A Quality Improvement Project to Decrease CLABSIs in Non-ICU Settings

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Background and Objectives: Central line–associated bloodstream infections (CLABSIs) are a common, preventable healthcare–associated infection. In our 3-hospital health system, CLABSI rates in non-intensive care unit (ICU) settings were above the internal target rate of zero. A robust quality improvement (QI) project to reduce non-ICU CLABSIs was undertaken by a team of Doctor of Nursing Practice (DNP)-prepared nurse leaders enrolled in a post-DNP Quality Implementation Scholars program and 2 QI experts. Based on a review of the literature and local root cause analyses, the QI team implemented the evidence-based practice of using 2% chlorhexidine gluconate (CHG) cloths for daily bathing for non-ICU patients with a central line. **Methods:** A pre-post-design was used for this QI study. CHG bathing was implemented using multifaceted educational strategies that included an e-learning module, printed educational materials, educational outreach, engagement of unit-based CLABSI champions, and an electronic reminder in the electronic health record. Generalized linear mixed-effects models were used to assess the change in CLABSI rates before and after implementation of CHG bathing. CLABSI rates were also tracked using statistical process control (SPC) charts to monitor stability over time. CHG bathing documentation compliance was audited as a process measure. These audit data were provided to unit-based leadership (nurse managers and clinical team leaders) on a monthly basis. A Qualtrics survey was also disseminated to nursing leadership to evaluate their satisfaction with the CHG bathing implementation processes. **Results:** Thirty-four non-ICU settings participated in the QI study, including general medical/surgical units and specialty areas (oncology, neurosciences, cardiac, orthopedic, and pediatrics). While the change in CLABSI rates after the intervention was not statistically significant ($b = -0.35$, $P = .15$), there was a clinically significant CLABSI rate reduction of 22.8%. Monitoring the SPC charts demonstrated that CLABSI rates remained stable after the intervention at all 3 hospitals as well as the health system. CHG bathing documentation compliance increased system-wide from 77% (January 2020) to 94% (February 2021). Overall, nurse leaders were satisfied with the CHG bathing implementation process. **Conclusions:** To sustain this practice change in non-ICU settings, booster sessions will be completed at least on an annual basis. This study provides further support for using CHG cloths for daily patient bathing in the non-ICU setting.

Key words: chlorhexidine gluconate (CHG) cloths, evidence-based practice, infection, nursing, quality improvement

Central line–associated bloodstream infections (CLABSIs) are one of the most common healthcare–associated infections. These preventable infections are a source of morbidity and mortality in the hospital setting, adding approximately $48 000 in additional costs per event and contributing an extra 10.4 days in the hospital.[1-3] Further, CLABSIs are a publicly reportable quality metric that impacts reputation rankings and can lead to financial penalties.[4,5]

Our 3-hospital health system in the southeastern United States consists of a large university hospital and 2 community hospitals. CLABSI rates in non-intensive care unit (ICU) settings were 0.70 CLABSIs per 1000 central line days for the system (CLABSI rates for university hospital: 0.74; Community Hospital A: 0.44; Community Hospital B: 0.60). Our health system had recently instituted a "Commit to Zero" campaign for preventable harms—the system rate failed to achieve the internal CLABSI target rate of 0. A root cause analysis was completed on each non-ICU CLABSI event to identify potential opportunities for improvement. Minimal opportunities were found as standard CLABSI prevention insertion and maintenance bundle compliance was high. A robust quality improvement (QI) study was launched to address the cause(s) of the important issue of non-ICU CLABSIs.

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The QI team, which included 4 Doctor of Nursing Practice (DNP)-prepared nurse leaders and 2 QI mentors, led this study as part of a post-DNP Quality Implementation Scholars program. Details of this program, including the curriculum and program evaluation data, have been previously described by Reynolds and colleagues.[6]

The QI team began by searching the literature to identify additional evidence-based CLABSI prevention practices. Articles were critiqued with the level and quality of evidence assessed by the QI team. A recent level 1, high-quality cluster randomized trial by Huang and colleagues[7] found that daily bathing with prepackaged 2% chlorhexidine gluconate (CHG) cloths reduced CLABSIs in non-ICU settings in patients with a central line. This study enrolled 53 hospitals and 194 non-ICU areas, of which 27 hospitals and 104 units, including over 183 000 patients, were enrolled in the intervention group with patients receiving daily CHG bathing. Post hoc analyses found that patients in the intervention group who had indwelling medical devices had a 32% greater reduction in all-cause bacteremia and a 37% reduction in methicillin-resistant *Staphylococcus aureus* and vancomycin-resistant enterococcus compared with those in the control group.[7] Whereas the post hoc analyses showed significant improvements for patients with a medical device, the authors noted that the trial was not designed or powered for this evaluation. However, similar findings have been replicated in other high-quality studies, with other articles consistently noting an improvement in CLABSI rates after implementing CHG bathing.[8,9] Additionally, CHG cloths for daily bathing were already instituted in our health system's ICU settings, and showed significant reductions in ICU CLABSI rates.[10] Given the evidence supporting use of CHG cloths, as well as support from hospital leadership, the purpose of this QI study was to implement daily 2% CHG bathing in non-ICU patients with a central line.

METHODS

A pre-/post-design was used to evaluate the impact of daily 2% CHG bathing on non-ICU CLABSI rates. Baseline CLABSI rates were collected from January 2018 to December 2019. Daily 2% CHG bathing in non-ICU settings began on January 6, 2020; post-implementation data were measured from January 2020 to February 2021. A total of 34 non-ICUs, with a baseline average of 182 central line days per month per unit, participated in the study. See Table 1 for an overview of each hospital's number of non-ICU settings, beds, and average central line days. Patient populations varied among the non-ICUs, including medical, surgical, cardiac, neuroscience, oncology, and pediatric specialties. Due to the variation in unit type, some non-ICUs (ie, cardiac and oncology) had patient populations at higher risk for CLABSI, including those who were immunocompromised and with higher utilization of central lines.

The Promoting Action on Research Implementation in Health Services (PARIHS) framework was used as a guide for this study.[11] This framework postulates that successful implementation of evidence-based practices is a function of the relationship and strength of the evidence, context, and facilitation.[11] As such, we attempted to account for each of these constructs prior to implementation by ensuring appropriate measures were in place. For this QI study, we had *evidence* for the practice change, a *context* that had robust leadership support, and a comprehensive plan to *facilitate* implementation of the practice change. This QI

Table 1. Number of Non-ICU Settings and Beds, and Average Number of Central Line Days Per Month for Each Hospital and the System

				Average Central Line Days/Month, n (SD)	
Type of Hospital	Non-ICU Settings, n	Type of Non-ICUs: n	Non-ICU Beds, n (Range/Unit)	Baseline (January 2018 to December 2019)	Post-implementation (January 2020 to February 2021)
University	23	General medical/surgical: 9 Cardiac: 6 Pediatric: 3 Oncology: 3 Neuroscience: 2 Orthopedic: 1	623 (12-32)	5031 (353)	4878 (498)
Community A	6	General medical: 2 General surgical: 1 Cardiac: 1 Neuro/ortho: 1 Oncology: 1	197 (26-36)	558 (79)	543 (89)
Community B	5	General medical/ surgical: 4 Neuroscience: 1	163 (9-45)	603 (143)	713 (164)
System (total)	34		983 (9-45)	6192 (434)	6134 (501)

Abbreviation: ICU, intensive care unit.

study was deemed exempt as QI by the university's institutional review board.

Measures

Outcome measure: CLABSI rates

CLABSI rates, defined as the number of CLABSIs per 1000 central line days, were measured on a monthly basis per standard National Healthcare Safety Network[12] criteria and provided by the hospital's infection prevention departments. Generalized linear mixed-effects (GLME) models were used to evaluate the change in pre- (January 2018 to December 2019) to post-CLABSI (January 2020 to February 2021) rates. Per the hospital's quality management department, CLABSI rates were also tracked using statistical process control (SPC) charts to monitor stability.

Process measure: CHG bathing treatment documentation compliance

To measure compliance with daily 2% CHG bath treatments, documentation from the electronic health record (EHR) was audited for those patients meeting criteria for receiving a CHG bath. Several times each month, a sample of patient charts was audited on each unit by the unit-based CLABSI champion and members of the QI team. Unit-based CLABSI champions are staff nurses who have attended additional training to learn about CLABSI prevention, and serve as local resources, change agents, and role models for nursing staff. Data were entered into The Joint Commission (TJC) Resources Portal, an online data repository. Documentation compliance from this audit data was regularly disseminated to unit leadership and champions via email and during daily huddles, and through various leadership meetings.

Satisfaction With implementation

We further sought to evaluate nursing leadership satisfaction with the CHG bathing implementation process. An 11-item Qualtrics survey was developed by the authors, with guidance taken from Proctor and colleague's implementation outcomes.[13] The survey was sent to nursing leaders from the 34 non-ICU settings 3 months after implementation. Eight questions asked participants to rate their satisfaction with various aspects of the implementation plan on a 5-point Likert scale (1 = extremely dissatisfied, 5 = extremely satisfied). They were also asked to rate their agreement with the adoption, value, and long-term sustainability of the CHG bathing treatment initiative. Three open-ended, free-text questions asked leaders to discuss the strengths, weaknesses, and opportunities of the QI implementation process. The survey remained open for 2 weeks at the beginning of March 2020.

Procedures

In collaboration with infection prevention, a comprehensive informational presentation was created by the QI team that outlined the study rationale, patient benefits, and frequently asked questions about the 2% CHG bathing treatment protocol. Using a standardized approach, the QI team presented the proposed study to stakeholder groups across the system, including clinical and operational leaders, and nursing staff. The QI team also developed a multifaceted education plan, which included: (1) an e-learning module with an assessment test, (2) printed educational materials, (3) educational outreach, (4) engagement of unit-based CLABSI champions, and (5) an EHR reminder. Education for the daily 2% CHG bathing process followed the protocol published by the Agency for Healthcare Research and Quality (AHRQ), which includes cleaning over transparent central line dressings and up to 6 inches of the catheter and tubing in addition to bathing the full body below the jawline.[14]

The e-learning module included background on the evidence supporting 2% CHG bathing and a short video; nurses and nursing assistants (NAs) completed the module before the study began. The term "CHG bath *treatment*" was adopted to raise awareness of the importance of the protocol.[15,16] Upon completion of the module, a knowledge assessment was provided utilizing a case study with a required passing score of 80%. This module was added to nursing and NA's orientation pathways to hardwire the protocol for new hires. Automated reports were disseminated to local leaders to track staff completion.

Printed educational materials provided an overview of the evidence and rationale for CHG bathing treatments, and a diagram of the appropriate bathing process as found in the AHRQ protocol.[14] The QI team attended local unit huddles across the system for bidirectional information sharing and gathering. Additionally, the QI team partnered with the infection prevention teams to provide logistical support for product allocation and warming devices.

The QI team engaged the CLABSI champions at their monthly meetings. They provided demonstrations of the bathing protocol, scripting for staff, patients, and families about the bathing process, and further assessed barriers and facilitators to the standard work. Electronic reminders for the daily CHG bath treatment were also built into the EHR creating a worklist task for nurses and NAs.

Continuous improvement

Standardized education was provided to all 34 units. Each unit has a unique culture and they were encouraged to operationalize the intervention based on their unit's context and patient population. For example, to integrate and sustain the practice change, many units tailored their daily huddle boards, nursing and NA report sheets, and charge nurse-rounding processes to include CHG bathing. Following implementation, and in conjunction with the Commit to Zero campaign, CHG bathing treatments were a regular agenda item presented at entity-specific leadership meetings, CLABSI champion meetings, and during daily huddles. Monthly CLABSI rates and CHG bathing documentation compliance were shared at these venues and feedback was sought to improve the process. Minor modifications were made to the printed educational materials,

EHR options, and information shared during educational outreach and huddles based on suggestions or clarification needed from leadership and direct care nurses. For example, an update was made to the printed educational materials providing staff with direction and scripting for what to do if a patient refused their CHG bath treatment. Also, the timing of when the EHR worklist task was changed after implementation to better fit with the nurse's workflow.

RESULTS

Daily 2% CHG bathing treatments in non-ICU settings for patients with a central line went live on January 6, 2020. The university hospital had the largest number of non-ICU areas (n = 23 units) and average central line days per month (4878) in the post-implementation period (January 2020 to February 2021). The 2 community hospitals had 5 to 6 non-ICU areas, with an average of 543 and 713 non-ICU central line days per month (Table 1).

Outcome measure: CLABSI rates

A GLME model was used to assess the effect of the intervention on CLABSI rates. In this, CLABSI rates in the various hospital units were regressed on the fixed effect of intervention, defined as 0 during the pre-implementation period (January 2018 to December 2019) and 1 during the post-implementation period (January 2020 to February 2021). Because this intervention is confounded by time, we also included the fixed effect of time, in months. To account for clustering within hospital units, a random intercept was included. Among all hospital units, time (in months) was not significant ($b = 0.009$, $P = .37$), and the change in CLABSI rates before and after the intervention was not statistically significant ($b = -0.35$, $P = .15$).

Additionally, SPC charts were used to monitor stability of CLABSI rates over time. Consistent with QI methodology,[17] baseline data (January 2018 to December 2019) contained at least 20 data points prior to the intervention. The mean CLABSI rate in this baseline period for the health system was 0.70. After CHG bathing was implemented, the mean and control limits were revised using January 2020 to February 2021 data. The mean system-wide CLABSI rate decreased to 0.54, a 22.8% reduction (Figure 1A). Community Hospital A and the university hospital saw reductions in their mean CLABSI rate from the baseline to post-implementation period (41% and 28% reductions, respectively) (Figures 1B and 1C). Hospital B saw a 29% increase in CLABSI rates after implementation (Figure 1D). In review of the SPC charts, CLABSI rates remained stable for all hospitals after the intervention.

Process measure: CHG bathing treatment documentation compliance

CHG bathing treatment documentation compliance was measured beginning in January 2020. Over the course of 14 months, a total of 6798 patient records were audited. In January 2020, system-wide CHG bathing documentation compliance was 77%; compliance increased by 17.1 points to 94.1% in February 2021 (Figure 2). For the first year post-implementation (January to December 2020), the compliance goal was set by the hospital at 90%, similar to other infection prevention compliance measures. As the overall health system consistently met this goal from September to December 2020, the compliance goal was increased to 95% starting in January 2021.

Satisfaction with implementation

A total of 68 nurse leaders completed the Qualtrics survey. Most were from the university hospital (n = 33). Participants had a variety of leadership roles, including clinical team leaders (n = 31), nurse managers (n = 21), Clinical Operations Director (n = 2), Associate Vice President (n = 1), and other roles (n = 5). Results of the survey can be found in Table 2. Most leaders were satisfied with the overall implementation of CHG bathing treatments. The highest rated component was the education provided during the rollout, as it included the rationale (or "why") for the importance of daily CHG bathing treatments. Nurse leaders also highly ranked their agreement with the adoption, value, and long-term sustainability of the CHG bathing initiative. Narrative strengths included the benefits to patient outcomes, feedback provided on CHG documentation compliance, and the logistical assistance provided by the QI team with acquiring warmers and CHG cloths. One nurse leader stated, "[A strength was that] education included the 'why' behind the initiative, so that staff better understood the importance of daily CHG bathing. Also, the QI team took the workload off of the local teams." Weaknesses included the quick implementation plan and lack of staff buy-in of the new process. One leader commented, "I feel we did not have enough time to provide training/education to staff before go-live, which can reduce staff's buy-in of the practice change."

DISCUSSION

Outcome measure: CLABSI rates

An overall 22.8% reduction in system-wide CLABSI rates after implementing the CHG bathing treatment protocol in non-ICU settings was achieved, with Community Hospital A and the university hospital seeing the largest reductions. The university hospital had the largest number of non-ICU settings (23 units), the highest number of central lines, and therefore had the greatest opportunity for reduction. Other studies have shown similar results, with reductions in CLABSIs after implementation of CHG bathing.[7,18,19] Whereas most studies have found a reduction in CLABSIs in the ICU setting,[10,19,20] this QI study adds to the body of knowledge supporting the use of CHG bathing to decrease CLABSI rates specifically in the non-ICU population for patients with central lines.

Community Hospital B unfortunately saw an increase in CLABSI rates after implementation of CHG

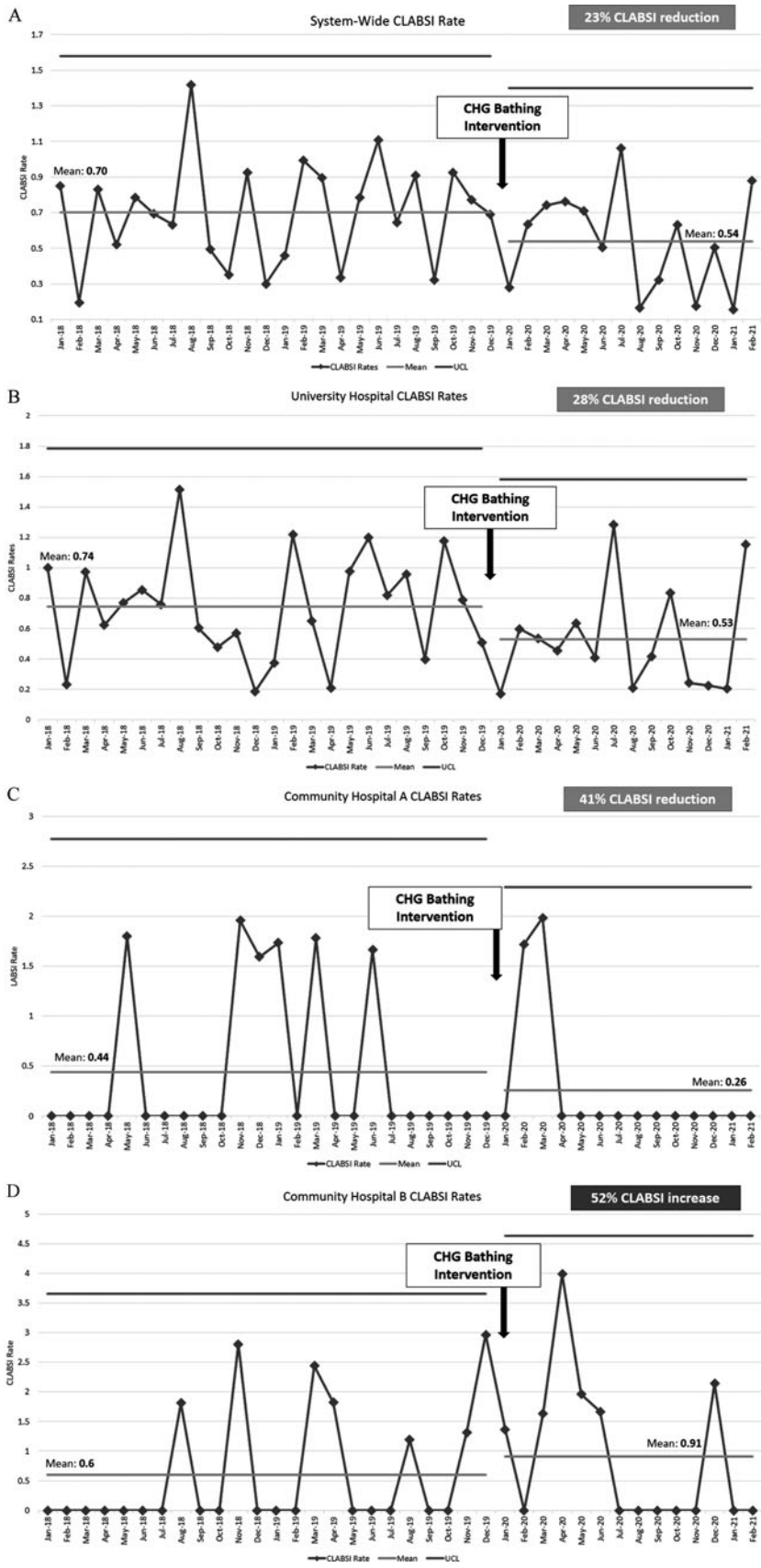

Figure 1. Statistical process control charts of CLABSI rates. (A) System-wide CLABSI rates. (B) University Hospital CLABSI rates. (C) Community Hospital A CLABSI rates. (D) Community Hospital B CLABSI rates. CLABSI indicates central line–associated bloodstream infection; UCL, upper control limit.

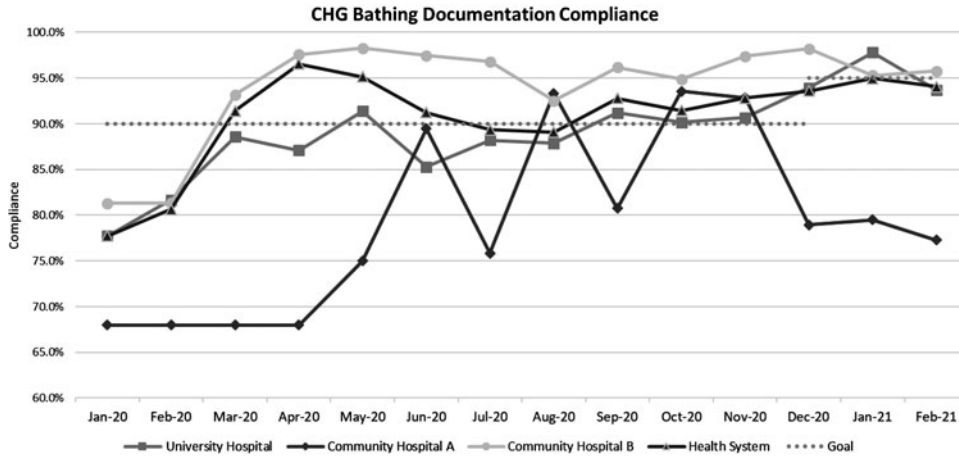

Figure 2. Non-ICU CHG bathing documentation compliance. CHG indicates chlorhexidine gluconate; ICU, intensive care unit.

bathing from March to June 2020, at the height of the COVID-19 pandemic. The community hospital may have admitted patients with higher acuity. Fakih and colleagues[21] found that the COVID-19 pandemic was associated with substantial increases in CLABSI rates in hospitals. It is important to note that, whereas this hospital saw an overall increase in CLABSI rates post-implementation, they did have a 5-month stretch (July to November 2020) with zero CLABSIs, as noted in Figure 1D.

In addition to the important clinical outcomes achieved in this QI study, there are sizeable financial implications of implementing CHG bathing. The average cost of a CLABSI event is $48 000.[2] The reduction in CLABSIs noted throughout our health system was associated with an annual cost aversion of approximately $768 000. However, CHG cloths cost approximately $5.25 more than nonmedicated pre-packaged cloths, adding an approximate annual additional cost of $387 600 to hospital expenses. Accounting for the increased cost of CHG cloths, the health system still realized a cost aversion of $380 400.

Even though CHG cloths are more expensive than nonmedicated cloths, the ultimate benefits to patient safety and CLABSI cost aversion are substantial. With an estimated increase in length of stay associated with CLABSI of 10.4 days per event, the impact for the health system on bed days was approximately 166.4 days.[3] Similar to the savings realized in our study, Huang and colleagues[22] also noted that implementing daily CHG bathing treatments may save hospitals an estimated $171 000. Reagan and colleagues[23] also found that improving daily CHG compliance could save over $800 000 from infection reduction.

Process measure: CHG bathing treatment documentation compliance

CHG bath treatment documentation compliance improved over the course of the 14 months following implementation of the intervention. Many other studies have also evaluated CHG bathing compliance through EHR documentation audits and have found similar improvements after education.[18,24,25] In addition to conducting documentation audits, leaders

Table 2. Nursing Leadership Satisfaction and Agreement With CHG Bathing Implementation

Question	Mean (SD) n = 60	Two-Top-Box Responses n = 60
Education provided (e-learning module, printed educational materials)	4.02 (0.76)	85%
Logistics (warmer acquisition, cloth ordering)	3.98 (0.96)	78%
EHR worklist task	3.71 (0.94)	62%
Audit and feedback provided on CHG documentation compliance	3.75 (0.99)	73%
Overall CHG bathing rollout	3.62 (1.07)	67%
CHG bathing has been well adopted on my unit/area	3.98 (0.85)	82%
This initiative is valuable to my unit/area	4.27 (0.75)	85%
This initiative will be sustainable long term	4.12 (0.86)	78%

Abbreviations: CHG, chlorhexidine gluconate; EHR, electronic health record.

were provided feedback on a regular basis on their unit's documentation compliance. Literature shows that this type of audit and feedback strategy is helpful in improving compliance with evidence-based practices.[26-29]

Documentation audits provide a relatively simple process metric to measure compliance with CHG bathing; however, documentation may not always reflect nursing practice. Community Hospital B had the highest CHG bathing documentation compliance, yet saw an *increase* in CLABSI rates. In contrast, Community Hospital A had lower CHG bathing documentation compliance (average of 79.2% after implementation) than the other hospitals, but showed the largest hospital-wide reduction of CLABSIs.

Documentation audits may not provide the most accurate measure of compliance with the practice change. Other process metrics may be helpful to further capture CHG bathing treatment compliance, such as observation of the bathing process or measuring the usage of CHG bath cloth packages.[24] Through mathematical modeling, Reagan and colleagues[23] completed an analysis noting that improving compliance with daily CHG bathing can result in 20 averted infections. Future CHG bathing treatment studies should consider monitoring compliance with other types of process metrics, not just documentation audits. They should also provide feedback on compliance to individual units and leaders.

Satisfaction with implementation

Most nurse leaders were satisfied with the overall implementation plan and processes. Previous evaluation research has reported on bedside nurses' experience with implementation process.[30] However, there is a paucity of evidence on nurse leaders' experience and satisfaction with implementation processes of CHG bathing at a system level. Reynolds and colleagues[31] conducted a qualitative study evaluating the impact of a CHG bathing implementation science study on nurse leaders' competencies. Findings showed that being a part of an implementation science study and associated processes was a positive experience and allowed leaders to promote the use of evidence-based infection prevention practices.[31] In a review of the literature, we did not find other studies evaluating nurse leaders' experience and satisfaction with implementation of other evidence-based practices.

Based on the leaders' feedback, they appreciated the hands-on approach of the QI team in assisting with education and the necessary logistics with implementing a large, system-wide study. However, as CLABSI prevention was a major focus for the hospital, the CHG bath treatment practice was implemented quickly. Several nursing leaders identified this as a weakness of the study, which could have contributed to suboptimal staff buy-in of the practice change. Further, CLABSI champions were used as local change agents to engage staff, yet lack of staff buy-in was a noted weakness. Per the PARIHS framework, we attempted to have a strong *facilitation* plan prior to the rollout of the initiative. The CLABSI champions were provided with resources; however, it may have been helpful for the QI team to provide additional tools and/or superusers to better support the practice change from a *facilitation* standpoint. For future implementation initiatives, it may be beneficial for studies to consider evaluating implementation processes from a leadership perspective to identify strengths and opportunities.

Limitations

This QI study has several limitations. First, this study was initially implemented on October 1, 2019. Two days after implementation, the CHG bath cloth manufacturer announced a nation-wide backorder of the cloths, forcing the QI study to suddenly stop. This abrupt pause may have negatively affected the robust implementation plan, as education was completed in September/October 2019, yet CHG bathing treatments were not officially (re)implemented until January 2020. Further, much of the post-implementation period coincided with the COVID-19 pandemic. With many competing priorities, CHG bathing treatments may have had lower priority for the staff and this could have affected compliance with the CHG bath treatment protocol. Finally, this study was conducted across a single health system in the southeastern United States, which may limit generalizability.

CONCLUSIONS

Findings of this QI study support daily bathing with pre-packaged 2% CHG bath cloths in non-ICU settings to reduce CLABSI, although the finding was not statistically significant. Booster sessions will be implemented during annual skills revalidation and as needed to sustain this practice change. CLABSI champions, as well as nurses participating in a new health system evidence-based practice fellowship, will be mentored by QI experts to maintain the gains made from this QI study.

CHG bathing, a nurse-led intervention, can reduce CLABSIs in the non-ICU setting. Other health care systems may seek to implement CHG bathing in this patient population. In addition to the main outcome of CLABSI rate reduction, other measures, such a CHG bathing documentation compliance and staff or leadership satisfaction, should be measured.

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