

Investigation of Nursing Compliance with Sterile Needleless Access Device Changes:

A Quality Improvement Project

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Abstract

Pediatric patients with central lines are at a higher risk for Central Line-Associated Blood Stream Infections (CLABSIs), which increases their risk for other consequences such as longer hospital stays, risk for prolonged or worsening illness, increased cost of healthcare, and increased risk for mortality. A Midwestern Children's Hospital's Pediatric Intensive Care Unit (PICU) has taken recommendations from the Solutions of Patient Safety (SPS), a National Pediatric Collaborative, to decrease the number of CLABSIs to zero. The PICU has implemented a "bundle" that consists of protocols and guidelines on the insertion, management, and removal of central lines. One of the main barriers to a successful implementation of a new protocol includes compliance. This quality improvement project addressed nursing education on the new protocol of a standardized work process for sterile Needleless Access Device (NAD) changes. The goal of the QI project was to determine current protocol knowledge and compliance concerning central line maintenance through bedside nursing surveys and audits, identify barriers to compliance and determine the impact of reinforced education on nursing knowledge and compliance through post-education audits. Key findings of this project suggest that reinforced education has a positive impact on nursing compliance, follow-up or re-education is needed when a new protocol is implemented, and nurses value reinforcement and a hands on approach when a new protocol including a hands on skill is implemented.

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Central venous catheters (CVCs), or central lines, play an integral role in Pediatric Intensive Care Unit (PICU) patient care as they allow for the administration of intravenous fluids, blood products, medications, parenteral nutrition, as well as providing hemodialysis access, hemodynamic monitoring, and other life-saving therapies and interventions (The Joint Commission, 2012). Despite these obvious benefits, there are inherent risks associated with CVC use. Research has shown that there is an estimated 248,000 bloodstream infections that occur in U.S. hospitals each year and it is believed that a large amount of these infections are associated with the presence of a central line (HealthyPeople.gov, 2016). A retrospective cohort and cost-of-illness study was conducted in 2013 by Stevens, et al., which found that on average Central Line Associated Blood Stream Infections (CLABSIs) cost an additional \$32, 000 for each patient affected. CLABSIs were associated with a two-fold increase in mortality after adjusting for individual factors. A meta-analysis of 26 studies completed by Waknine, (2013), emphasized that CLABSIs and Healthcare Associated Infections (HAIs) are a major threat to patient safety as they are the most common source of preventable harm.

CLABSIs put an increased economic and social burden on the United States as well as increase the morbidity and mortality rates among patients. CLABSIs account for between 600 million and 2.7 billion US dollars in annual costs (Stevens, et al., 2013). CLABSIs in the PICU are a threat to quality related outcomes such as, increased length of hospital stay, increased risk for additional comorbidities and illnesses, increased risk of mortality, increased hospital expenses, denial of hospital reimbursement for services, and

increased risk for readmission (AHRQ, 2014).

There are various healthcare agencies, governing bodies, and professional organizations that have taken notice of CLABSIs as a national problem. The Centers for Disease Control and Prevention (CDC), The Joint Commission (JC), and The National Healthcare Safety Network (NHSN) have collectively compiled the evidence to develop current recommendation and protocols on central line maintenance in hospitalized pediatric patients. This Midwestern Children's Hospital is a part of a The Children's Hospital's Solutions for Patient Safety Children's Network which is a pediatric collaborative to create a safe and healing environment for all patients. The Solutions for Patient Safety (SPS) has taken the recommendations of these national organizations to develop goals and solutions to improve patient safety. SLCH uses these recommendations to guide the implementation of new protocols.

Significance

The Center for Medicare and Medicaid Services, as of 2008, will no longer reimburse the costs of additional care required to treat conditions that develop in the hospital, including CLABSIs (Stevens, et al., 2013). The denial for reimbursement for treatment of patients with Healthcare Associated Infections (HAI) puts an increased emphasis on prevention from an institutional standpoint. The movement for the future of healthcare reimbursement is working towards payment for quality, not quantity, which will not include preventable harm. Now, more than ever, there is urgency towards prevention of harm and avoiding the unnecessary costs associated with CLABSIs. According to the Agency for Healthcare Research and Quality, (2014), CLABSIs result annually in 84,551 to 203,916 preventable infections and 10,426 to 25,145 preventable

deaths. The key word is preventable.

Healthcare providers are responsible for inserting central lines and making sure that the maintenance care is current with the national protocols. While there are studies supporting the benefit of CLABSI prevention bundles, there is a gap in the research evaluating outcomes of individual bundle components. Examples of gaps in the research are studies specifically focusing on individual aspects of the bundle such as the impact of IV fluid, syringe, and tubing change protocols on CLABSIs in PICU patients and nursing compliance with these protocols.

In 2013, the Joint Commission developed a Maintenance Bundle to Reduce CLABSI Rates that included individual components. Under the *catheter hub, cap, and tubing care* bundle component are the current recommendations to replace administration sets, including add-on devices, no more frequently than every 72 hours, and to change caps no more often than 72 hours (or in accordance with manufacturer recommendations); however, caps should be replaced when the administration set is changed. The Joint Commission created this piece of the bundle in accordance to the CDC recommendations for central line maintenance. Although there has been an estimated 46% decrease in CLABSIs incidence in U.S. hospitals, CLABSIs still occur every year (CDC, 2016). Solutions for Patient Safety (SPS) has recognized the recommendations from the CDC on central line maintenance and the PICU has implemented a central line maintenance bundle.

Currently this Midwestern Children's Hospital has reported each individual units monthly infections of CLABSIs in 2014, 2015, and 2016. There were four confirmed CLABSIs per 5,190 central lines days in the PICU in 2014. In February of 2015, the

“Love Your Lines” protocol was implemented that included guidelines on IV bag, tubing, and syringe changes. There were three CLABSIs per 3,912 line days in 2015 and there were two CLABSIs per 3,819 line days in 2016. Essentially, the CLABSI rates per central line days were unchanged, so although recommendations were adopted, a decrease in CLABSI rates was not appreciated suggesting that compliance to guidelines and newly adopted protocols should be considered. CLABSI rates have been shown to decline when focused prevention efforts adhering to CDC's guidelines and recommendations have been adopted (HealthyPeople.gov, 2016). With recommendations from the CDC, the Solutions for Patient Safety Council made an addition to the current “Love Your Lines” protocol that includes a sterile Needleless Access Device (NAD) change process and was implemented in April of 2017. Protocol compliance has not been examined to determine the relationship between nursing staff’s routine CVC maintenance, including NAD change process, and CLABSI rates. The goal for this organization is to have zero CLABSIs.

Compliance can be defined in many ways and is dependent upon the discipline and concept in which it is being used. Webster’s Dictionary, (2017), defines compliance as “the act or process of complying to a desire, demand, proposal, or regimen or to coercion; conformity in fulfilling official requirements.” Nursing compliance refers to the extent that a nurse is practicing within his or her scope under the guidelines and protocols set by their individual institution (Furuya, et al, 2016). For the purpose of this project, compliance will be determined using an “all or nothing” approach. A nurse is determined to be compliant if all the steps of the protocol are followed.

Clinical Problem

Pediatric patients with central lines are at a higher risk for blood stream infections than patients without central lines, which ultimately increases their risk for longer hospital stays, adds to their medical expenses, and increases their morbidity and mortality rates. Maintenance bundle protocols have been implemented to decrease the incidence of CLABSIs; however, lack of nursing compliance diminishes the potential for these maintenance bundles. Most CLABSIs occur after insertion, suggesting lapses in maintenance care (Pennsylvania Safety Authority, 2011). Nursing compliance to maintenance central line protocols is a potential contributor to CLABSIs. Despite adopting the CDC's guidelines for reducing CLABSIs, a decrease in CLABSI rates was not appreciated in a 30-bed PICU located in a 280-bed Midwestern Children's Hospital. Nursing compliance with a newly implemented protocol that included a sterile needleless access device change process had not been investigated.

Purpose Statement and Aims

The clinical purpose for this quality improvement project was to determine initial nursing knowledge and improve compliance with the "Love Your Lines" protocol that includes a sterile Needleless Access Device (NAD) change process as part of the maintenance CVC bundle in a 30-bed PICU in a Midwestern Children's Hospital. Ultimately the goal was to optimize the PICU nurses' care and maintenance of CVCs and reduce the PICU CLABSI rates over time. It was anticipated that increasing adherence and knowledge of the NAD change protocol would have the potential to ultimately decrease CLABSI rates in the long term. The purpose of this QI project was completed with the following aims:

1. *Determine the PICU nurse's current knowledge of the sterile needleless access device change protocol using a short questionnaire (Appendix A). Additionally, utilization of the protocol will be determined by random bedside audits of the PICU nurse's sterile NAD change practice (Appendix C) that was developed from the standard of work document (Appendix B).*
2. *Through observation and information obtained from nursing audits, barriers and/or deviations from the current sterile NAD change protocol were identified.*
3. *Provided education based off of the survey results to reinforce the sterile NAD change protocol.*
4. *Evaluated central line maintenance practices post-education with follow-up post-education random bedside audits (Appendix C)*

Literature Review

To assess the impact of CLABSIs on PICU patients as well as the effect of evidence-based protocols for maintenance of CVLs, current literature was gathered from a variety of databases. Database used included PubMed, CDC.gov, AHRQ.gov, EBSCO Host, Elsevier Clinical Key, Google Scholar, and CINAHL. The search words and phrases included *central line changes, central line infection prevention, catheter related BSI, sterile central line changes, BSI, pediatric infections, intensive care units, nursing compliance, central line maintenance bundle, compliance, pediatric, prevention, central line associated blood stream infection, PICU, and tubing changes*. A total of 40 articles and guidelines were reviewed that were published between 2001 and 2016 and ultimately 7 were used for the literature review that were relevant to this project. The references included studies on the effect of central line bundles and IV tubing/NAD change

protocols. Recommendations from national organizations on procedures for central line maintenance were included. There was limited data published that specifically focuses on PICU patients as well as the effects of one single bundle component. Due to this limitation, studies that discuss BSI prevention bundles for pediatric cancer patients and patients in the NICU with central lines were also included. There were limited studies on specific pediatric outcomes and sole pediatric recommendations, therefore some studies including adult populations with central venous lines (CVL) were considered. The intent of this literature review was to compile the current evidence on CVL maintenance as it relates to IV fluid, syringe, tubing, and sterile NAD changes. The goal was to identify national guidelines, address the importance of compliance, understand barriers to implementation, and understand the effect that bundle compliance has on CLABSI rates.

Central Line Maintenance Bundles Decrease CLABSI Rates

A meta-analysis study by Ista, et. al., in 2016, aimed at researching the effectiveness of BSI bundles in the ICU. The sample for this meta-analysis consisted of 79 studies that all reported on the implementation of central line bundles in an ICU. For the meta-analysis, estimates of infections were pooled using a DerSimonian and Laird random effect model and the outcome was number of CLABSIs per 1000 central line days before and after the bundle implementation. This study reported on adult ICUs, pediatric ICUs, and neonatal ICUs. The results showed that the incidence of infections decreased after implementation of a maintenance bundle. The incidence of infections decreased significantly from median 6.4 per 1000 catheter-days (IQR 3.8–10.9) to 2.5 per 1000 catheter-days (1.4–4.8) after implementation of bundles (IRR 0.44, 95% CI 0.39–0.50, $p < 0.0001$; $I^2 = 89\%$) (Ista, 2016). This meta-analysis emphasized the

relationship between BSI bundle implementation and decreased CLABSI rates in all ICU settings; however, the meta-analysis did not break down individual components of one specific bundle as it related to CLABSI rates.

In 2010, Miller, et al. published a study was a multi-institutional interrupted time series design of 29 pediatric intensive care units documenting the CLABSI rates over time. The study focused on insertion and maintenance bundle adherence. Two maintenance bundles were used in the intervention that included an insertion bundle of pediatric elements derived from adult efforts, and a maintenance central line bundle derived from the CDC guidelines and expert pediatric clinicians. The bundles were implemented through teaching efforts in the participating PICUs. The measured outcomes were rate of CLABSIs and compliance with each element of the bundles. The adherence was assessed as “all or none” meaning, the providers maintaining the CVL needed to be compliant with all elements of the bundle for a bundle to be considered adherent. The study revealed that insertion bundle adherence was 84% and maintenance bundle adherence was 82% over the study period. This study also showed a 43% decrease in CLABSIs among PICU patients across the 29 PICUs. This study compared the importance of CVC insertion compliance versus maintenance compliance and found that, the only significant factor of decreased CLABSI rate was adherence to the maintenance bundle component (Miller, et al, 2010). This study further establishes a relationship between the adherence to maintenance bundle care and PICU CLABSI rates over time.

In addition to the 2010 study, Miller published a three-year, multi-institutional study in 2011 to evaluate the long-term impacts of PICU BSI bundle implementation. Included in the study were the central line insertion bundle and central line maintenance

bundle discussed in the 2010 study but with the addition of chlorhexidine scrub and chlorhexidine-impregnated sponges. Compliance rates for each bundle as well as each additional component were assessed across the same 29 PICUs. There was no significant CLABSI difference based off of the two additional interventions but the average baseline PICU CLABSI rate decreased 56% over 36 months from 5.2 CLA-BSIs per 1000 line-days (95% confidence interval [CI]: 4.4–6.2 CLA-BSIs per 1000 line-days) to 2.3 CLA-BSIs per 1000 line-days (95% CI: 1.9–2.9 CLA-BSIs per 1000 line-days) (rate ratio: 0.44 [95% CI: 0.37–0.53]; $P < .0001$) (Miller, 2011). This study is the first to show decreased PICU CLABSI rates that were sustained and continued to decrease over 3 years and across multiple PICUs (Miller, 2011). Miller identified the importance of bundle compliance and addressed this as an integral part in the successful decrease in CLABSI rates. This study also discussed that although BSI prevention bundles may be implemented, continuing reinforcement and adherence to the maintenance policies are what will yield the most desirable results to decrease the number of CLABSIs in a PICU.

The *Standardizing Line Care Under Guideline Recommendations (SLUG) Bug* study published by Piazza, et al., (2016), was one of the few studies that discussed the reduction of CLABSI rates while addressing individual bundle components. This study was a multicenter improvement collaborative that performed a literature review, used expert opinion, and benchmarking to develop recommendations on central line care. Four CLABSI prevention strategies were incorporated that included tubing change technique, hub care monitoring, central venous catheter access limitation, and central venous catheter removal monitoring. CLABSI rates were compared between 17 participating Children's Hospitals. There were 8 test groups (developed from 8 factor/level

combinations) dividing the hospital centers to identify the CLABSI prevention component that had the greatest impact on rates. The combinations this study included for the test groups were sterile versus clean tubing change (TC) technique, Hub Care (HC) compliance monitoring versus not monitoring, CVC line entry access limitation versus no specific limitations, and CVC line removal tracking versus no tracking policy. This study identified that 16 of the 17 centers had a >75% compliance of the identified process measures. The results were significant for a 19.28% decrease in CLABSI rates over time. When monitoring was done on hub scrub compliance in combination with sterile tubing change, CLABSI rates decreased by 1.25 per 1000 line days. This study further suggests a relationship between sterile tubing changes in combination with compliance monitoring has a potential to decrease CLABSI rates among ICU patients.

Nursing Compliance and Effects on Patient Outcomes

For CLABSI prevention, a majority of the responsibility falls on the providers and nurses, as they are the ones inserting and managing these lines. It is important to understand one major barrier to implementation of new guidelines as it relates to staff compliance.

A longitudinal study done by Edwards, (2015) looked at PICUs in NHSN hospitals and conducted cross-sectional surveys of directors and managers of infection prevention control departments. The surveys looked at PICU CLABSI prevention practiced and self reported compliance with elements of central line bundles. This study found that, only 35% of the PICUs with central line maintenance policies reported a $\geq 95\%$ compliance. Subsequently, this study found that PICUs with >95% compliance had lower rates of reported CLABSIs. CLABSI rates decreased during the study period, from

5.8 per 1,000 line days in 2006 to 1.4 in 2011-2012 ($P < .001$). The conclusions drawn from this study stated that the healthcare facility and unit management is responsible for education and reinforcement of new policies so that compliance rates will increase.

Additionally, in a cross-sectional study by Furuya, et al., (2016), the presence of an infection prevention department, and even compliance in one BSI bundle component were associated with lower CLABSI rates. This study surveyed a national sample of adult ICUs to determine compliance with CL insertion bundle elements in ICUs.

Corresponding NHSN ICU CLABSI rates were obtained. This study assessed associations between CL bundle compliance and CLABSI rates and the researcher conclude that compliance with CL bundle components yielded a decrease in CLABSI rates. These studies outline the importance of a collaborative effort with focused prevention strategies that include CLABSI prevention education and compliance monitoring to decrease CLABSI rates.

A study reported by Hebbbar, (2014), included a multidisciplinary team that performed a randomized comparison study on BSI bundle training for bedside nurses in a 30 bed multidisciplinary PICU. This study looked at a sample of bedside nurses who received bedside BSI bundle, simulation training (intervention group, IG) with refresher sessions at three months and six months, and those that did not (control group, CG). The bedside simulation studied nurses completing a central line dressing change on a mannequin in the presence of an observer using a CVL maintenance bundle checklist. The results of this study were statistically significant in that, BSI rates decreased from a mean of 1.9 ± 2.2 BSIs per 1000/CVL days for the six months pre-study to 0.6 ± 1.6 BSIs per 1000/CVL days for the last six months. This study supports the need for not only BSI

prevention bundles, but also the benefit of bedside observation of skills and education reinforcement for all healthcare personnel involved in management of a central line. These interventions are important to improve compliance and in turn, patient outcomes.

Nursing Theory/ Conceptual Model

The nursing theory used as a basis for this project was the Iowa Model of Evidence Based Practice (EBP) to Promote Quality Care. The Iowa Model was originated in 1994 and allows staff to use their knowledge to identify a problem and form an evidence-based solution. There are ten steps to the Iowa Model including selection of a topic based on a “trigger” to change practice, determining if the research is priority for the institution, forming a team, evidence retrieval, evidence critique and synthesis, grading the evidence, developing a plan to pilot change, determine if change is appropriate for adoption, implement the practice change, and evaluation and monitoring of results.

The first step involved selecting a topic that considers the relevance and contribution to improving health care. The topic is improving nursing compliance with central line maintenance protocols in the PICU based on the current evidence of poor outcomes associated with a blood stream infection. The trigger to evaluate the NAD change protocol compliance was a result of unchanged CLABSI rates despite the implementation of a sterile NAD change protocol in April 2017. Increased compliance with central line protocols has a correlation to decreased CLABSI rates among PICU patients. This Midwestern Children’s Hospital’s PICU has a goal of zero CLABSIs; therefore, making this quality improvement project a priority for the institution.

The team involved was the PICU Blood Stream Infection Prevention team that consists of the PICU nurse manager, twelve PICU registered nurses, two PICU personal care techs, and one Nurse Practitioner. The researcher chose to incorporate the BSI team because this team was able to provide insight and support as frontline employees. According to Doody, (2011), “A bottom-up approach to implementing evidence-based practice is essential as change is more successful when initiated by frontline practitioners, rather than imposed by management.” The BSI team members see the consequences of CLABSIs first hand and also make up a majority of the staff members that are maintaining the central lines. This PI has also collaborated with Lisa Steurer, PhD, RN, Manager of Nurse Research at SLCH and Susan Connelly DNP, MN, APRN-NP Assistant Professor Creighton University College of Nursing.

The next step was evidence retrieval, critique, synthesis, and grading to determine if the evidence supports a practice change. This primary investigator (PI) has provided the current evidence through a formal literature review showing the importance of sterile NAD changes and nursing maintenance bundle compliance. The CDC recommendations for the sterile NAD change process are used by the Solutions for Patient Safety to develop the PICU central line maintenance protocols. The literature review resulted in two level I, four level II, and one level III quality evidence, and the inclusion of clinical practice guidelines, which provided the foundation for this project. This evidence includes research studies on the effectiveness of implementation of BSI bundles on CLABSI rates. A meta-analysis of maintenance bundle adherence on CLABSI rates and a multi-institutional study to evaluate long-term effects of bundle adherence was incorporated into the review. These studies showed the importance of not only protocol

implementation, but also compliance. National organizations such as the CDC, recommendations for central line maintenance were used and incorporated as strong evidence. A study regarding the positive reduction of CLABSI rates when focusing on compliance of sterile tubing changes was also included. This level I evidence strongly supports the need for audits on nursing compliance and reinforced protocol education to improve overall compliance and decrease CLABSI rates.

The next step in the process was to develop a plan for change by evaluating the associated risks and benefits to the patients. After a review of current literature was performed, and recommendations from SPS were reviewed, the decision to evaluate compliance to the recently initiated, sterile NAD change protocol in the PICU was made. The plan was to conduct the pre-education audits, nursing surveys, deliver reinforced nursing education, and perform post-education audits. Ultimately, the goal was to evaluate nursing compliance pre and post education reinforcement. Step six of the Iowa Model is to implement the project. This PI conducted 12 bedside audits pre education, 24 pre education nursing surveys, and 12 post education bedside audits during two consecutive months to investigate nursing protocol compliance and the effect of reinforced education on compliance. This PI completed the 12 audits by observing 12 nurses perform the sterile NAD change at bedside (Appendix C). These audits were developed from the Sterile NAD change Standard of Work Document (Appendix B). Additionally, this PI administered a developed questionnaire (Appendix A) on the sterile NAD change process to 24 nurses to gain knowledge on barriers to protocol compliance. This PI then created a PowerPoint presentation including return demonstrations as reinforced education on the sterile NAD change process. Improvements on individual

audit items from pre-education to post-education were considered an increase in compliance for that individual item. Total nursing compliance was also reported pre vs. post education using the “all or nothing” approach from the audits. The results of this project helped determine if it will be appropriate for the PICU to incorporate protocol auditing, compliance tracking, and re-education for the purpose of increasing compliance and decreasing infection rates.

The next steps are to pilot the practice change and monitor the results. Through observation, surveys, and audits, barriers and/or deviations from the current sterile NAD change protocol was identified. Education based on the survey results was presented during a nursing in-service. Additional audits were performed using the same tools as pre-education and compliance was re-evaluated post-education to reinforce standard of work process for the sterile NAD change. The final step was to evaluate whether the reinforced education intervention increased nursing NAD change protocol compliance. Evaluation consisted of the comparison of pre/post education data to determine its influence on nursing compliance.

The role of a Doctor of Nursing Practice (DNP) in the PICU is to understand the interrelationship of compliance and the provider associated factors as they contribute to central line infection and patient outcome. Recognizing all of these factors, the DNP will understand the importance of implementation and adherence to the evidence-based guidelines and protocols set out by national organizations. This conceptual model was chosen because it provides the framework for creating an evidenced-based practice change. The results of this project will determine if it will be appropriate for the PICU to incorporate protocol auditing, compliance tracking, and re-education for the purpose of

increasing compliance and decreasing infection rates. Applying this model to the research project will help practitioners understand the importance of evidence-base guidelines and protocols for the insertion and care of central lines. This project focuses on provider specific factors as they relate to CLABSI prevention. Providers manage and maintain central lines based on national guidelines and protocols developed by their individual institution. Therefore, this project investigated the importance of protocol compliance, the effect of reinforced nursing education, and the role it has on improving patient outcomes.

Methodology

Design

This QI project evaluated the effects of reinforced education on nursing compliance with sterile NAD changes in the PICU utilizing a pre and post survey design. This PI conducted 12 pre education bedside nurse audits on the sterile NAD change process and 24 pre education questionnaires. Ultimately, the results of the pre education questionnaires and audits provided insight into barriers to compliance for the purpose of reinforcing knowledge of and compliance with the sterile NAD change protocol. The 12 post education bedside audits were compared to the pre education audits to determine the influence of education on protocol knowledge and compliance.

Study Setting and Sample

This project took place at a 30-bed PICU in a 280-bed Midwestern Children's Hospital. There are 120 PICU bedside nurses employed. The population of interest was PICU nursing staff caring for patients with central venous lines. The subject criteria for this project consisted of twelve PICU nurses being audited pre education, twenty four

nurses taking the designed questionnaire after the pre education auditing was complete, and twelve nurses audited post education. A convenience sample of 12 nurses (10% of PICU nursing staff) was selected for the pre and post education bedside audits and 24 nurses (20% of the PICU nursing staff) was selected for the pre education surveys.

Inclusion and Exclusion Criteria.

Inclusion criteria consisted of: 1) Nurses caring for PICU patients with a tunneled central venous catheter, port, or PICC in place for >48 hours, 2) Nurses caring for PICU patients with single, double, and triple lumen central lines, 3) Per PICU NAD change protocol, NADs are due to be changed every 96 hours. Nurses identified for the bedside audits cared for a patient with a central line that is due for a NAD change that day, 4) All PICU bedside nurses (full and part-time) were included in the audits and education.

Nurses were free to refuse auditing and data from those who chose to participate remained de-identified. *Exclusion criteria* consist of: 1) Patients with a hemodialysis or apheresis catheter 2) Patients on Extracorporeal Membrane Oxygenation or Continuous Venovenous Hemofiltration 3) Patients with known bacteremia or central line infection as their admitting diagnosis 4) Patients with a central line inserted prior to admission to the PICU 5) Nurses in the float pool or travel nurses were excluded from the audits as there is no way to show they were educated on the sterile NAD change or hold them accountable to PICU in-service education days.

Collaboration

The PICU blood stream infection prevention team was in support of this study. This PI also collaborated with the Children's Hospital Manager of the PICU, the Nurse Manager of Vascular Access, and Manager of Research. Letter of Support from SLCH

PICU is attached in Appendix D. Following Institutional Review Board (IRB) approval, the PI worked directly with the BSI team and these additional parties to identify appropriate participants based on the inclusion and exclusion criteria used.

Procedure and Data Collection

Measured Variable: Nursing compliance related to the NAD protocol. Utilization and compliance with the protocol was determined by bedside audits (Appendix C) of the PICU nurse's sterile NAD change practice. Measurement of the PICU nurses' current knowledge and self reported barriers to compliance with the NAD change protocol was determined by using the short questionnaire (Appendix A).

The audit (Appendix C) was created using the sterile NAD change Standard of Work Document (Appendix B--Provided to all nursing staff during initial education.) An excel spreadsheet was used to track items #1-15 on the audit. Each nurse remained de-identified and labeled nurse #1-12. Each of the 15 audit items held the weight of one point. If the item was completed, it was scored with one point indicating compliance. Missing items were scored a zero, indicating non-compliance with that particular step. The participant's individual item scores were compared to the other participants' individual item scores to determine the specific educational needs. For example, if several participants were non-compliant with items 1, 3, 5, and 9, these steps were emphasized in the educational session.

Additionally, the 12 participant's overall score was tallied. The audits were scored on an "all or nothing" basis meaning if there is a zero on any audit item #1-15, that nurse was considered non-compliant. The percentage of nurses who were compliant with the protocol was determined by the 12 nurse participants' total scores. For example, if only 3

nurses were deemed compliant with the bedside audit, this would indicate that only 25% of the participants were compliant.

Intervention: All PICU nursing staff received education that addressed the identified barriers (survey and audit scores) and reinforced the sterile NAD change protocol during shift change. A Powerpoint presentation was created using the following outline.

- a. Introduction (Brief statistics on current CLABSI rates in the PICU and what the implications are...i.e. no reimbursement and extended hospital days)
- b. Literature review (Importance of nursing care/maintenance of the lines)
- c. Reviewed results of the questionnaires (Missing knowledge/nursing identified barriers to compliance)
- d. Reviewed steps of sterile NAD change protocol
- e. Demonstrated proper steps of sterile NAD change protocol
- f. Allowed time for return demonstrations with a sterile NAD change kit and supplies
- g. Answered questions and provided PowerPoint as a printed handout for nurses to keep and reference

Timeline: One-week post educational sessions, a convenience sample of 12 nurses was selected according to the inclusion/exclusion criteria described earlier. Compliance with the NAD change protocol was determined through follow-up post education bedside audits (Appendix C) using the same process as described above. (The brief survey was not administered post-education session).

Outcomes: The individual item scores were compared pre and post educational session to determine the percent change of that particular item. Additionally, the participant's overall change in compliance was determined by comparing the pre-education participants compliance percentage to the post-education participants compliance percentage (i.e. 3 out of 12=25% compliant vs. 6 out of 12=50% compliant). Ultimately, the results of the pre education questionnaires and audits provided insight into barriers to compliance for the purpose of reinforcing knowledge of and compliance with the sterile NAD change protocol. The post education bedside audits were compared to the pre education audits to determine the influence of education on protocol knowledge and compliance.

Protection of Human Subjects

For the protection of subjects in this study, IRB approval was obtained. No patient identifiers were used in this study. Nurses remained de-identified on the questionnaires and audit results and had the right to refuse to participate. There was the possibility that a nurse may be audited twice. This study posed no risk to the participants, as the focus was on nursing compliance and the effect of reinforced education. There was a potential that the PI observed non-adherence to the protocol during a spot audit, which could have posed a risk to the patient safety at that point. Wherever a potentially threatening deviation occurred during an audit, that item was scored a zero and the consecutive items were all scored a zero. The PI corrected the nurse at that time to prevent any patient harm. There was no punishment for this deviation from the protocol, as the PI used this to obtain information on barriers to compliance. There is potential for this study to benefit

future PICU patients since nursing compliance with the NAD change protocol has increased.

Quantitative Data Analysis

The PI worked alongside the Children's Hospital epidemiologist and nurse researcher as well as Creighton University's statistician to analyze statistically significant data. The initial goal was to identify baseline knowledge and compliance from the pre-education surveys and audits and identify which items needed reinforcement. Items needing reinforcement were emphasized in the education materials. The ultimate goal was to determine if auditing and re-educating nursing staff based on the gathered evidence, would increase knowledge and compliance with the sterile NAD change protocol. The overall outcome measured was change in compliance from each individual audit item and overall nursing compliance, with the goal to determine the influence of re-enforced education.

Results

Participants were 6 times more likely to be compliant post-education (Odds Ratio: 95% CI [1.02, 35.37]). A statistically significant increase in compliant audit steps occurred post-education (Independent t –test Mean difference=2.70, $t(22)=2.96$, $p = .007$, 95% CI[-4.54, -.80]). Total Compliance Pre-education was 33.3% with the average number of compliant audit steps pre-education being 11.67 (2.81). Total Compliance Post-Education was 75% with the average number of compliant audit steps post-education being 14.33 (1.37). The pre and post audit compliance results by question are

displayed below.

	Compliance by Question	
	Retrospective Frequency (%)	Prospective Frequency (%)
1. Obtains sterile cap change kit and additional supplies (y/n)	10 (83%)	12 (100%)
2. Explains procedure to patient and family (y/n/na)	10 (83%)	11 (92%)
3. Performs hand hygiene and put on clean gloves (y/n)	11 (92%)	12 (100%)
4. Prepare patient to gain access to line & sets up sterile field (y/n)	7 (58%)	11 (92%)
5. Unfold kit to gloves and mask, don mask(s), and place gloves to the side (y/n)	10 (83%)	12 (100%)
6. Unfold kit further exposing sterile field (y/n)	10 (83%)	12 (100%)
7. Open sterile flush & any other additional supplies and drop onto sterile field (y/n)	7 (58%)	10 (83%)
8. Don sterile gloves (y/n)	12 (100%)	12 (100%)
9. Prime NAD (y/n)	7 (58%)	11 (92%)
10. Grasp catheter lumen with sterile 4x4, use CHG swab to scrub the hub for 15 seconds and allow to dry for 15 seconds (y/n)	7 (58%)	11 (92%)
11. Use sterile 2x2 to remove existing NAD (y/n)	7 (58%)	11 (92%)
12. Take primed NAD and saline, bubble in and connect to lumen (y/n)	12 (100%)	12 (100%)
13. Unclamp line and flush lumen (y/n)	11 (92%)	12 (100%)
14. Remove gloves and perform hand hygiene (y/n)	12 (100%)	12 (100%)
15. Document in EMR once procedure is completed by selecting "changed needleless infusion device" & updated the "date changed" field (y/n)	7 (58%)	11 (92%)

The odds ratio (OR) gives an idea that compliance (as an all-or-nothing event) is higher in the post education sample. The independent t-test treats the idea of compliance as a continuous construct and gives an idea of the degree to which compliance is higher. In this project, $t(22) = 2.96, p = .007, 95\% \text{ CI } [-4.54, -.80]$. In practical terms, the t-test shows that a statistically significant increase in compliant audit steps occurred post-education.

The average years as a PICU nurse both pre and post education was three and a half years. The years as a nurse had no statistical impact on compliance. Gender information was also collected and showed 20% male nurses were audited pre-education and 8% male nurses were audited post-education. Possibly due to a small sample size, gender revealed to have no significant impact on compliance.

Discussion

With results of the literature review and this project, it appears that reinforced education has a positive impact on nursing compliance as it relates to protocol knowledge and adherence. Pre-education data from this project suggests that follow-up/re-education is needed when a new protocol is implemented. Anecdotal data from the pre-education survey implied that nurses value reinforcement and a hands-on approach when a protocol including a technical skill is implemented. This project reinforces and adds to the information obtained from the literature review in regards to increasing nursing compliance with central line maintenance protocols has the potential to decrease CLABSI rates among PICU patients.

Study Limitations

It was almost impossible to control for outliers related to patient conditions. There are many factors that relate to and contribute to a CLABSI including patient factors, device factors, and provider factors. Patient factors relate to acute illness status and continuous access and use of the central line for life saving interventions. Device factors include number of lumens and insertion site. Provider factors include insertion technique and adherence to central line access practices. Nursing factors include the “Hawthorne Effect” which is a phenomenon referred to a type of reactivity where people modify their

behavior in response to being observed. Although audits were performed at bedside, there was no way to guarantee that every nurse was compliant or followed the protocol when they were not being directly observed. The nurses could be non-compliant while not being observed yet compliant while being observed. Additionally, the data collected was only a small sample of patients with central lines in the PICU and many exclusion factors block out a large sample of patients. Small sample size of PICU nurses limited ability to generalize the impact of reinforced education on compliance with newly implemented protocols to all nurses. Short time interval from intervention to post-education audits limited ability to determine lasting impact of re-enforced education on nursing adherence to protocols.

Future Studies

This study has potential to continue in the future however it will reveal more telling results with a few adjustments. A larger sample size will promote generalizability. This PI plans to continue post-education audits at additional time intervals, 6 months & 1 year, to potentially understand appropriate time interval for re-enforced education based off of compliance. Finally, a longitudinal study tracking NAD change protocol compliance and PICU CLABSI rates for 2017 and in the future, would determine the impact of re-enforced education on CVC maintenance care and CLABSI rates.

Acknowledgments

This PI could not have completed this project without the assistance from my project chair, Susan Connelly, DNP, APRN-NP. Susan assisted in the editing and constructive feedback with the project design as it was developing. My committee member, Lisa Steurer, PhD, RN, CPNP-PC is the manager of research and assisted in the literature

review as well as determining important information to include to create a strong background. I would also like to thank the PICU BSI team for assisting me in gathering PICU CLABSI information and providing feedback for my education tool. Alex Hall, MA, is Creighton University's statistician and assisted in the statistical analysis of data and results.

APPENDIX A***Sterile NAD Change Questionnaire (Pre-education)***

1. Do you know when your NAD is due to be changed and where to find that in KIDDOS? (have nurse demonstrate how to find NAD date in EMR): **YES/NO**
2. Do you know where to obtain all the supplies needed for a sterile NAD change (have nurse walk you to correct spot in supply Pyxis)?: **YES/NO**
 - Do you know what is included in the sterile NAD change kit?: **YES/NO**
3. Can you describe the process used when performing a sterile NAD change?:
 - Nurse lists 10/15 major steps from the Sterile NAD Change Standard of Work Document: **YES/NO**
4. Are there any barriers to this sterile NAD change Standard of Work process for you as a bedside nurse?




APPENDIX B

Standard of Work Document: Sterile NAD Change Process

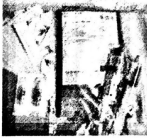









Name of Job: CVC Sterile Needleless Access Device (NAD) Change

Initials & Date
CLABSI Team
2/21/17

Symbols for Key Points:

Safety  Tip  Critical Step 

Role Performing the Job: RN

Major Steps (What)	Key Points (How)	Reasons (Why & References)	
1. Obtain Sterile Cap Change Kit and additional supplies.	Sterile Cap Change kit for each NAD change, additional masks as needed; sterile gloves if size 7 will not fit, heparin or saline flushes.	If performing cap changes on multi-lumens, may use one kit and drop an additional NAD & NS flush on sterile field.	 
2. Explain procedure to patient and family.			
3. Perform hand hygiene.	Moment of Hand Hygiene		
4. Don sterile gloves.			
5. Prime needleless access device (NAD).			
6. Open sterile CHD swabs.		 Tear across the top of the CHD package. Gently squeeze package while pulling out wipe to remove excess fluid. Careful not to tear.	
7. Wipe catheter lumen with sterile 4x4. Use CHD swab to scrub hub for 15 seconds and allow to dry for 15 seconds.	<ul style="list-style-type: none"> Check for visible debris among threads of lumen hub. Use clean CHD swab to remove debris allowing plenty of dry time, 15 second minimum. 		
8. Use sterile 2x2 to remove existing NAD.			
9. Take primed NAD and saline, bubble in and connect to lumen.	<ul style="list-style-type: none"> Fill hub of lumen with saline, to prevent air from getting into the line. 		
10. Unclamp line and flush lumen.			
11. Remove gloves and perform hand hygiene.	 Moment of Hand Hygiene		
12. For each NAD change, repeat steps above.		 To ensure the integrity of the entire process, treat each lumen and NAD change as a separate process.	
13. Document as appropriate.	Once the procedure is completed, document the cap change in KIDDOS under line assessment by selecting Changed needleless infusion device & update the Date Changed field.	 Document Intake if applicable.	

APPENDIX C***Sterile NAD Change Bedside Nursing Audit*****Years experience as a PICU nurse: _____ Gender: M/F**

1. Obtains sterile cap change kit and additional supplies (y/n)
2. Explains procedure to patient and family (y/n/na)
3. Performs hand hygiene and put on clean gloves (y/n)
4. Prepare patient to gain access to line & sets up sterile field (y/n)
5. Unfold kit to gloves and mask, don mask(s), and place gloves to the side (y/n)
6. Unfold kit further exposing sterile field (y/n)
7. Open sterile flush & any other additional supplies and drop onto sterile field (y/n)
8. Don sterile gloves (y/n)
9. Prime NAD & open sterile CHG swabs (y/n)
10. Grasp catheter lumen with sterile 4x4, use CHG swab to scrub the hub for 15 seconds and allow to dry for 15 seconds (y/n)
11. Use sterile 2x2 to remove existing NAD (y/n)
12. Take primed NAD and saline, bubble in and connect to lumen (y/n)
13. Unclamp line and flush lumen (y/n)
14. Remove gloves and perform hand hygiene (y/n)
15. Document in EMR once procedure is completed by selecting “changed needleless infusion device” & updated the “date changed” field (y/n)

APPENDIX D

PICU Letter of Approval

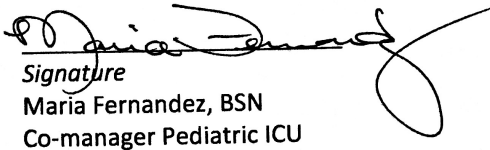


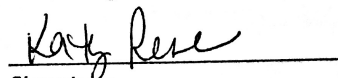
9/15/2017

To Whom It May Concern:

The St. Louis Children's Hospital Pediatric Intensive Care Unit fully endorse the project entitled "Investigation of Nursing Compliance with Sterile Needless Access Device Changes: Effects on Central Line Catheter-Associated Blood Stream Infections in the Pediatric Intensive Care Unit; A Quality Improvement Project." It is the desire of the department that this project will enhance nursing compliance on central line protocols. This project aligns with the hospital goals to decrease the number of central line associated blood stream infections and improve overall patient outcomes.

Respectfully Submitted,


Signature
Maria Fernandez, BSN
Co-manager Pediatric ICU


Signature
Katy Reese, MSN, RN, NP-C
Co-Manager Pediatric ICU
Manager Pediatric Critical Care Nurse Practitioner Program

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