Feature Article

A Clinical Nurse Specialist–Led Quality Improvement Initiative to Identify Barriers to Adherence to a Bundle for Central Line Maintenance

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Purpose:
This clinical nurse specialist–led quality improvement project identified barriers to adherence to a bundle for central line maintenance and examined the relationship between increased bundle adherence and central line–associated bloodstream infections.

Project Description:
Oncology and critical care nurses were surveyed to identify barriers to adherence to a bundle for central line maintenance. Targeted initiatives based on survey responses were implemented focusing on antimicrobial bathing, increasing confidence in an evidence-based bundle, and its ability to reduce infections. Adherence and central line–associated bloodstream infection rates were monitored at baseline and at 3, 9, and 15 months post intervention.

Outcomes:
Adherence to bundle elements improved post intervention in 4 areas in critical care units: correctly labeling catheter dressings, maintaining an occlusive dressing, clamping unused catheter lumens, and daily antimicrobial bathing. In oncology units, adherence improved in clamping unused lumens and daily antimicrobial bathing. At 9 months post intervention, infection rates decreased from 6.08 to 1.48 in critical care units and 3.13 to 0.30 in oncology units.

Conclusions:
Identifying unit-specific barriers to adherence to bundles for central line maintenance and implementing targeted initiatives to reduce barriers increase adherence and prevent central line infections.

KEY WORDS:
central line–associated bloodstream infection, evidence-based practice, quality improvement

The Institute for Healthcare Improvement has endorsed the use of the bundle, a small straightforward set of guidelines that support evidence-based practices (EBPs). Bundles are a structured way of improving the processes of care and patient outcomes.[1] Procedure-specific evidence-based central line maintenance bundles are widely disseminated in hospitals across the United States; adherence to the bundles is directly linked to reduced central line–associated bloodstream infection (CLABSI) rates.[2,3]

Despite a positive view of EBP by nurses and recognition of the consequences of CLABSIs, incorporation of bundles into clinical practice is slow and met with resistance.[4,5] The overall rate of adherence to evidence-based protocols is as low as 39.5%.[6] It has been suggested that fewer years of nursing experience,[7] inability to access[8] and understand research,[8,9] and lack of managerial and physician support are barriers to nurses' adherence to these bundles.[9,10]

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PURPOSE

The purpose of this clinical nurse specialist (CNS)-led quality improvement project was to identify barriers to nurses' adherence to an already established central line maintenance bundle and determine whether a relationship exists between increased adherence to the bundle and reduced CLABSI rates. This was accomplished by (1) identifying barriers that influence utilization of a central line maintenance bundle in our institution and (2) developing, implementing, and evaluating targeted initiatives aimed at improving use of the bundle.

CURRENT PRACTICE

Clinical nurse specialists are uniquely positioned to implement change within 3 spheres of impact—organizational, nursing staff, and patient/family.[11] In 2017, CNSs at our institution developed and implemented a multifaceted, evidence-based central line maintenance bundle used by nursing and support staff to reduce the institutions' increasing CLABSI rates.[12] Key components of the bundle included the following: (1) date of dressing change was visible, (2) dressing was occlusive, (3) antimicrobial disk was placed at the insertion site, (4) catheter lumens were clamped, (5) central venous catheter (CVC) insertion site was assessed for signs of infection within 24 hours of the audit, and (6) daily antimicrobial bath was documented in the patient's electronic health record (Table 1). All nurses providing direct patient care at the institution participated in a 2-hour interactive presentation developed by our advanced practice nurse about the bundle elements. Each nurse was observed by a CNS or trained registered nurse unit champion completing a CVC dressing change to validate use of bundle elements.

The CLABSI rate decreased on the targeted units after bundle implementation but was still greater than the national average of 0.56 infections per 1000 catheter days.[13] Our project team discovered that nurses' overall adherence to the bundle was still only 48%. Adherence to specific bundle elements, namely, daily antimicrobial bathing and clamping catheter lumens when not in use, was as low as 33% and 40%, respectively. On the basis of these data found during monthly CVC audits, we identified elements requiring increased education to improve bundle adherence.

METHODS

Our team completed a preinitiative-postinitiative quality improvement (QI) project with a convenience sample of intensive care unit (ICU) and oncology nurses and patients. In phase 1, the CNS project leader distributed an online survey to eligible nurses to identify perceived barriers that contribute to nonadherence to the organization's central line maintenance bundle. For phase 2, the leader and 2 advanced practice nurses developed and implemented targeted initiatives, based on survey responses, to increase bundle adherence. Adherence was defined as 100% completion of all steps necessary to be fully compliant with each bundle element.

ETHICAL CONSIDERATIONS

Approval for this project was obtained from the healthcare institution's QI review committee and was deemed a QI project. Nurses' responses were anonymous and were not personally identifiable. Informed consent was implied by participants' completion of the survey, and only aggregate data were shared with individuals outside the project team. Patient information was collected in accordance with the institution's current procedure and did not require informed consent. All data were stored securely on the project leader's secure password-protected network account and backed up on 2 team members' secure password-protected accounts.

SETTING AND SAMPLE

The project team completed the project in 2 ICUs, 2 oncology units, and a combined oncology/bone marrow transplant unit at a 520-bed tertiary care facility and academic medical center in the Middle Atlantic United States. The critical care units included the cardiothoracic ICU and the medical ICU and comprised 40 beds. There were 114 beds on the oncology units.

Eligible nurses were those who completed the 2-hour training on the bundle and worked on a casual to full-time basis on one of the targeted units (n = 277). We excluded nurses who did not work as a nurse on the targeted units and those working on the units but not providing direct patient care. Patients 18 years or older who had at least 1 CVC placed before or during their admission to the

Table 1. Bundle for Central Line Maintenance: Key Elements and Dressing Change Products

Key elements	• Labeling catheter dressings with the date the dressing was changed • Maintaining an occlusive catheter dressing • Antimicrobial disk placed at the insertion site • Inspecting catheter insertion site daily for infection and dressing integrity • Clamping catheter lumens when not in use • Bathing patients daily with 4% CHG solution

Abbreviation: CHG, chlorhexidine gluconate.

All elements and products were included in the central line maintenance bundle by advanced practice nurses at the project site.

selected units were eligible for inclusion in the patient sample. Central venous catheters were defined as internal and external jugular, subclavian, femoral, and peripherally inserted CVCs, and implanted chest ports. Patients with midline or peripheral catheters were excluded from the sample.

PHASE I: SURVEY TO IDENTIFY BARRIERS TO NURSES' ADHERENCE

Survey Development

The CNS project leader developed a survey based on the Comprehensive Framework for Implementation Research to identify site-specific barriers to implementation of a central line maintenance bundle.[14] The framework includes 5 comprehensive domains that are (1) the characteristics of the intervention to be implemented, (2) nurses' characteristics, (3) the implementation process, (4) inner (organizational) setting, and (5) outer (environmental) setting. By grouping respondents' answers regarding barriers into one of the domains, investigators can identify which domain is likely to have the greatest influence on adherence to the change implemented by the organization. This information can also be used to develop targeted interventions to increase adherence to EBP guidelines and improve patient outcomes.[14,15] This framework was used to develop 4 of the 5 sections that make up the second part of the survey. The outer setting domain was considered irrelevant to this project; hence, an additional information section was included in the survey in lieu of questions falling into this domain.

The survey was divided into 2 parts. Part 1 identified nurses' demographic information, including age, education, and experience as a nurse in general and within our organization. Part 2 of the survey was composed of 19 questions divided into 5 sections: (1) the central line dressing change kit (intervention), (2) education and resources

Table 2. Facilitators and Barriers to Implementing the Central Line Maintenance Bundle: 4-Point Scale Questions

Survey Question Topic	Unit	1	2	3	4
Intervention domain					
Dressing kit usability	ICU, n = 49	5 (10.20)	14 (28.57)	17 (34.69)	10 (20.41)
	Oncology, n = 61	0 (0)	15 (24.59)	36 (59.02)	3 (4.92)
Quality of supplies	ICU, n = 49	3 (6.12)	9 (18.37)	24 (48.98)	10 (20.41)
	Oncology, n = 61	3 (4.92)	12 (19.67)	23 (37.70)	16 (26.23)
Ease in using kit	ICU, n = 49	1 (2.04)	12 (24.49)	25 (51.02)	8 (16.33)
	Oncology, n = 61	0 (0)	4 (6.56)	37 (60.66)	13 (21.31)
Availability of supplies not included in kit	ICU, n = 49	0 (0)	9 (18.37)	23 (46.94)	14 (28.57)
	Oncology, n = 61	1 (1.64)	6 (9.84)	32 (52.46)	15 (24.59)
Implementation domain					
Explanation of bundle in education class	ICU, n = 49	0 (0)	9 (18.37)	20 (40.82)	16 (32.65)
	Oncology, n = 61	1 (1.64)	8 (13.11)	35 (57.38)	9 (14.75)
Inner setting domain					
Supported to spend additional time on dressing change	ICU, n = 49	2 (4.08)	15 (30.61)	19 (38.78)	9 (18.37)
	Oncology, n = 61	2 (3.28)	11 (18.03)	20 (32.79)	19 (31.15)
Supported to be second trained observer	ICU, n = 49	4 (8.16)	21 (42.86)	11 (22.45)	9 (18.37)
	Oncology, n = 61	3 (4.92)	12 (19.67)	20 (32.79)	17 (27.87)
Bundle will reduce central line infections	ICU, n = 49	5 (10.20)	12 (24.49)	19 (38.78)	9 (18.37)
	Oncology, n = 61	1 (1.64)	12 (19.67)	21 (34.43)	18 (29.51)
Nurses' education domain					
Willing to embrace change	ICU, n = 49	1 (2.04)	8 (16.33)	24 (48.98)	9 (18.37)
	Oncology, n = 61	0 (0)	8 (13.11)	23 (37.70)	21 (34.43)
Confident in the bundle	ICU, n = 49	3 (6.12)	12 (24.49)	18 (36.73)	9 (18.37)
	Oncology, n = 61	3 (4.92)	12 (19.67)	27 (44.26)	10 (16.39)

Abbreviation: ICU, intensive care unit.

This table describes the facilitators and barriers to implementing the central line maintenance bundle and lists nurses' responses to each item.

(implementation process), (3) personal assessment of barriers to implementation (inner setting), (4) comfort level adapting to change (nurses' characteristics), and (5) additional information. The first 4 sections asked respondents to use a scale from 1 to 3 or 4 to rate the impact that listed factors had on their ability to implement the central line maintenance bundle (Tables 2 and 3). The last section asked them to use a scale from 1 to 5 to report the percentage of time they adhered to key elements of the bundle. The instrument was reviewed by an expert panel of 2 doctorally prepared nursing faculty and the team from the project site to establish face validity. This iterative process of review and revision occurred until consensus was achieved, and the panel had no further recommendations. The thirteen 3- to 4-point scale questions had a Cronbach's α of 0.82. The question asking whether nurses could locate the user manual on the Infonet was specific to the institution and was omitted from the analysis.

Nurse Recruitment and Survey Completion

Participants were recruited and able to complete the survey during a 6-week period. An email explaining the project and containing the survey link was delivered to the targeted nurse population through the Qualtrics Survey System (Qualtrics, Provo, Utah) using the institution's nurse email alias. On weeks 1 and 2, the CNS project leader rounded on all units on both weekdays and weekends to present the project to nurses and request their participation. Unit managers also invited the project leader to recruit nurses during monthly staff meetings. On week 5, the project leader sent an email reminding eligible participants to complete the survey; the recruitment period ended on week 6. Participants were given the option to submit their contact information on a separate page of the Qualtrics Survey System (Qualtrics, Provo, Utah) to be entered into a raffle. Nurses' contact information was not linked to their survey responses to ensure anonymity. Three nurses received a $25.00 Visa gift card.

Identification of Barriers to Adherence

Frequencies and percentages were obtained using IBM SPSS Statistics for Windows, version 25.0 (IBM Corp, Armonk, New York) to identify the barriers to nurses' adherence to the central line maintenance bundle. During monthly audits, nurses also provided verbal feedback to the project leader and other CNSs on the team about perceived barriers to adherence to the central line maintenance bundle. Identified barriers were consistent with those identified during the survey. We used survey data and verbal feedback to determine which factors were most frequently reported to influence participants' adherence to the bundle. We addressed the following problems: (1) lack of confidence in the evidence used to develop the bundle, (2) disbelief that the bundle would reduce

Table 3. Facilitators and Barriers to Implementing the Central Line Maintenance Bundle: 3-Point Scale Questions

Survey Question Topic	Unit	Descriptor		
Implementation domain				
Ability to implement bundle		Yes, if I can ask questions	Moderately comfortable	Very comfortable
	ICU, n = 49	5 (10.20)	25 (51.02)	15 (30.61)
	Oncology, n = 61	5 (8.20)	19 (31.15)	29 (47.54)
Inner setting domain				
Needing additional time for dressing change		Additional time is adding stress	I will follow the new guidelines though it is more time	Patient safety is important so I will use whatever time I need
	ICU, n = 49	10 (20.41)	18 (36.73)	17 (34.69)
	Oncology, n = 61	3 (4.92)	15 (24.59)	34 (55.74)
Nurses' education domain				
Trust EBP results		Somewhat describes me	Describes me well	Totally describes me
	ICU, n = 49	8 (16.33)	20 (40.82)	14 (28.57)
	Oncology, n = 61	4 (6.56)	27 (44.26)	21 (34.43)

Abbreviations: EBP, evidence-based practice; ICU, intensive care unit.

This table describes the facilitators and barriers to implementing the central line maintenance bundle and lists nurses' responses to each item.

CLABSIs, (3) inconsistent patient education regarding daily antimicrobial bathing and providing patients with a daily antimicrobial bath, and (4) nurse's level of exposure to EBP (Table 4). The team developed targeted initiatives to increase nurses' adherence to the institutions' evidence-based central line maintenance bundle.

PHASE 2: IMPLEMENTATION OF TARGETED INITIATIVES

Although survey respondents reported the dressing change kit as a barrier to adherence, advanced practice nurses developed a new kit during survey implementation. Therefore, the project team focused on the remaining barriers. Operating within the nursing sphere of impact, the CNS project leader developed and implemented a 10-minute in-service to educate direct care nurses and patient care assistants because these individuals are responsible for monitoring central line dressings and bathing patients on the unit. The session aimed to increase nurses' confidence in the evidence used to develop the bundle by sharing how the bundle was developed and providing data showing its effectiveness since its inception. It also aimed to increase the belief the bundle would reduce CLABSIs and improve the direct care staff's understanding of the importance of daily antimicrobial bathing. A product representative from the institution's supplier of the chlorhexidine gluconate (CHG) bathing solution educated nurses on the antimicrobial solution's safety, efficacy, and correct use.

In-services were provided to nurses and patient care assistants on selected units 4 times per week. Overall, 77.1% (n = 262) of registered nurses and 62.8% (n = 86) of patient care technicians completed the in-person in-service. The nurses and patient care assistants who did not attend the in-services during the intervention period were still responsible for reviewing the provided education. Binders containing all education materials reviewed in the in-service were left on the unit as a reference for new and current staff.

The project team reinforced the importance of daily antimicrobial bathing by placing signs in all unit supply rooms reminding nurses and patient care assistants to provide patients with the 4% chlorhexidine bathing solution. The team also displayed signs in all patient rooms on the oncology units because these patients were able to participate in self-care. The signs described the rationale for daily antimicrobial bathing with 4% CHG, outlined the bathing procedure, and encouraged patients to ask nurses and patient care assistants for assistance with bathing. In addition, the team received permission to have screen savers displayed on all desktop computers to remind staff to assist patients with antimicrobial bathing. Finally, the project team also aimed to increase nurses' adherence to daily antimicrobial bathing and exposure to EBP by participating in the project site's Article of the Month Program. The institution currently provides nurses with access to evidence-based articles and the opportunity to earn continuing education units by reading the featured monthly article and completing the corresponding quiz. The project team selected an article that focused on the benefits and safety of daily CHG bathing.

DATA COLLECTION

Nurses' Adherence to the Central Line Maintenance Bundle

Data were collected at baseline and at 3, 9, and 15 months post intervention using a central line audit tool previously developed by the institution. The audit tool contained 2 sections, bedside assessment and documentation. The

Table 4. Survey Results and Development of Targeted Initiatives

Barrier to Adherence to Central Line Maintenance Bundle	Targeted Initiative to Mitigate Barrier
Lack of confidence in the bundle	• 10-min educational in-service, including evidence used to develop the bundle
Disbelief the bundle would reduce CLABSIs	• 10-min in-service, including reduced CLABSI rates since bundle implementation
Inconsistent education regarding daily antimicrobial bathing	• 10-min in-service including education on importance of daily antimicrobial bathing and proper use of 4% chlorhexidine gluconate solution • Placement of signs in supply room reminding staff to provide patients with 4% chlorhexidine bathing solution • Placement of signs in patient rooms (oncology units only) reminding patients to perform daily antimicrobial bathing • Placement of screen savers on all hospital desktop computers reminding staff to perform daily antimicrobial bathing
Lack of exposure to evidence-based practice	• Continuing education credit to read evidence-based practice article on daily antimicrobial bathing

Abbreviation: CLABSI(s), central line–associated bloodstream infection(s).

This table describes the barriers to adherence to the central line maintenance bundle and outlines the targeted initiatives developed and implemented to mitigate the barrier.

bedside assessment section addressed the following elements: dressing labeled correctly (date of dressing change and initials of the nurse who changed the dressing), dressing occlusive, antimicrobial disk placed at the insertion site, and catheter lumens clamped. These data were obtained by direct observation of central lines. The documentation section addressed the remaining 2 bundle elements: CVC insertion site assessed for signs of infection within 24 hours of the audit and daily antimicrobial bath documented in the patient's electronic health record. Each element in the central line maintenance was composed of multiple steps. Therefore, nurses' adherence to a bundle element was defined as completion of all appropriate steps required to complete that element.

CLABSI Rates

The project team obtained the monthly CLABSI rates for all units during the preimplementation and postimplementation periods from the institution's Infection Prevention Department. This department reviews the medical records of all patients with a suspected or known infection and uses the Centers for Disease Control and Prevention's definition to determine whether the infection is a CLABSI.

Data Analysis

Nurses' survey responses were reported using frequency distribution and percentages and dichotomized as negative or positive. Percent adherence to the bundle was compared pre and post intervention; CLABSI rates were also compared pre and post intervention. Because of the number of cofounding variables and small sample size, we were unable to run analyses predicting whether the intervention had a direct effect on CLABSI rates.

RESULTS

Nurse Demographics

All eligible nurses were invited to complete the survey to identity facilitators and barriers to adhering to the central line maintenance bundle. Among 277 nurses invited to the survey, 40% (n = 110) of nurses responded, 45% (n = 49) worked in an ICU, and 55% (n = 61) worked on an oncology unit. Most nurses (62%, n = 68) were educated at the baccalaureate level.

SURVEY DOMAINS

Dressing Kit

Nurses were asked to rate the impact of the dressing kit on their adherence to changing a central line dressing using the bundle. Sixty percent responded that the kit had a moderate to strong impact on adherence to the intervention. Approximately 66% of nurses also reported the supplies included in the central line dressing kit moderately or strongly impacted their adherence. Seventy-five percent of nurses responded that ease in using the dressing kit was helpful or very helpful. Seventy-six percent said additional supplies needed to change a central line dressing were usually or always available (Table 2).

Education Classes

Most of the nurses indicated the education classes facilitated their understanding of the process used to implement the bundle and enabled them to practice changing the dressing with the new policy. More than two-thirds of the nurses reported the classes provided an adequate or detailed explanation of the bundle. In addition, 80% felt moderately or very comfortable using the bundle in clinical practice (Tables 2 and 3). Eighty-one percent were able to access the user manual placed on the hospital's private internal network.

Personal Assessment

When assessing nurses' perception of the clinical (inner) setting, 61% of nurses felt supported or well supported by their unit culture to spend extra time changing central line dressings using the new bundle. Fewer nurses (51%) felt supported or well supported by their unit culture to take extra time to be the second trained observer. When asked about their willingness to spend additional time performing central line dressing changes according to the bundle, 30% of nurses said they would adhere to the guidelines. Nearly half (46%) said they would use all needed time to change the dressings correctly because they believed patient safety is important. Sixty-one percent believed the bundle would reduce CLABSIs (Tables 2 and 3).

Adaptation

While assessing nurses' characteristics, 70% of the respondents (n = 77) said willingness to embrace change was a good or full description of themselves. Forty-eight percent (n = 53) were confident or very confident in the evidence used to develop the bundle. In addition, 75% of nurses (n = 83) felt having trust in the results of EBP in general described themselves well or completely (Tables 2 and 3). Finally, most nurses (61%, n = 67) had only 1 type of exposure to EBP. The most commonly reported type of exposure (45%, n = 50) was being aware of evidence-based initiatives being implemented on the unit or throughout the hospital.

Additional Information

When asked specific questions related to adherence to specific elements of the bundle, we obtained the following results. Forty-five percent of nurses (n = 50) reported being the second trained observer for the dressing change 100% of the time, indicating they had never changed a central line dressing themselves. In addition, 42% (n = 46) reported seeing a break in sterility during the dressing

change process 25% of the time. Nurses were not asked to report whether they reminded the nurse changing the central line dressing to stop the procedure when the break in sterile technique occurred. Finally, one-third (33%, n = 37) reported educating their patients on daily antimicrobial bathing 100% of the time. One-third (35%, n = 38) of nurses also provided patients with a daily antimicrobial bath 75% of the time.

Nurses' Adherence to the Central Line Maintenance Bundle

Positive changes were seen across all bundle elements in the ICUs at 3 months post intervention (Table 5). The greatest changes were seen in providing daily antimicrobial bathing (54%), correctly labeling the dressing (48%), and maintaining an occlusive dressing (23%). Adherence to all bundle elements increased in oncology units at 3 months post intervention with the exception of correctly labeling dressings (0%) and clamping unused catheter lumens (−8%).

On these units, the greatest changes were seen in daily antimicrobial bathing (17%), followed by performing a daily site assessment (11%). At 9 months post intervention, the greatest changes seen in the ICU were in correctly clamping unused lumens (30%) and providing a daily antimicrobial bath to patients (67%). Adherence to placing a Biopatch (Acelity/Systageinx, Brookfield, Connecticut) at the insertion site and performing a daily site assessment decreased by 3% and 75%, respectively. On oncology units, increases were seen in clamping unused catheter lumens (45%) and daily antimicrobial bathing (25%). Decreases were seen in the remaining bundle elements.

CLABSI Rates

Clinically significant decreases were seen in CLABSI rates in the ICUs at 3 and 9 months post intervention of the targeted initiatives. The CLABSI rate decreased by 6.08 infections per 1000 catheter days at 3 months post intervention and 4.6 infections per 1000 catheter days at 9 months post intervention. Central line–associated bloodstream infection rates in the oncology units also decreased by 0.95

Table 5. Adherence to Central Line Maintenance Bundle at Baseline and at 3, 9, and 15 Months Post Intervention

Bundle Elements	Baseline (n = 25), Frequency (%)	3 mo Post Intervention (n = 23), Frequency (%)	9 mo Post Intervention (n = 32), Frequency (%)	15 mo Post Intervention[a] (n = 18), Frequency (%)	Percent Change in Adherence		
					Baseline to 3 mo	Baseline to 9 mo	Baseline to 15 mo
ICU							
Correct dressing label	12 (48)	22 (96)	23 (72)	16 (89)	48	24	41
Occlusive dressing	16 (64)	20 (87)	25 (78)	16 (89)	23	14	25
Biopatch	21 (84)	21 (91)	26 (81)	18 (100)	7	−3	16
Site assessment	22 (88)	21 (91)	10 (31)	16 (89)	3	−57	1
Unused lumens clamped	12 (48)	12 (52)	25 (78)	18 (100)	4	30	52
Antimicrobial bath	6 (24)	18 (78)	29 (91)	7 (39)	54	67	15
Overall adherence	15 (59)	19 (83)	23 (72)	15 (83)	23	13	24
Oncology	n = 80	n = 82	n = 69	n = 40[a]			
Correct dressing label	53 (66)	54 (66)	40 (58)	40 (100)	0	−8	34
Occlusive dressing	64 (80)	68 (83)	47 (68)	36 (90)	3	−12	10
Biopatch	62 (78)	65 (79)	45 (65)	40 (100)	1	−13	22
Site assessment	62 (78)	73 (89)	26 (38)	39 (98)	11	−40	20
Unused lumens clamped	38 (48)	33 (40)	64 (93)	39 (98)	−8	45	50
Antimicrobial bath	13 (16)	27 (33)	28 (41)	21 (53)	17	25	37
Overall adherence	49 (61)	53 (65)	42 (61)	36 (90)	4	0	29

This table describes adherence to the bundle for central line maintenance at baseline and at 3, 9, and 15 months post intervention. "ICU" indicates combined cardiothoracic and medical intensive care units, and "Oncology" indicates combined 2 oncology units and 1 oncology/bone marrow transplant unit.

[a]Three- and nine-month postintervention data were collected on all patients on targeted units who had a central line. Fifteen-month postintervention data were collected on a convenience sample of 9 to 10 patients per targeted unit who had a central line.

infections per 1000 catheter days and 2.83 infections per 1000 catheter days at 3 and 9 months post intervention, respectively (Table 6).

DISCUSSION

Our CNS-led project team identified barriers to the use of an evidence-based central line maintenance bundle by tertiary care oncology and ICU nurses. In our sample, the survey components that had the greatest influence on adherence to change were the

- dressing change kit itself;
- support needed to be the second trained observer;
- belief the bundle would reduce CLABSIs; and
- confidence in the bundle.

The main barriers were

- unit support for the additional time required to change the dressing; and
- nurses' willingness to adhere to the bundle to improve patient safety.

In addition, less than half of the nurses had confidence in the evidence used to develop the bundle. Another area of concern was that nearly half of the nurses had only observed, rather than performed, a central line dressing change. Perhaps the greatest challenge to reducing the CLABSI rate was the low percentage of nurses who reported providing a daily antimicrobial bath to all of their patients.

Although improvement in adherence varied across bundle elements, our program was successful in increasing staff engagement in several ways. Nurses began approaching the CNS project leader with additional questions regarding the bundle after they received the initial in-service. They specifically asked the CNS for assistance resolving safety issues related to inappropriate CVC care. In 1 ICU, nurses made suggestions for additional kits to change arterial line dressings to reduce waste. Nurses on all shifts approached the CNS and received immediate feedback. These instances provided anecdotal evidence that frequent rounding on the targeted units and managerial support facilitated relationship building and increased nurses' engagement in the process.

With implementation of our project, nurses' adherence was improved. Adherence to correctly labeling the central line dressing and providing daily antimicrobial bathing showed the greatest improvement at 9 months post intervention. Daily CHG bathing increased the most in the ICUs, and these units demonstrated the greatest reduction in their CLABSI rate. However, placement of a Biopatch (Acelity/Systageinx, Brookfield, Connecticut) at the insertion site decreased at 9 months post intervention. This is an interesting finding considering the Biopatches (Acelity/Systageinx, Brookfield, Connecticut) are part of the dressing change kit and additional patches are available on the units. It is unclear why staff were not using the patches regularly. Overall, these outcomes are consistent with findings reported

Table 6. Central Line–Associated Bloodstream Infection Rates

Unit	Baseline			3 mo Post Intervention			9 mo Post Intervention			15 mo Post Intervention			Baseline to 3 mo	Baseline to 9 mo	Baseline to 15 mo
	Catheter Days	Infections	Rate	Catheter Days	Infections	Rate	Catheter Days	Infections	Rate	Catheter Days	Infections	Rate			
ICU	687	4	6.08	3240	0	0.00	693	1	1.48	667	0	0.00	− 6.08	− 4.60	− 6.08
Oncology	2368	8	3.13	2789	7	2.18	2028	1	0.30	2466	4	1.67	− 0.95	− 2.83	− 1.46

This table describes central line–associated bloodstream infection rates at 3, 9, and 15 months post intervention. "ICU" indicates combined cardiothoracic and medical intensive care units, and "Oncology" indicates combined 2 oncology units and 1 oncology/bone marrow transplant unit.

in other studies and are clinically significant for several reasons.[16,17] Chlorhexidine gluconate bathing solution with a concentration as low as 0.5% kills 99% of CLABSI-causing bacteria on the patient's skin; this greatly reduces patients' risk for developing an infection.[18] In addition, the antimicrobial disk placed at the insertion site offers 360° protection and leads to a reduction in CLABSIs when the dressing is changed every 7 days.[19] After this point, nurses must change the dressing and place a new antimicrobial disk to maintain site protection. Labeling CVC dressings with the date they were changed provided a clear visual cue for nurses on the units to know when to perform the next dressing change.

Monthly audit results also pointed to bundle elements that required an improvement in adherence. In ICUs, decreased adherence was seen in placing a Biopatch (Acelity/Systageinx, Brookfield, Connecticut) at the insertion site and performing a site assessment. Oncology units had decreased adherence to correctly labeling the dressing, maintaining an occlusive dressing, placing a Biopatch (Acelity/Systageinx, Brookfield, Connecticut) at the insertion site, and performing a site assessment. Despite these declines in adherence, the CLABSI rate on both units decreased at 3 and 9 months post intervention, suggesting that improved adherence to even some elements of the bundle related to reduced CLABSI rates.

Frequent monitoring of adherence to the bundle may increase overall compliance. Our CNS continued assessing a sample of 10 patients with CVCs on a monthly to bimonthly basis after the project was completed. At 15 months post implementation of the targeted initiatives, adherence increased to all bundle elements in both ICUs and oncology units (Table 5). This improvement in adherence led to zero CLABSIs in the ICUs and a rate of 1.67 in the oncology units compared with rates of 6.08 and 3.13 at baseline, respectively. These findings suggest that there is a relationship between increased adherence to the bundle and reduced CLABSI rates.

The end goal of our CNS-led QI project was to improve patient care by decreasing the overall CLABSI rate within the targeted units. However, we noted variation between units. Rate decreases were seen on 3 units (2 ICUs and 1 oncology unit), whereas increases occurred on 1 oncology unit and the combined oncology/bone marrow transplant unit. Rates of adherence to bundle elements did not consistently increase on the units that had reduced infection rates. These findings suggest additional unit-specific barriers to implementation may exist.

LIMITATIONS

Our project was not without limitations. The patients' electronic health record did not provide a clear, consistent location for nurses and patient care assistants to document when a patient bathed themselves independently with the 4% CHG solution. This led to confusion with documentation and likely resulted in a lower percentage of adherence to daily antimicrobial bathing during monthly audits. Finally, baseline and postintervention data were only collected for 3, 9, and 15 months. Extending the timeframe for data collection may have led to greater improvements in nurses' adherence to the bundle and further reduction in the CLABSI rates.

IMPLICATIONS

Barriers to using the bundle included the dressing change kit and time needed to be the second trained observer. Nurses reported the kit itself and supplies needed to change the dressing that were not contained in the kit served as barriers to implementing the bundle. In addition, only half of the nurses on targeted units felt supported to take additional time from their work day to be the second trained observer during the central line dressing change. To mitigate these barriers, the institution developed and implemented a new dressing kit containing all supplies needed to change the central line dressing. The CNS also made herself available during unit rounding to serve as the second trained observer for the central line dressing change. This behavior supported and modeled the cultural change sought out by the project team.

Although results of this project highlight the need for increased adherence in several elements of the bundle, it lays the foundation for continuous quality improvement to further reduce CLABSI rates. For example, the project team will continue educating staff on the importance of the Biopatch (Acelity/Systageinx, Brookfield, Connecticut) and address other deficiencies. Perhaps the most notable result of this project is that it facilitated bottom-up decision making and empowered care providers directly responsible for reducing CLABSI rates. As nurses develop their "voice" in using the central line maintenance bundle, additional improvements can be made to ensure nurse satisfaction and improved adherence to the bundle. The additional support on the units from the CNS also provided the opportunity to identify areas where greater support is needed to fully adhere to the bundle. Continued central line audits and a CNS presence on the units will further demonstrate the importance of this initiative. Finally, another unit-specific survey can be developed to identify other areas of concern regarding the central line maintenance bundle and additional targeted initiatives.

CONCLUSION

Central line–associated bloodstream infections impact a quarter of a million patients each year and increase morbidity and mortality. Evidence-based central line maintenance bundles have been widely disseminated throughout healthcare organizations across the United States, and adherence to these bundles is directly linked with reduced CLABSI rates. Barriers that impact adherence have been identified across organizations, but literature has not focused on factors that exist in specific clinical settings.

Identification of unit-specific barriers and implementation of targeted interventions to reduce these barriers increase nurses' adherence to these evidence-based bundles. These QI initiatives improve patient outcomes by preventing CLABSIs and reduce healthcare spending for the treatment of these potentially lethal infections.

References

1. Institute for Healthcare Improvement. What is a bundle? 2018. http://www.ihi.org/resources/Pages/ImprovementStories/WhatIsaBundle.aspx Accessed May 10, 2021.
2. Edwards JD, Herzig CT, Liu H, et al. Central line-associated blood stream infection in pediatric ICUs: longitudinal trends and compliance with bundle strategies. *Am J Infect Control*. 2015;43(5):489–493. doi:10.1016/j.ajic.2015.01.006. Accessed May 10, 2021.
3. Gilmartin HM, Sousa KH, Battaglia C. Capturing the central line bundle infection prevention interventions: comparison of reflective and composite modeling methods. *Nurs Res*. 2016;65(5):397–407. doi:10.1097/NNR.0000000000000168. Accessed May 10, 2021.
4. Majid S, Foo S, Luyt B, et al. Adopting evidence-based practice in clinical decision making: nurses' perceptions, knowledge, and barriers. *J Med Libr Assoc*. 2011;9(3):229–236. doi:10.3163/1536-5050.99.3.010. Accessed May 10, 2021.
5. Williams B, Brown T, Costello S. A cross-cultural investigation into the dimensional structure and stability of the Barriers to Research and Utilization Scale (BARRIERS Scale). *BMC Res Notes*. 2015;8:601. doi:10.1186/s13104-015-1579-9. Accessed May 10, 2021.
6. Grau D, Clarivet B, Lotthe A, Bommart S, Parer S. Complications with peripherally inserted central catheters (PICCs) used in hospitalized patients and outpatients: a prospective cohort study. *Antimicrob Resist Infect Control*. 2017;6(18):18. doi:10.1186/s13756-016-0161-0. Accessed May 10, 2021.
7. Zhou F, Maier M, Hao Y, et al. Barriers to research utilization among registered nurses in traditional Chinese medicine hospitals: a cross-sectional survey in China. *Evid Based Complement Alternat Med*. 2015;2015:475340. https://doi.org/10.1155/2015/475340. Accessed May 10, 2021.
8. Mohsen MM, Safann NA, Okby OM. Nurse's perceptions and barriers for adoption of evidence based practice in primary care: bridging the gap. *Am J Nurs Res*. 2016;4(2):25–33. http://pubs.sciepub.com/ajnr/4/2/1/index.html9. Accessed May 10, 2021.
9. Tacia L, Bisdupski K, Pheley A, Lehto RH. Identifying barriers to evidence-based practice adoption: a focus group study. *Clin Nurs Stud*. 2012;3(2):90–96. doi:10.5430/cns.v3n2p90. Accessed May 10, 2021.
10. Wallis L. Barriers to implementing evidence-based practice remain high for U.S. nurses. *Am J Nurs*. 2012;112(12):15. doi:10.0000423491.98489.70. Accessed May 10, 2021.
11. Manchester C, Atherton SL, Baker KA, et al. *Statement on Clinical Nurse Specialist Practice and Education*. 3rd ed. Reston, VA: National Association of Clinical Nurse Specialists; 2019.
12. Lucas W, Kennell J. Best practice for line care by bedside nurses: what would Florence do? Paper presented at: American Vascular Association 2019 Annual Scientific Meeting; 2019; Las Vegas, NV.
13. Centers for Disease Control and Prevention. National and state healthcare-associated infections progress report. 2016. https://www.cdc.gov/hai/pdfs/progress-report/hai-progress-report.pdf. Accessed May 10, 2021.
14. Damschroder LJ, Aron DC, Keith RE, Kirsh SR, Alexander JA, Lowery JC. Fostering implementation of health services research findings into practice: a consolidated framework for advancing implementation science. *Implement Sci*. 2009;4:50. doi:10.1186/1748-5908-4-50. Accessed May 10, 2021.
15. Dyson J, Lawton R, Jackson C, Cheater F. Development of a theory-based instrument to identify barriers and levers to best hand hygiene practice among healthcare practitioners. *Implement Sci*. 2013;8:111. https://doi.org/10.1186/1748-5908-8-111. Accessed May 10, 2021.
16. Dicks KV, Lofgren E, Lewis SS, Moehring RW, Sexton DJ, Anderson DJ. A multicenter pragmatic interrupted time series analysis of chlorhexidine gluconate bathing in community hospital intensive care units. *Infect Control Hosp Epidemiol*. 2016;37(7):791–797. doi: 10.1017/ice.2016.23. Accessed May 10, 2021.
17. Pallotto C, Fiorio M, De Angelis V, et al. Daily bathing with four percent chlorhexidine gluconate in intensive care settings: a randomized controlled trial. *Clin Microbiol Infect*. 2019;25:705–710. https://doi.org/10.1016/j.cmi.2018.09.012. Accessed May 10, 2021.
18. Gunther F, Kaiser S, Fries T, Frank U, Mutters NT. Is your antiseptic effective against clinical multidrug-resistant microorganisms? A chlorhexidine digluconate formulation demonstrating efficacy even at lower concentrations. 2015. https://sageproducts.com/wp-content/uploads/2015/09/Heidelberg-Gram-negative-ICPIC-poster.pdf. Accessed May 11, 2021.
19. Schwebel C, Lucet JC, Vesin A, et al. Economic evaluation of chlorhexidine-impregnated sponges for preventing catheter-related infections in critically ill adults in the dressing study. *Crit Care Med*. 2012;40(1):11–17. doi:10.1097/CCM.0b013e31822f0604. Accessed May 11, 2021.