access ports	83.00	97.20	+17.11%
6	Needleless access device (NAD) present on all ports	100.00	100.00	0.00%
7	Needleless access device dated/ timed and changed as indicated	88.70	100.00	+12.74%
8	Lines are dated/timed and changed as indicated	88.70	100.00	+12.74%
9	Dressing is clean, dry, and intact	88.70	91.65	+3.33%
10	Dressing is dated/ timed and changed as indicated	88.70	97.20	+9.58%
11	Sutureless securement device present	83.30	91.70	+10.08%
12	Audit Overall Compliant	60.90	80.55	+32.27%

Note. Abbreviations: CLABSI= Central Line- associated Blood Stream Infection; CHG= Chlorohexidine Gluconate

Table 3

Demographics of audited CLABSI prevention bundle among Cardiac Intensive Care Unit Patients from February 11, 2023- April 19th, 2023 (N=36)

Variables	n	%
Gender		
Male	30	55.6
Female	24	44.4
Age		
Neonate: birth to 29 days old	6	11.1
Infant: 29 days to < 2 years old	30	55.6
Young child: 2 years to < 6 years old	7	13.0
Child: 6 to < 12 years old	9	16.6
Adolescent 12 to < 18 years old	2	3.7
Central Line Location		
Intrajugular	4	7.4
Subclavian	3	5.6
Femoral	39	72.2
Basilic/ Arm	2	3.7
Saphenous/ Foot	6	11.1
Central Line Type		
Permanent	9	16.7
Temporary	45	83.3

Note. Abbreviations: CLABSI= Central Line- associated Blood Stream Infection

Table 4

Key Elements of Facility's Central Venous Line Maintenance Policy

Key Elements	Strength of Evidence	Supporting Evidence
Hand hygiene performed before line care or access	IB	Centers for Disease Control and Prevention [CDC], (2011) Rinke et al., (2012) Dandoy et al., (2015) Infusion Nurses Society [INS], (2016) Yuan et al., (2016) Lin et al., (2017)
An appropriate indication for the line	IA	Centers for Disease Control and Prevention [CDC], (2011) Infusion Nurses Society [INS], (2016) Lin et al., (2017)
A dry, occlusive, dated, and timed dressing per policy: • Dressing changed if damp, loose, or soiled • Gauze dressing changed every 48 hrs • Transparent dressing changed every 7 days	IB, II	Centers for Disease Control and Prevention [CDC], (2011) Rinke et al., (2012) Atilla et al., (2016) Infusion Nurses Society [INS], (2016)
Lines dated and changed per policy: • At least every 5 days/120 hours and no more often than every 4 days/96 hours • With insertion of new central line • With port needle change • Lipids and any fluid containing albumin are changed every 24 hours • Propofol set is changed every 12 hours	IA, IB	Centers for Disease Control and Prevention [CDC], (2011) Rinke et al., (2012) Atilla et al., (2016) Infusion Nurses Society [INS], (2016)

A needleless access device present on all indicated sites, labeled with the date and time, and changed per policy: • Every 7 days if locked • With continuous IV tubing changes • PRN for leaking/contamination • Upon admission to the facility prior to accessing the CVAD • Within 24 hours of blood product administration • When removed for any reason • Within 12 hours of propofol infusion • Within 24 hours of lipid infusion	IB	Centers for Disease Control and Prevention [CDC], (2011) Rinke et al., (2012) Infusion Nurses Society [INS], (2016)
15 second hub disinfection visualized	IA	Centers for Disease Control and Prevention [CDC], (2011) Rinke et al., (2012) Infusion Nurses Society [INS], (2016) Pavia & Mazza, (2016)
Curos® alcohol disinfection cap in place on all access ports	IA	Rinke et al., (2012) Infusion Nurses Society [INS], (2016) Pavia & Mazza, (2016)
A daily chlorohexidine gluconate bath performed every 24 hours	II	Centers for Disease Control and Prevention [CDC], (2011) Dandoy et al., (2015) Lin et al., (2017)
Oral care performed per policy on all oncology patients	II	Sarmiento et al., (2014) Best et al., (2016) Wittekamp et al., (2018)

Catheters should be secured with a sutureless securement device (i.e. Statlock)	II	Yamamoto et al., (2002) Centers for Disease Control and Prevention [CDC], (2011) Ulman et al., (2016)

Note. Level of Evidence: Level IA= Strongly recommended for implementation and strongly supported by well-designed experimental, clinical, or epidemiologic studies.; Level IB= Strongly recommended for implementation and supported by some experimental, clinical, or epidemiologic studies, and by a strong theoretical rationale.; Level IC= Required by state or federal regulations. Because of state differences, readers should not assume that the absence of an *IC* recommendation implies the absence of state regulations.; Level II= Suggested for implementation and supported by suggestive clinical or epidemiologic studies or by a theoretical rationale.

Figure 1

Donabedian's Theoretical Model of Healthcare (1980)

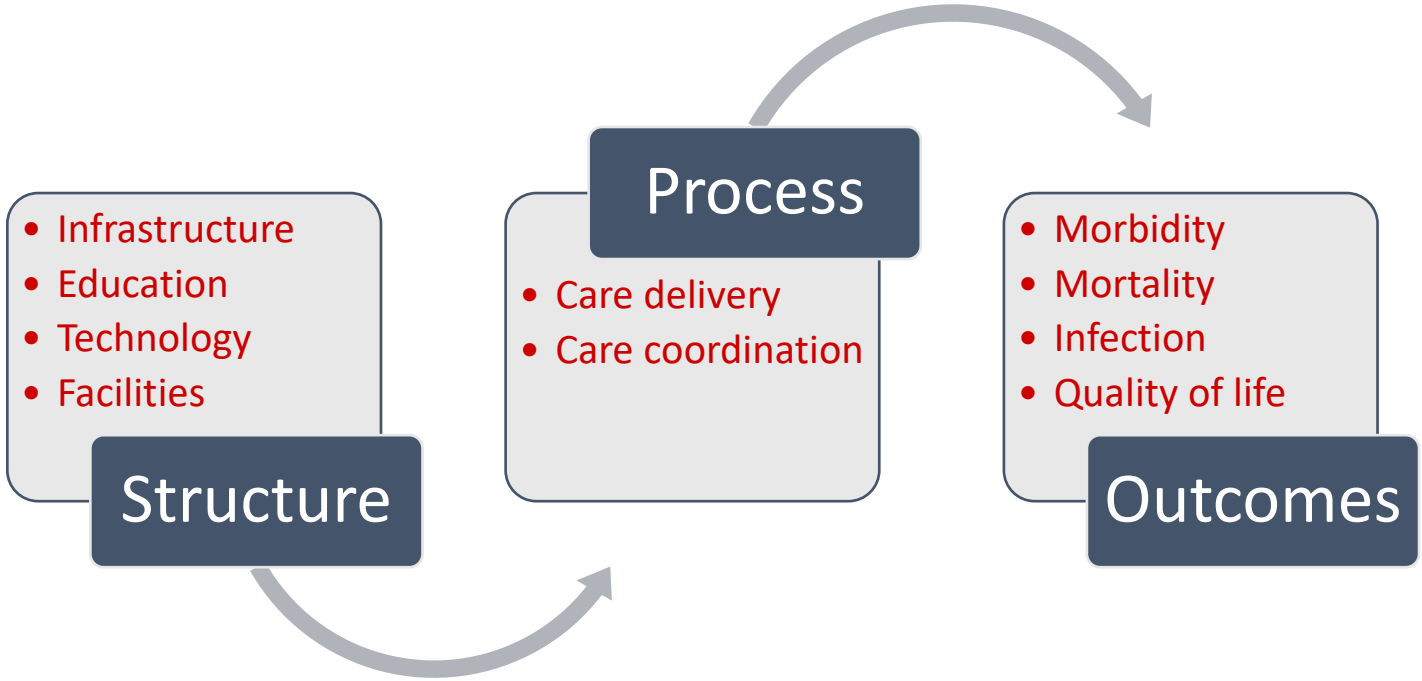

Figure 2

Logic Model: CLABSI Prevention and Bundle Compliance

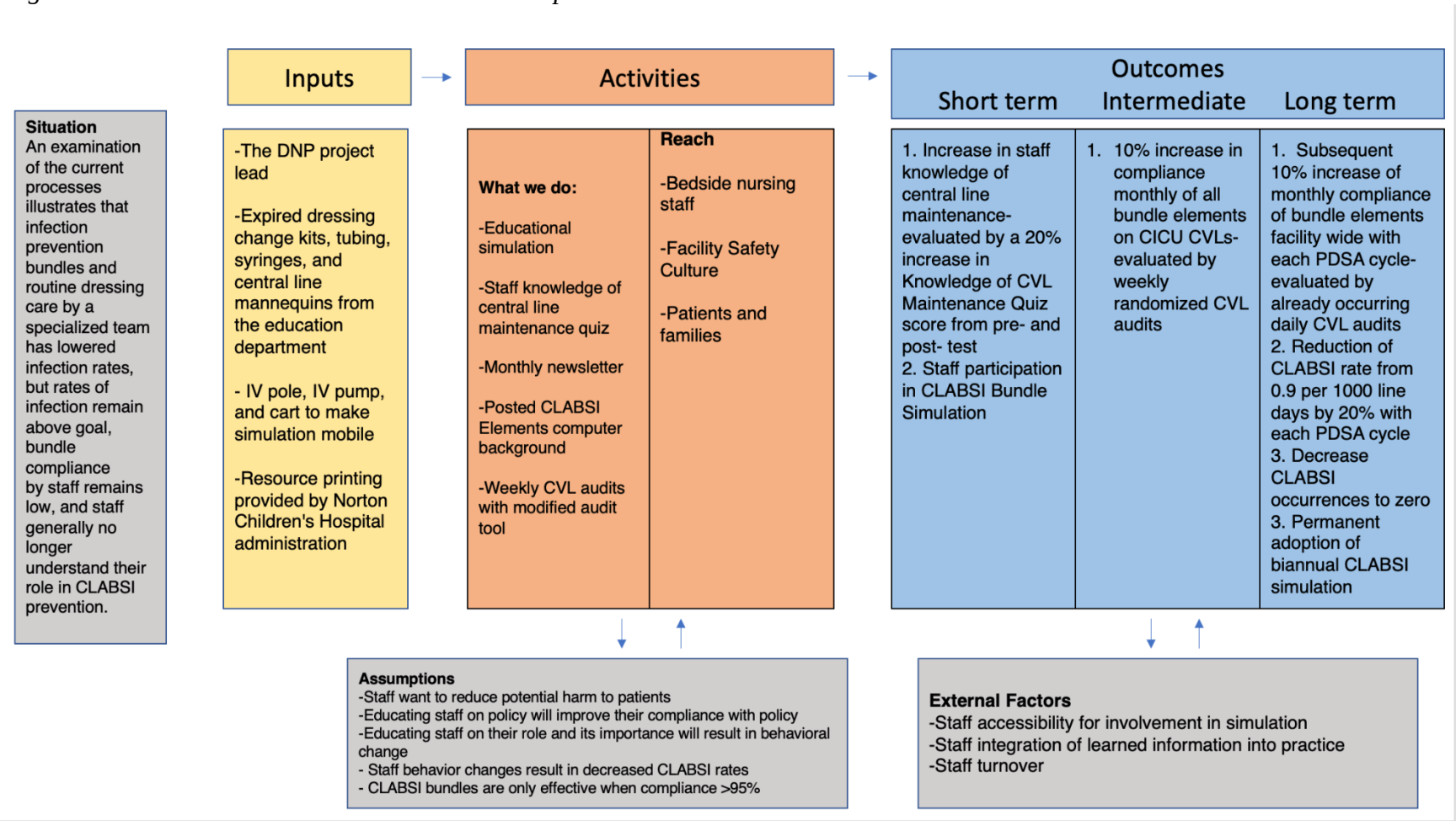

Figure 3

Gantt Chart: Project Timeline

GANTT CHART

Activity	May 2022	June , 22	July , 22	August , 22	September , 22	October , 22	November , 22	December , 22	January 2023	February , 23	March , 23	April , 23	May , 23	June , 23	July , 23
Proposal submission to U of L Faculty															
Approval from Norton Manager and Facility															
NHC IRB Submission															
U of L IRB Submission															
Briefing with unit managers establish timeline of project															
Implementation of intervention															
Regular meetings with Project Advisors															
Data collection															
Data Analysis															
Preparation & Submission of DNP Project paper															
Dissemination of project results															