The Art and Science of Infusion Nursing

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Use of a Policy-Driven Education Program to Reduce Central Line-Associated Bloodstream Infection Rates

ABSTRACT

Central line-associated bloodstream infections (CLABSIs) account for a significant portion of hospital-acquired infections. Current research supports the use of chlorhexidine for site cleansing and staff education programs on infection-control practices to reduce CLABSI rates. This project evaluates the efficacy of implementing site cleaning policies and protocols and formal staff education in reducing CLABSI rates in a critical access hospital. Efficacy was measured by infection rates per 1000 catheter days through a retrospective chart review before and after implementation of a policy and protocol bundle and staff education.

Key words: central line, chlorhexidine, CLABSI, infection, policy

Hospital-acquired infections (HAIs) occur in approximately 5% of all hospitalized ed complication rates for patients who may be hospitalized for even potentially minor patients in the United States each year.[1] HAIs lead to longer hospital stays for patients and increased illnesses. Patients with chronic illness who acquire HAIs have longer hospital stays and typically require extended invasive treatment. Complications from the extended hospital stay cost patients, taxpayers, and the health care system millions of dollars annually.[2] In the past 10 years, 1 type of HAI—central line-associated bloodstream infection (CLABSI)—has accounted for a significant portion of these, with a documented mortality rate between 15% and 25%.[1] In 2009, the national average CLABSI rate was 1.14 infections per 1000 catheter days.[3] For this study, central lines were defined as any type of intravenous catheter with terminal placement in one of the great vessels near the heart that are used for therapeutic or diagnostic reasons.[4]

Although multiple interventions have been implemented to reduce CLABSI rates during the past 10 years, research has not established the most effective type of intervention.[3] Of the research reported, there is evidence that using standardized policies and protocols for care of catheters reduces infection rates.[1,5-7] The Centers for Disease Control and Prevention (CDC) has created guidelines for the prevention of CLABSI, and the Agency for Healthcare Research and Quality (AHRQ), among others, has implemented national research projects to compare the effectiveness of various interventions.[3,8] Research indicates that cleansing of the catheter insertion site is paramount for preventing the occurrence of CLABSI.[3,5-7,9] Among the many available site-cleansing formulations, chlorhexidine solution has been shown to be superior for the prevention of CLABSI.[10-14]

The purpose of this project was to validate a program that has been effective in reducing the incidence of CLABSI in a clinical hospital setting using chlorhexidine solution. The following clinical question was examined: In adult patients with central catheters, does the development and implementation of an evidence-based infection control protocol reduce CLABSI, when compared with current facility practice? CLABSI rates pre- and post implementation of the policy and educational program were compared.

REVIEW OF LITERATURE

CLABSI Prevention

Studies overall have been inconclusive regarding the efficacy of chlorhexidine versus povidone-iodine (PI) in

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reducing CLABSI. Some evidence suggests that there is no difference in efficacy when comparing chlorhexidine and PI.[15-17] There is, however, greater evidence suggesting that chlorhexidine is superior in reducing CLABSI when compared with other solutions.[5,10,13,14] In addition, PI solutions have an increased risk of allergic sensitivity in most patient populations.

Throughout the literature, varying concentrations of chlorhexidine have been used with reported effectiveness in CLABSI reduction. Valles et al[14] used chlorhexidine in concentrations of 0.5% and 2% in their research, finding that both were superior to PI solution. Mimoz et al[12] compared concentrations of chlorhexidine as small as 0.25% versus PI with superior results using higher concentrations of chlorhexidine. Comparisons of varying concentrations of chlorhexidine have found that chlorhexidine concentrations greater than 0.5% provide better results when compared with lower concentrations of the same solution.[10,13] A meta-analysis by Chaiyakunapruk et al[10] reviewed 8 studies that used various concentrations of chlorhexidine and found that site preparation with any concentration of chlorhexidine provided a 49% decrease in risk for catheter-related bloodstream infection with confidence intervals between 0.27 and 0.95. The combined evidence suggests that concentrations of greater than 0.5% of chlorhexidine should be used for CLABSI reduction.

CLABSI Reduction Intervention

The implementation of a stepwise, systems-based intervention that includes education, evidence-based policies, and protocols has been shown to positively affect desired outcomes. Multiple studies provide evidence of decreased CLABSI rates following the implementation of stepwise intervention and CLABSI reduction bundles.[6,7,11] In addition, there is evidence that an educational program for staff that includes feedback focused on corrective efforts reduces CLABSI infection rates.[18,19] The AHRQ and CDC have established guidelines supporting the use of educational programs for nurses and other providers related to the insertion and care of central catheters and peripherally inserted central catheters (PICCs) as an avenue for reducing CLABSI nationwide.[3,8]

METHODS

The CLABSI reduction intervention was implemented in a 25-bed critical access hospital with a surgical center, a physician specialty clinic with 20 outreach physicians, an infusion/chemotherapy clinic, and a busy emergency department. The facility's medical staff includes 5 family practice physicians, 2 general surgeons, 1 radiologist, 1 pathologist, 2 physician assistants, 2 nurse practitioners, and 2 nurse anesthetists.

A PICC care policy, addressing appropriate site-cleansing techniques at the time of insertion and regularly scheduled dressing changes, was implemented in 2004, but a specified cleansing agent was not standardized, and there was minimal consistency with regard to site-cleansing frequency and solution, frequency of dressing changes, and staff awareness of the current policy in place for the insertion and care of central venous catheters (CVCs) and PICCs. A formal study of CLABSI rates at the facility had not been conducted.

Because the health care facility does not have a formal internal review board, the project was approved by nursing and hospital administration, the risk management department, the quality council, and medical staff members. For baseline data acquisition, a chart audit of patients admitted to 1 of 3 departments—surgery, inpatient medical-surgical, and the infusion clinic—was conducted. All patients with a CVC or PICC placed during inpatient or outpatient treatment within selected time periods were included in data collection. The CLABSI reduction bundle using chlorhexidine as the lone cleansing solution, designed and made available by John Hopkins University Hospital, was reviewed, edited for facility adjustments, and approved by facility administrators. Nursing care staff and practitioners involved in the care of the patients with CVCs or PICCs participated in an educational program that included a review of CVCs and PICCs, CLABSI identification and reduction, and the Johns Hopkins CLABSI reduction bundle to be implemented. Participants in the educational program completed a pre- and posteducation evaluation to assess knowledge gain. The CLABSI reduction intervention was then implemented, and data collection began.

Research Subjects

Staff

Staff education was provided to the nursing departments where the CLABSI reduction intervention was to be implemented, as well as to practitioners—advanced [AQ7] practice registered nurses (APRNs), certified registered nurse anesthetists (CRNAs), and physicians—who inserted CVCs and PICCs. Participants included staff from the outpatient infusion clinic, emergency department, inpatient medical/surgical unit, and surgery department. Emergency department staff were included in the education program because the infusion clinic is staffed from the department.

Patient selection

A retrospective review of patients who had at least 1 CVC or PICC inserted during a 1-year period, between January 2012 and December 2012, was performed. The evidence-based policy and protocol, along with the educational program for all health care providers involved in the

insertion and care of CVCs and PICCs, was implemented. Postintervention data for comparison were collected over a 6-month period from April 2013 to September 2013.

For the study, CLABSI was defined as fever and leukocytosis with a leukocyte count greater than 13 500 U/L without apparent cause or infectious diagnosis (ie, pneumonia, meningitis, cellulitis), along with at least 1 of the following: discharge from the insertion site, pain at the insertion site, or erythema at the insertion site.

Bard PowerPICCs and Bard CVCs (Bard Access Systems, Salt Lake City, UT) had been used exclusively in the study facility for the previous 3 years and were the only catheters available in both the control retrospective group and the experimental group. In the retrospective group, varied manufacture dates and practitioner preferences guided the cleansing solution used at the time of insertion and dressing changes. Physicians, nurse anesthetists, or nurse practitioners with at least 1 year of experience in placing CVCs and PICCs inserted all catheters in both study groups.

Catheter locations for insertion included subclavian, internal jugular, and antecubital veins. Patients older than 75 years and patients with catheters to be used for chemotherapy or dialysis were excluded from the study, as were patients who had catheters placed in the emergency department.

IMPLEMENTATION

Staff Education

All registered nursing staff in the study departments who were involved in the care of patients with CVCs or PICCs were required to attend 1 of 6 identical educational sessions. Practitioners inserting CVCs and PICCs were offered the same education with focus directed toward policy adherence and CLABSI reduction. Education was offered by the primary researcher, using a PowerPoint presentation followed by a question-and-answer session. The presentation included an overview of CVCs and PICCs, insertion guidelines, identification of CLABSI, methods for CLABSI reduction, and monitoring for CLABSI, as well as a review of the new policy and protocol that would be implemented.

DATA COLLECTION

Staff Education Data Collection

An identical 5-question, multiple-choice pre- and posttest evaluation was administered by the facility's education coordinator to all study participants at the beginning and end of each educational session. Topics covered on the evaluation included frequency of dressing changes, appropriate cleansing solution, identification of CLABSI, frequency of CLABSI monitoring, and general CVC and PICC knowledge. The evaluations were numbered and not allowed to leave the presentation room to ensure security and validity of the results.

CLABSI Reduction Program: Postimplementation Chart Review

Charts were selected by querying current procedural terminology codes for CVC and PICC insertions by the facility's health information management staff. Charts were reviewed by the primary researcher for specific data. Data collection for the preintervention group included location of insertion within the facility, anatomical location, type of use (inpatient versus outpatient), number of catheter days, evidence of CLABSI, type or types of cleansing solution used at the time of insertion and subsequent dressing changes, patient disposition, and demographic data.

Once the policy was implemented, all CVCs and PICCs were monitored for CLABSI using the standardized monitoring form included in the policy and protocol. Data were recorded on the standard form included in the CLABSI reduction bundle. In addition, pre- and intraprocedure checklists were completed by nursing staff to ensure asepsis, adherence to guidelines, and appropriate cleansing solution use by the practitioner inserting the catheter. All CVC and PICC insertion trays include only chlorhexidine as the disinfectant. Sterile techniques were used during all insertions, with sterility monitored by the assisting nurse. Study participants with signs or symptoms of CLABSI had their CVC or PICC removed immediately by appropriate staff.

Postimplementation data were collected at the time of the patient's discharge from the facility, catheter removal, or transfer to another facility with the catheter intact. Data collected in the postimplementation group included location of insertion within the facility, anatomical location, type of use (inpatient versus outpatient), number of catheter days, evidence of CLABSI, type or types of cleaning solution used at the time of insertion including subsequent dressing changes, patient disposition, and patient demographics.

RESULTS

Demographics

Hospital staff population

The educational intervention was provided to 73 employees at the study facility. Participants included 65 registered nurses (RNs) and 8 practitioners (2 APRNs, 1 nurse anesthetist, and 5 physicians). Physician assistants were not educated because they are not credentialed to insert central catheters at the study facility and

do not provide patient care outside of the family practice and urgent care clinic. RNs included staff from the surgery department (11), inpatient medical-surgical unit (39), and infusion clinic/emergency department (15).

Patient population

Chart review included 116 subjects in the preintervention group and 65 subjects in the postintervention group who received CVC or PICC placement. A total of 20 subjects older than 75 were disqualified secondary to increased risk of infection and comorbidities, 14 in the preintervention group and 6 in the postintervention group. Preintervention data were collected on 102 subjects who received CVC (13) or PICC (89) placement, and 59 patients in the postintervention group (6 CVC and 53 PICC placements, respectively).

Demographic variables examined included age, gender, and ethnicity (Table 1). The preintervention group was larger (n = 102) than the postintervention group (n = 59). Demographic composition was similar for both groups for each variable, both being composed primarily of Caucasian males with a mean age of 62.5 years.

Data Analysis

Knowledge gain from the educational sessions was evaluated by comparing pre- and postevaluation scores for each test item, as well as overall evaluation scores. Data were analyzed using Microsoft Excel 2013. Each test question was evaluated using a *t* test of independent samples, with a significance level set at $<.05$. The null hypothesis for this outcome was *an educational intervention covering CLABSI reduction would not increase student postevaluation scores*. Efficacy of the protocol and policy implementation was evaluated by analyzing pre- and postimplementation data. These data were also analyzed using Microsoft Excel 2013, as well as SPSS statistical analysis software.

Research question: Does increasing staff knowledge of a new evidence-based policy and protocol for the insertion and care of CVCs and PICCs help reduce CLABSI rates as evidenced by improved scores on a posttest evaluation?

All participants (N = 73) completed the pre- and postevaluations. A *t* test of independent samples demonstrated a cumulative pretest evaluation mean score of 60% of questions answered correctly, compared with posttest evaluations that demonstrated 99% percent of questions accurately answered. Posttest scores for each individual item improved significantly ($P < .001$) (Table 2). Improvement on individual items ranged from 22% to 56%. Test question analysis demonstrated 100% knowledge gain for multiple evaluative questions. The greatest knowledge gain was demonstrated for the item addressing site inspection for signs of CLABSI.

Research question: Do CLABSI rates decrease after implementation of a staff education program and an evidence-based policy and protocol on site cleansing and care with chlorhexidine as evidenced by lower infections per 1000 catheter days?

For both the preintervention and the postintervention group, data suggest that PICCs were used more frequently than CVCs (Table 3). In the control and intervention group, CVCs and PICCs were used in inpatient and outpatient environments, with most insertions occurring in the medical/surgical unit and the infusion clinic. Catheters were inserted primarily by APRNs (46 vs 40) and CRNAs (42 vs 12), with more insertions by CRNAs in the preintervention group and more by APRNs in the postintervention group. Physicians inserted fewer than 15% of catheters in both groups. In the postintervention group, CVCs and PICCs were placed for administration of long-term antibiotics (40), difficult peripheral intravenous placement (12), administration of total parenteral nutrition (4), or monitoring of central venous pressures (4). Data were missing for much of the preintervention group regarding indication for insertion.

In the preintervention group, there were 1580 catheter days, with length of use ranging from 3 to 32 days (m = 15.49 days). In this group, 3 site-cleansing agents/regimens were used at the time of insertion: PI (72), chlorhexidine (14), or a combination of both (16). CLABSI was identified in 9 patients. Because data regarding cleansing solutions used during dressing change were missing for most patients in the preintervention group, they were not included in the analysis.

In the postintervention group, there were 917 catheter days, with length of use from 7 to 32 days (m = 15.81 days), comparable with the mean length of use in the preintervention group. In this group, 2 site-cleansing agents/regimens were used at the time of insertion: PI (1) and chlorhexidine (58). CLABSI was identified in 1 patient. All patients received chlorhexidine solution as the site-cleansing agent every 3 days or when the site became soiled. The isolated potential CLABSI was a patient hospitalized for

TABLE 1
Demographic Variables by Group

Demographic Variables	Preintervention Group (n = 102)	Postintervention Group (n = 59)
Age (mean)	65	60
Male	69 (68%)	37 (63%)
Female	33 (32%)	22 (37%)
Caucasian	68 (66%)	41 (69%)
Native American	27 (26%)	15 (25%)
African American	7 (7%)	3 (5%)

TABLE 2

Educational Intervention Evaluation Scores (n = 73)

Evaluation Item	Pretest Correct Response (%)	Posttest Correct Response (%)	Improvement (%)
Overall cumulative score	60%	99%	33%
Frequency of dressing changes	50 (68%)	71 (97%)	29%
Site cleansing solution	57 (78%)	73 (100%)	22%
CLABSI identification	43 (59%)	73 (100%)	41%
Terminal tip location	37 (53%)	71 (97%)	44%
Site inspection for CLABSI	32 (44%)	73 (100%)	56%

Abbreviation: CLABSI, central line-associated bloodstream infection.

administration of intravenous antibiotics with a diagnosis of osteomyelitis complicated by uncontrolled insulin-dependent diabetes. The potential CLABSI was not associated with the patient whose site was cleansed with PI solution. One noted variable was the increased insertion rate by APRNs as compared with CRNAs in the postintervention group, which may be attributable to the training of a second APRN in PICC insertion.

A *t* test was conducted to compare signs of CLABSI in subjects before and after implementation of the CLABSI reduction protocol. There was a significant difference in the CLABSI rates for subjects after implementation of the CLABSI reduction bundle (M = 0.016, SD = 0.13) and before implementation (M = 0.088, SD = 0.78) with a significance level of .05. These results suggest that there was a significant decrease between the preintervention and postintervention groups (8.8% vs 1.7%, $P = .03$). The preintervention group data demonstrate a CLABSI rate of 5.72 per 1000 catheter days, while the postintervention group data demonstrate a CLABSI rate of 1.09 per 1000 catheter days.

DISCUSSION/IMPLICATIONS FOR PRACTICE

Results demonstrated that implementation of an educational program covering topics associated with CLABSI and CLABSI reduction resulted in a statistically significant increase in participant knowledge. No data to

TABLE 3

[AQ8]

CLABSI Analysis	Preintervention Group (n = 102)	% of Total	Postintervention Group (n = 59)	% of Total
Catheter type				
PICC	89	87.3	53	89.8
CVC	13	12.7	6	10.1
Insertion department				
Outpatient	54	52.9	30	50.8
Medical-Surgical	40	39.2	26	44.1
Surgery	8	7.9	3	5.1
Inserting practitioner				
Physician	14	13.7	7	11.9
APRN	46	45.1	40	67.7
CRNA	42	41.2	12	20.4
CLABSI data				
Central catheter days	1580		917	
CLABSI days	9		1	
CLABSI rate (per 1000 days)	5.72		1.09	

Abbreviations: CLABSI, central line-associated bloodstream infection; PICC, peripherally inserted central catheter; CVC, central venous catheter; APRN, advanced practice registered nurse; CRNA, certified registered nurse anesthetist.

support retention of covered material across time were collected. Readministration of the 5-item pre- and posttest among original participants after 6 months may be beneficial to evaluate retention and determine a need for regular staff updates.

Data from the pre- and postintervention groups found a statistically significant decrease in CLABSI rates in patients who received chlorhexidine solution for site cleansing at the time of CVC and PICC insertion. Consideration of other variables, including the increased number of catheter insertions by APRNs, may provide additional insights into the decrease in CLABSI rates in the postintervention group. Interestingly, the single patient in the postintervention group who had potential signs of CLABSI was not the patient who received site cleansing with PI solution versus chlorhexidine.

Data suggest that site cleansing with chlorhexidine decreases rates of CLABSI, which leads to the recommendation that creation of an annual competency program, along with annual education on this topic, may be beneficial for the institution. More frequent competency assurance has been suggested; however, the facility currently has annual competency assurance in place. Licensed practical nurses and nurse aides may benefit from attending training to improve their understanding of CLABSI and allow for earlier CLABSI detection. Data collection for an additional 6 months to allow for comparison of pre- and poststudy results across equivalent time periods has been suggested to the facility.

Continuation of the policy and protocol implemented in this study, as well as continued data collection by the quality assurance coordinator, have been recommended to medical staff and nursing administration. In addition, it may be beneficial to track admitting diagnoses and comorbidities to provide additional insights into other factors that may affect CLABSI rates.

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