

Catheter-associated urinary tract infection prevention:

Implementation of a multimodal and evidence-based education program

By Mary Beth Russell, PhD, MA, RN, NPDA-BC, NEA-BC, FNAP, CPHQ; Jill Cox, PhD, RN, APN-c, CWOCN, FAAN; Naomi Fox, DNP, RN, NPJ-BC, CCRN; and Nancy E. Holecek, MAS, MHA, BSN, RN

Urinary tract infections (UTIs) are the fifth most common type of health-care-associated infection, with virtually all associated with instrumentation of the urinary tract.¹ In the hospitalized population, approximately 12% to 16% of inpatients will have an indwelling catheter during their stay, and for each day the catheter remains in place, the risk of catheter-associated urinary tract infection (CAUTI) increases by 3% to 7%.¹ CAUTIs are a serious concern for patients and can lead to complications including bacteremia, pyelonephritis, sepsis, and endocarditis.¹ Additionally, CAUTIs can result in prolonged hospitalizations, higher costs, and increased mortality.²

In an effort to decrease CAUTIs and the associated risk of complications, hospital leaders must monitor and reduce catheter use. Once a potential CAUTI is suspected, they should conduct a root cause analysis to understand the clinical and environmental factors that contribute to its occurrence. Measures to

address deficits should include: education and surveillance initiatives focusing on catheter maintenance practices, proper specimen collection, and expeditious discontinuation of indwelling catheters. Incorporating these actions has resulted in improvements nationally in CAUTI outcomes.³⁻⁶

The use of a multimodal approach to CAUTI prevention has also garnered support in the literature. In a study focused on educational initiatives for frontline staff, Van Decker and colleagues introduced a multimodal educational approach, including online learning modules and catheter care simulation, and reported statistically significant reductions in CAUTI rates.⁷ In a multifaceted prevention campaign that included incorporating educational initiatives aimed at various aspects of catheter maintenance, Schweiger and colleagues reported decreases in CAUTI rates and catheter utilization.⁵ Other studies also found that CAUTI rates were reduced with a multimodal approach, implementing a vari-

ety of educational initiatives, nurse-driven or automated catheter removal protocols, and daily checklists with bedside catheter reminders.^{4,6}

In a large healthcare system, leaders identified a need to examine catheter-related practices after detecting an enterprise-wide increase in CAUTI rates. In 2019 to 2020, a preliminary analysis of catheter practices was conducted in all 11 hospitals within the system. This analysis included catheter insertion practices and catheter maintenance techniques (such as catheter securement and drainage tubing placement) and an evaluation of urinary collection systems. Results of this preliminary data revealed opportunities for improvement in all areas of catheter management. Based on the identified practice gaps and the upward trend in CAUTI rates, the need to further examine current practice was evident. The purpose of this process improvement project was to determine if the implementation of a multimodal education program would



FATCAMERA/ISTOCK

result in decreased CAUTI rates in a large healthcare system.

Methods

Design

This process improvement project utilized a pre-post intervention design. The preintervention phase included collecting data on CAUTI rates and catheter utilization rates and from observational audits of CAUTI prevention practices for three subsets of time starting in July 2020 and ending in March 2021. The intervention included multimodal education focusing on CAUTI prevention and maintenance. Although the interprofessional team is responsible for CAUTI prevention and catheter maintenance practices, the RN is the primary person responsible and accountable. This was specifically important at the time of the design and implementation phase due to the negative impact of the COVID-19 pandemic on staffing and resources. Therefore, RNs were

the target population for the multimodal education. The postintervention phase focused on data analysis of CAUTI rates, catheter utilization rates, and observational audits for CAUTI prevention for three subsets of time starting in October 2021 and ending in June 2022.

Setting

The setting for this study was 11 acute care hospitals within a large healthcare system. This included urban, suburban, and small community hospital geographic areas. The unit types included in the analysis were inpatient medical-surgical units, telemetry units, and CCUs. The nurse leaders selected these units because they had the highest preintervention CAUTI rates and are the areas in which catheter usage is historically the highest. Nurses employed on these units on a full-time, part-time, or per diem basis were the target audience learners in the implementation.

The data collection and observational audits were conducted on these units.

Materials

Human, financial, and material resources were utilized. Human resources were the representatives and study team members who conducted observational audits, education, and data collection. Financial resources included the time paid for education multiplied by the number of RNs, multiplied by the hourly rate. Material resources were the urinary catheter kits used for the skills lab and printing materials.

Preintervention

In the preintervention phase, the investigators analyzed CAUTI rates and catheter utilization rates for Q3 (July through September) 2020, Q4 (October through December) 2020, and Q1 (January through March) 2021. An interprofessional team (including nurse

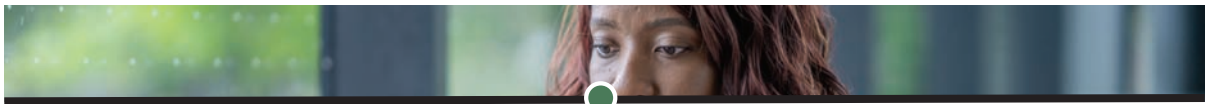
leaders, educators, staff, and the vendor providing urinary catheters and supplies) conducted observational audits of CAUTI prevention practices for patients with catheters to determine compliance rates. Practices observed included: 1) presence of tamper-evident seals, 2) absence of dependent loops, 3) use of catheter securement device, 4) drainage bags positioned below the bladder level, 5) drainage bags not touching the floor, and 6) presence of an insertion label indicating the date of insertion.

on the included units about the available education options. For the first part of the two-part educational process, RNs voluntarily enrolled in either a synchronous or an asynchronous online program. Two options were offered to meet the needs of staffing schedules and provide flexibility to learners. The synchronous option required participation in a vendor-hosted webinar regarding best practices in CAUTI prevention. The asynchronous option included completion of an online learning module that addressed best practices in indwelling catheter management.

eter securement device, drainage bags positioned below the bladder level, drainage bags not touching the floor, and the presence of insertion labels. A standardized competency checklist was used to validate adherence to the intervention techniques, which included demonstration and return demonstration.

Postintervention

The postintervention analysis included a comparison of CAUTI rates from Q4 (October through December) 2021, Q1 (January through March) 2022, and Q2 (April through June) 2022 with



The results demonstrate a statistically significant decline in CAUTI rates when comparing the pre- and postintervention phases.

Education programs

The intervention consisted of implementing a multimodal, evidence-based education program during Q2 (April through June) and Q3 (July through September) 2021. Two modes of education were included. The first mode was an online education program. Participants had the option to engage in either synchronous or asynchronous instruction. The second mode of education was participation at an in-person skills lab. The goal was to have the majority of nurses employed on medical-surgical units, telemetry units, and CCUs at all sites attend these educational interventions.

Nurse leaders and nurse educators informed RNs practicing

It was created by the vendor and assigned through each hospital's learning management system. Whether the nurse attended synchronously or completed the learning module, the content and objectives were the same. Prior to implementation, the nursing education team reviewed both options for consistency in content and adherence to evidence-based practices.

The second mode of education was an in-person skills lab coordinated by the nursing education departments at the participating hospitals. Educational priorities focused on the CAUTI prevention practices assessed in the preintervention time frame; namely, the presence of tamper-evident seals, the absence of dependent loops in tubing, the use of a cath-

eter securement device, drainage bags positioned below the bladder level, drainage bags not touching the floor, and the presence of insertion labels. A standardized competency checklist was used to validate adherence to the intervention techniques, which included demonstration and return demonstration.

The investigators also analyzed RN participation in the education program and in-person skills lab across the hospital system. The number of RNs who participated in the educational programs was compared with the total number of RNs in the hospital system employed on the participating units to establish the overall participation rate.

Ethics

This study was approved by the institutional review boards of the participating institutions within the healthcare system.

Data analysis

All data were analyzed using IBM SPSS for Windows version 27. The primary outcome measured for this study was the pre- to postintervention change in CAUTI rates, defined as the number of catheter-associated infections per 1,000 days. Pre- and postintervention CAUTI rates were compared for the identified time frames for the 11 hospitals in the system using independent samples *t* test analysis.

The investigators also analyzed the mean number of catheter utilization days, comparing the pre- and postintervention time frames using independent samples *t* test analysis. Rates of compliance with CAUTI prevention practices were compared for the pre- and postintervention phases. The rate of participation in the educational initiatives was calculated by dividing the number of RNs who participated by the total number of RNs in the study units across the hospital system.

Results

CAUTI rates

CAUTI rates for the studied units across the 11 hospitals in this system are shown in *Table 1*. The mean CAUTI rate was 1.07 (SD 0.42) for the preintervention time frame (Q3 and Q4 2020 and Q1 2021) and .055 (SD 0.22) for the postintervention time frame (Q4 2021 and Q1 and Q2 2022). The *t* test analysis revealed a

Table 1: CAUTI rates per 1,000 patient days

CAUTI rate	Mean (SD)	<i>t</i> test	<i>P</i> value
Preintervention phase: July 2020-March 2021	1.079 (.42)	-3.27; df (11.9)	.007*
Postintervention phase: October 2021-June 2022	0.554 (.22)		

**P* < .05

Note: Data analysis was limited to 9 months preintervention and 9 months postintervention.

Table 2: Catheter utilization rate

Catheter utilization rate	Mean (SD)	<i>t</i> test	<i>P</i> value
Preintervention phase: July 2020-March 2021	0.16 (0.01)	-2.98; df (15.2)	.009*
Postintervention phase: October 2021-June 2022	0.15 (0.01)		

**P* < .05

Note: Data analysis was limited to 9 months preintervention and 9 months postintervention.

statistically significant difference in pre- and postintervention CAUTI rates (*t* = -327; *df* = 11.96; *P* = .007).

Catheter utilization rates

Catheter utilization rates by month for the studied units across the hospital system are reported in *Table 2*. The mean catheter utilization rate was 0.16 (SD 0.01) for the preintervention time frame and 0.15 (SD 0.01) for the postintervention time frame. The *t* test analysis revealed a statistically significant change in catheter utilization between the pre- and postintervention time periods (*t* = -2.984; *df* = 15.2; *P* = .009).

Catheter practices

In the preintervention phase, the interprofessional team conducted a total of 256 observations of catheter practices. Rates of compliance with the catheter maintenance techniques ranged from 44% to 91% with the prac-

tice of keeping drainage bags lower than the bladder having the highest compliance.

In the postintervention phase, a total of 197 observations of catheter practices were conducted. Investigators noted that compliance with CAUTI prevention practices improved from the pre- to postintervention phases in all but one practice area. The practice areas with the greatest improvement were the absence of dependent loops, from 44% to 58% (+31%) and the presence of insertion labels, from 45% to 59% (+31%). In one area (the presence of tamper-resistant seals), compliance decreased slightly (-2.5%) when comparing these time periods (see *Figure 1*).

Education interventions

The total number of nurses employed on the selected units across the 11 hospitals in the system was 4,410. Of those, 3,025 (69%) attended either the syn-

Catheter-associated urinary tract infection prevention

chronous or asynchronous education. A total of 3,529 RNs from the study units (80%) participated in the in-person skills lab education program. The total number of nurses who attended both education programs was 2,401, representing 54% of the RNs employed on these units.

Discussion

The primary outcome of this initiative was a reduction in CAUTI rates. The results demonstrate a statistically significant decline in CAUTI rates when comparing the pre- and post-intervention phases. Moreover, compliance to catheter practices improved in five of the six catheter practice areas examined during the project time frame. Although statistical significance is an important metric when evaluating a project's outcomes, in a clinically focused project such as CAUTI prevention, clinical significance is equally important. Therefore, education initiatives aimed at maintaining compliance to CAUTI prevention practices among frontline caregivers are essential. In studies that have examined the role

of education strategies in reducing CAUTI rates, the implementation of a wide range of education programs has proven effective. These include on-site lectures, asynchronous education programs given through a hospital-based learning management system, the use of videos, and the implementation of multidisciplinary education campaigns.^{4,7-10}

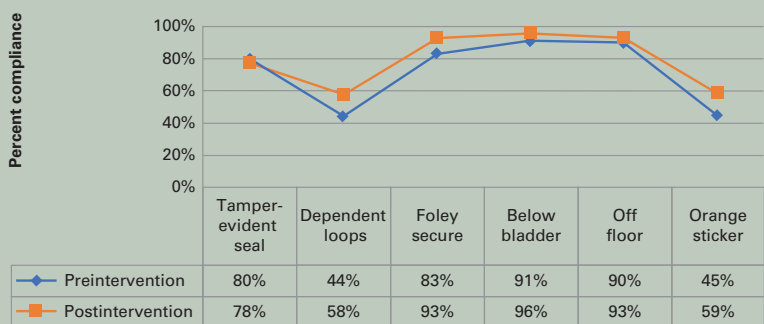
In addition, a comparison of the study periods showed a statistically significant decline in catheter utilization rates. Although the main focus of the multimodal education was catheter placement and CAUTI prevention measures, due to the standard of care, it also covered proper indication for placement; catheter utilization; and early, nurse-driven catheter removal. Additionally, a systemwide aim to decrease catheter utilization is discussed and addressed in start-of-shift huddles, staff meetings, interdisciplinary rounds, and leadership committees. This multidisciplinary approach may have contributed to decreased catheter utilization.

Because learning styles may differ among staff, incorporating a multimodal education approach to CAUTI prevention practices is logical and was a successful strategy in this project for both improving indwelling catheter practices and reducing CAUTI rates. Overall, 80% of staff attended the in-person skills lab on the selected units, and attendance at one of the education programs was slightly less at 69%. There's room for improvement in these participation rates, but the results demonstrate that a large percentage of staff were part of these initiatives, which likely influenced the positive change in CAUTI rates.

Establishing nurse-directed CAUTI bundles including catheter removal protocols is another essential strategy to reduce CAUTI rates that's used within this system. In the literature, this intervention was implemented using a variety of mediums, including automated catheter discontinuation orders, electronic daily checklists or alerts, and nurse-driven protocols for catheter removal.^{3,4,6,7,10-12} As a result of the heightened awareness of appropriate CAUTI practices from this project, healthcare system nursing leadership and CNOs reviewed and revised nursing practice addressing nurse-driven CAUTI bundles, and they continually monitor and reevaluate these practices. Awareness and feedback can't be underestimated during this process. Feedback on the observations was part of the strategy throughout the process. A CNO CAUTI committee and an oversight system committee address all components associated

Figure 1: CAUTI prevention practices

This figure illustrates the difference in the data collected during pre- and post-intervention audits of CAUTI prevention practices.



with the prevention of CAUTIs. The focus on this initiative at all levels of the organization increased awareness and enabled wider dissemination of information.

Sustainability in practice is always a challenge because of the ever-changing landscape within healthcare institutions. Changes in staff due to attrition and competing patient care and institutional priorities are two major challenges faced by acute care organizations, as was the case throughout this healthcare system. These challenges were even more apparent as a result of the COVID-19 pandemic. Offering educational programs more frequently has proven to be a successful strategy for sustaining positive practice changes. In a previous study, biannual training on CAUTI practices has effectively maintained quality CAUTI practices.⁹ Providing education asynchronously via an institution's learning management platform, an option employed in this study, provides flexibility of educational delivery to accommodate caregiver schedules and enables caregivers to learn at their own pace.

In this project, an in-person simulation or skills lab was part of the multimodal educational plan. Interestingly, there was better attendance at the in-person offering, potentially attesting to the staff's desire to learn in a live setting. The importance of in-person education can't be underestimated, especially when clinical/psychomotor skills are the focus. In-person simulation enables the staff to ask questions and receive immediate feedback on clinical skills. For this project,

this was deemed to be a successful strategy.

CAUTIs are a systemwide adverse event, and prevention goes beyond the purview of the nurse. Therefore, engaging staff at all levels including ancillary departments may play a larger role in CAUTI prevention. Compliance to CAUTI practices during patient transports, while in a radiologic test or procedure or during a rehabilitation session is as important as the practices monitored by professional nursing staff when the patient is on the care unit. The inclusion of ancillary and support staff in research or process improvement projects has proven effective in reducing CAUTI rates.^{3,8,13} Therefore, future projects examining the impact of education for all caregivers would be an important next step in sustaining decreases in CAUTI rates. Exploring the impact of patient engagement in CAUTI initiatives is another facet of care to examine in an effort to sustain improvements in CAUTI rates.

Limitations

We acknowledge limitations to this study. First, due to the COVID-19 pandemic, the time frame for interventions had to be adjusted to maintain consistency within the hospital system. The number of RNs who could participate in the online education and the skills lab was lower than anticipated, which can also be attributed to the ongoing pandemic during the project time period. Data analysis was limited to 9 months preintervention and 9 months postintervention. Therefore, sustainability of

CAUTI rates outside of this time frame couldn't be examined.

Finally, because this project was limited to RNs, it's unknown if the inclusion of ancillary staff in the education initiatives would have resulted in greater improvements in CAUTI rates.

Identifying effective strategies

CAUTIs have serious implications for patients and healthcare institutions; therefore, it's imperative to identify and implement strategies that will reduce their occurrence. Through initiatives that standardize CAUTI practices, such as multimodal educational offerings, it was possible for a large healthcare system to achieve a reduction in CAUTI rates. Including all levels of caregivers in CAUTI education to improve systemwide adherence to evidence-based practice holds even greater promise for realizing improved patient outcomes and an overall reduction in healthcare costs. **NM**

REFERENCES

1. National Healthcare Safety Network. Urinary Tract Infection (Catheter associated urinary tract infection [CAUTI] and non-catheter associated urinary tract infection [UTI] events). Centers for Disease Control and Prevention. 2021. www.cdc.gov/nhsn/pdfs/pscmanual/7pscCAUTICurrent.pdf. Accessed November 1, 2023.
2. Agency for Healthcare Research and Quality. Estimating the additional hospital inpatient cost and mortality associated with selected hospital-acquired conditions. 2017. www.ahrq.gov/hai/pfp/haccost2017-results.html. Accessed November 1, 2023.
3. Patel PK, Advani SD, Kofman AD, et al. Strategies to prevent catheter-associated urinary tract infections in acute-care hospitals: 2022 Update. *Infect Control Hosp Epidemiol*. 2023; 44(8):1209-1231.

4. Shadle HN, Sabol V, Smith A, Stafford H, Thompson JA, Bowers M. A bundle-based approach to prevent catheter-associated urinary tract infections in the intensive care unit. *Crit Care Nurse*. 2021;41(2):62-71.
5. Schweiger A, Kuster SP, Maag J, et al. Impact of an evidence-based intervention on urinary catheter utilization, associated process indicators, and infectious and non-infectious outcomes. *J Hosp Infect*. 2020;106(2):364-371.
6. Gupta P, Thomas M, Mathews L, et al. Reducing catheter-associated urinary tract infections in the cardiac intensive care unit with a coordinated strategy and nursing staff empowerment. *BMJ Open Qual*. 2023;12(2):e002214.
7. Van Decker SG, Bosch N, Murphy J. Catheter-associated urinary tract infection reduction in critical care units: a bundled care model. *BMJ Open Qual*. 2021;10(4):e001534.
8. Potugari BR, Umukoro PE, Vedre JG. Multimodal intervention approach reduces catheter-associated urinary tract infections in a rural tertiary care center. *Clin Med Res*. 2020;18(4):140-144.
9. Meneguetti MG, Ciol MA, Bellissimo-Rodrigues F, et al. Long-term prevention of catheter-associated urinary tract infections among critically ill patients through the implementation of an educational program and a daily checklist for maintenance of indwelling urinary catheters: a quasi-experimental study. *Medicine*. 2019;98(8):e14417.
10. Zurmehly J. Implementing a nurse-driven protocol to reduce catheter-associated urinary tract infections in a long-term acute care hospital. *J Contin Educ Nurs*. 2018;49(8):372-377.
11. Giles M, Graham L, Ball J, et al. Implementation of a multifaceted nurse-led intervention to reduce indwelling urinary catheter use in four Australian hospitals: a pre- and postintervention study. *J Clin Nurs*. 2020;29(5-6):872-886.
12. Tyson AF, Campbell EF, Spangler LR, et al. Implementation of a nurse-driven protocol for catheter removal to decrease catheter-associated urinary tract infection rate in a surgical trauma ICU. *J Intensive Care Med*. 2020;35(8):738-744.
13. Davies PE, Daley MJ, Hecht J, et al. Effectiveness of a bundled approach to reduce urinary catheters and infection rates in trauma patients. *Am J Infect Control*. 2018;46(7):758-763.

Mary Beth Russell is a senior vice president at The Center for Professional Development, Innovation, Research and The Institute for Nursing Excellence and a nursing professional development (NPD) specialist at RWJBarnabas Health in West Orange, N.J. Jill Cox is a clinical professor at Rutgers University School of Nursing in Newark, N.J. Naomi Fox is the director of education and a nursing professional development (NPD) specialist at the Association for Nursing Professional Development, Inc. (ANPD) in Chicago, Ill. Nancy E. Holecek is an executive vice president and CNO at RWJBarnabas Health in West Orange, N.J.

The authors have disclosed no financial relationships related to this article.

DOI-10.1097/nmg.0000000000000147