

Preventing Catheter-Associated Urinary Tract Infections in the Pediatric Intensive Care Unit

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BACKGROUND Catheter-associated urinary tract infections are common health care–associated infections and have been associated with increased mortality, morbidity, length of stay, and cost. Prevention strategies are grouped into bundles focused on reducing unnecessary catheter use and promptly removing urinary catheters. Before intervention in the study institution, no urinary catheters were unnecessarily used and compliance with the catheter-associated urinary tract infection bundle was 84%.

OBJECTIVE To increase bundle compliance by using targeted rounds specifically focused on eliminating dependent loops in drainage tubing and ensuring appropriate catheter use to reduce the incidence of catheter-associated urinary tract infections.

METHODS A multidisciplinary team was formed to identify misperceptions, highlight best practices, and eliminate barriers to success over 1 year in a single pediatric intensive care unit. The team completed a quality improvement project of daily targeted rounding for patients with an indwelling urinary catheter. The goals were to assess appropriateness of catheterization, increase bundle compliance, and decrease catheter-associated urinary tract infection risk. Targeted rounds were conducted in addition to the medical team rounds.

RESULTS Bundle compliance supported by targeted rounding increased from 84% to 93% and helped reduce the overall catheter-associated urinary tract infection rate from 2.7 infections per 1000 catheter-days at baseline to 0. This change was sustained for 1 year.

CONCLUSION Targeted rounding for pediatric patients with an indwelling urinary catheter is an effective and sustainable strategy to reduce catheter-associated urinary tract infections. The ease of implementation for this intervention lends itself to generalizability to other patient populations. (*Critical Care Nurse*. 2020;40[1]:e12-e17)

Hhealth care–associated infections (HAIs) are common complications for hospitalized patients in the United States.¹ Indwelling devices, such as urinary catheters, increase the risk of infection in critically ill patients. Catheter-associated urinary tract infection (CAUTI) is one of the most common device-related HAIs, accounting for more than 30% of all acute care hospital infections.¹

Multiple national agencies, including The Joint Commission with its National Patient Safety Goals, have underscored the need to reduce CAUTI rates.² CAUTIs have been associated with increased mortality, morbidity, bacterial resistance, length of stay, and cost.³ Annually, 13 000 deaths are attributed to urinary tract infections and an estimated 450 000 CAUTI events occur.^{4,5} Approximately \$1.7 billion of direct health care costs in the United States can be attributed to CAUTIs each year.⁵

Research and quality improvement initiatives reported in the literature have primarily been aimed at preventing CAUTIs in adults. Few studies of epidemiology or prevention in the pediatric population have been published.⁶ Therefore, national guidelines for CAUTI prevention are based largely on data from studies in adults.⁷ The National Healthcare Safety Network demonstrated that pooled mean CAUTI rates were similar in adults and children. The national pooled mean for pediatric intensive care units (PICUs) was 2.5 infections per 1000 catheter-days.^{1,8} In a recent study of 2150 CAUTI events in 10 hospitals, 83% of cases were reported in PICUs, as compared with 13% reported in pediatric inpatient units.⁸

Prevention strategies for CAUTIs and other HAIs have been grouped into bundles, a concept developed by the Institute for Healthcare Improvement to describe structured processes for group interventions.⁹ Although a

variety of CAUTI bundles exist, many stress 2 key principles: reducing unnecessary catheter use and ensuring prompt removal of urinary catheters.^{7,10} Despite early success with CAUTI prevention bundles to reduce urinary catheterization rates, CAUTI prevention remains challenging. According to the National Healthcare Safety Network HAI progress report, overall CAUTI rates did not change from 2009 to 2014.^{1,6}

In 2008, the Centers for Medicare & Medicaid Services instituted a policy of nonpayment for HAIs, including CAUTIs,¹¹ and in 2012 the agency started the Hospital Value-Based Purchasing Program to offer financial incentives based on patient care experiences, clinical process of care, and outcomes.¹⁰ Interest in CAUTI prevention has therefore been renewed, spurring further research and quality improvement projects.

Patients without a urinary catheter will not develop a CAUTI. Studies in adults have shown that up to 50% of patients with an indwelling urinary catheter (IUC) do not have an appropriate indication for an IUC.¹⁰ However, the same result was not found in a pediatric study in which more than 90% of patients had an appropriate indication

for an IUC.⁷ Appropriate indications for IUCs are surgical procedures, need

Engaging multidisciplinary team members and leaders from all levels is vital to the sustained success of CAUTI prevention.

for continuous urine monitoring, presence of acute urinary retention or obstruction, healing pressure ulcers in incontinent patients, need to improve end-of-life comfort, presence of an abnormal genitourinary system, and administration of caustic chemotherapy agents.⁷

Although educational interventions are an easy first step in decreasing unnecessary catheter use, more complex strategies are often needed to ensure sustainability.¹⁰ Engaging the leadership team in harm prevention is vital to implement and sustain interventions aimed at decreasing HAIs and is important to ensure the success of new patient safety initiatives.^{12,13} Purvis et al¹³ found that CAUTI prevention strategies implemented in isolation and without engagement of the leadership team did not reduce CAUTI rates. We used our institution's quality improvement framework to design an intervention that engaged the leadership team and a multidisciplinary team. We implemented targeted rounds to increase bundle compliance and reduce

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unnecessary catheter use, aiming to ultimately reduce CAUTI incidence.

Methods

This project was conducted in a 55-bed PICU within a large (520-bed), urban, academic quaternary care hospital in the mid-Atlantic region. Our PICU accepts 3500 admissions per year. The PICU is staffed by 30 faculty members, 19 fellows, and more than 20 nurse practitioners in pediatric critical care medicine and by rotating residents and fellows in pediatrics, emergency medicine, and anesthesiology. Patients are cared for by 275 pediatric critical care nurses. In the 9 months before intervention (July 2014-March 2015), our PICU averaged 195 IUC days per month. All patients in the PICU had appropriate indications for catheter placement.

The PICU CAUTI working group consisted of an attending physician, nurse practitioner, unit-based clinical nurse specialist, unit-based safety quality specialist, clinical nurse leader, staff nurse, infection control specialist, executive sponsor, and data analyst. The team met 1 to 2 times per month for a year to track progress and make any needed modifications.

Although targeted rounding has not been comprehensively reported in published studies, we implemented targeted rounds for patients with an IUC to support bundle compliance. We used targeted rounds to provide a systematic approach to rounding only for patients with an IUC to ensure that their catheter care adhered to the bundle elements. The bundle, which was implemented in October 2010, included the following elements: ensuring that the urinary catheter was secure, documenting

Daily targeted rounds and real-time training helped achieve and sustain a rate of 0 CAUTIs for more than a year.

urinary catheter care, ensuring that the urinary drainage bag was

below the level of the bladder, ensuring that the drainage collection tubing had no dependent loops, and checking that the patient still met criteria to keep the IUC in place. Dependent loops occur when the IUC forms a *U* shape, impeding the flow of urine from the bladder into the drainage bag. Compliance with the CAUTI bundle was calculated as the percentage of patients with an IUC for whom all 5 of the bundle elements were met during rounding and chart review. In March 2015, the PICU CAUTI team leader began conducting targeted rounds

for patients with an IUC. It quickly became apparent that relying on 1 person was not a practical way to create change. A multidisciplinary approach was needed, and engagement of nurses and physicians was vital to success.

In March 2016, the PICU CAUTI working group formalized a daily targeted rounding plan for all patients with an IUC. Each clinical member of the PICU CAUTI working group was assigned a day to conduct rounds each week. Rounds occurred at least once per day and included education (real-time training) for all nurses caring for a patient with an IUC. The duration of rounds varied according to the number of patients with an IUC but averaged less than 5 minutes per patient.

To evaluate the impact of targeted rounding for CAUTI prevention, our team examined overall CAUTI bundle compliance as well as each individual bundle component to identify areas for improvement. We tracked the CAUTI count (the raw number of infections) and the CAUTI rate (the number of infections divided by the number of opportunities) as balancing metrics, expecting that higher bundle compliance would result in fewer CAUTIs and a lower CAUTI rate.

Intervention

The targeted rounds focused on bundle compliance, real-time training, and the indications for IUC use. Real-time training covered any bundle element with an opportunity for improvement. Topics included risks of CAUTI, the need for an IUC, catheter securement, and strategies to eliminate dependent loops in the tubing.

We built a Harm Prevention Data Review dashboard with the support of a data analyst from the Office of Clinical Quality Improvement and an improvement advisor from the Office of Safety and Medical Operations. Before this dashboard was available, we had no systematic way to easily share data across the institution, making it hard to spread information readily to the frontline staff every day. Through this work, our team was able to measure and track bundle compliance and CAUTI rate and to access bedside review data. The dashboard collates data from a variety of sources such as the electronic health record and secure electronic surveys and displays the data comprehensively, allowing anyone in the institution to see a clear snapshot of the harm metrics updated daily. As a result, we could review compliance and outcome trends in real time and take a more proactive approach to CAUTI prevention.

Table Compliance with catheter-associated urinary tract infection bundle components by fiscal year

Component	FY 2015		FY 2016		FY 2017	
	Count ^a	Percentage	Count ^a	Percentage	Count ^a	Percentage
Overall CAUTI bundle compliance ^b	358/467	77	325/386	84	208/223	93
Checking that catheter is secure	462/467	99	385/386	100	220/223	99
Documenting urinary catheter care	420/466	90	374/386	97	219/223	98
Ensuring that drainage bag is below bladder level	437/437	100	373/373	100	223/223	100
Avoiding dependent loops in drainage tubing	377/438	86	327/373	88	214/223	96
Checking that criteria for catheter are met	459/467	98	384/386	99	222/223	100

Abbreviations: CAUTI, catheter-associated urinary tract infection; FY, fiscal year.

^a Count indicates the number of bundle audits completed.

^b Overall CAUTI bundle compliance is not a simple mean of all of the bundle components. Failure to meet more than 1 bundle component in the same patient has a cumulative effect, reducing the calculated overall CAUTI bundle compliance.

Measures and Analysis

We collected data from at least 20 IUCs per month to track bundle compliance and CAUTI rate. To ensure accurate sampling of our patient population, the team entered data from 1 critically ill patient, 3 moderate-acuity patients, and 1 low-acuity patient per week.

We analyzed our hospital process metrics by using a data visualization tool that captured bundle compliance measures obtained from secure electronic surveys to identify bundle components that were most often missed in the audits (a major contributor to noncompliance was dependent loops in the tubing). We focused daily targeted rounds and follow-up education practices on these components. We also continuously tracked the audit data and outcomes to determine if our targeted rounding and real-time training was making a difference. Tracking our outcomes revealed a significant decrease in CAUTIs over time. The PICU CAUTI working group tracked the data and discussed them at each meeting. In accordance with institutional standards, this project was considered quality improvement and did not necessitate institutional review board oversight.

Results

Between July 2014 and June 2017, bundle compliance in the PICU increased (77% in fiscal year 2015, 84% in fiscal year 2016, and 93% in fiscal year 2017). We tracked overall CAUTI bundle compliance according to individual bundle components to identify areas of improvement (see Table). Compliance for avoiding dependent loops in the drainage collection tubing (ie, no urine stasis in the

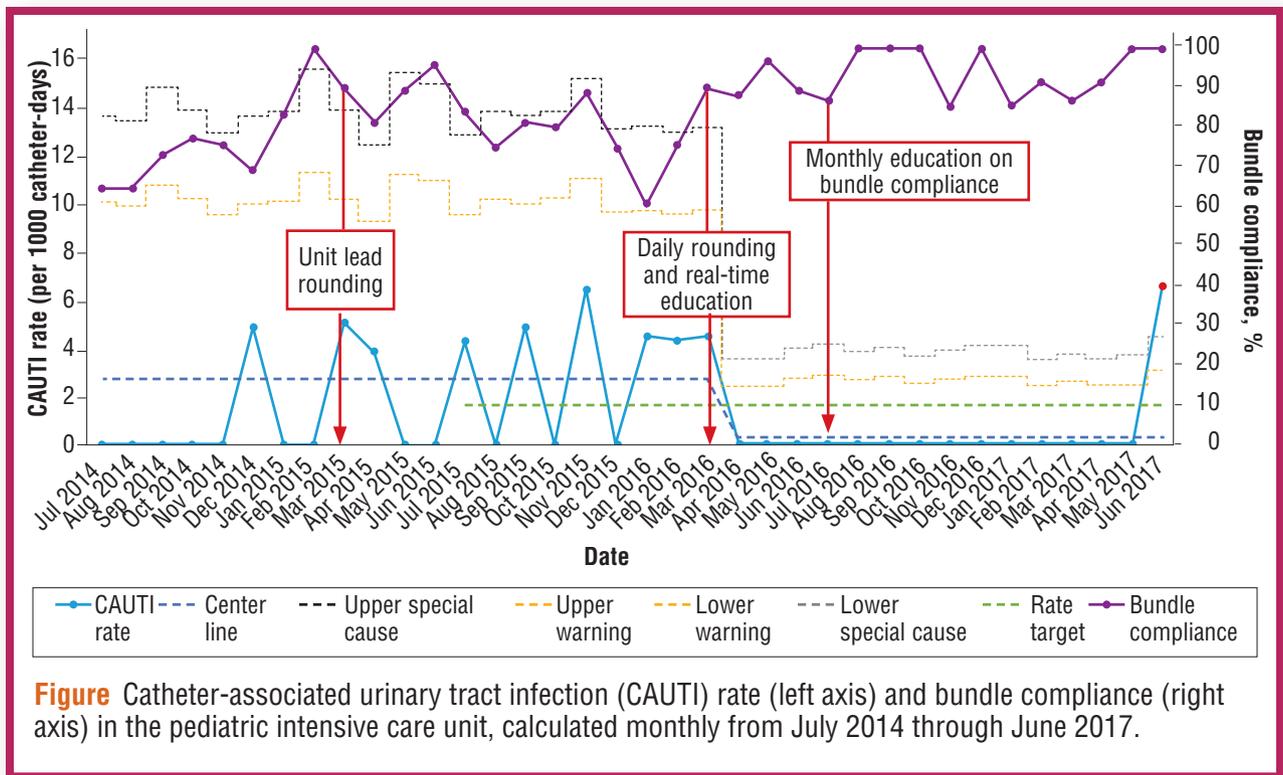
tubing) reached 96% in fiscal year 2017, an improvement over the 88% compliance in fiscal year 2016. This particular bundle element drove our overall bundle compliance, which was 93% for fiscal year 2017 (see Table). Additionally, in the 27 months after implementing the intervention (April 2015 through June 2017), our PICU averaged 208 IUC days per month.

Before implementing daily targeted rounds, our unit's overall CAUTI rate was 2.7 infections per 1000 catheter-days. After implementing daily targeted rounds and real-time training, we sustained a rate of 0 CAUTIs for more than 1 year (see Figure). The rate of IUC use did not change over time until June 2017. In June 2017, our IUC use decreased by approximately 50% and 1 patient developed a CAUTI, leading to a higher CAUTI rate. Targeted rounds also provided an opportunity to highlight best practices and congratulate staff on providing excellent care when all bundle elements reached full compliance. For continued success, we disseminated monthly emails starting in July 2016 to highlight CAUTI bundle compliance and best practices and to provide education on areas for improvement.

Discussion

Targeted rounding has been very successful, and we have continued this practice with the goal of sustaining a low CAUTI rate. The PICU has become a model of best practices and improving harm prevention throughout the organization.

Over time, several themes consistent with the results of previous studies emerged from our targeted rounds.



As with another study of pediatric patients,⁷ all of our patients had a recognized indication for an IUC. Our results also demonstrated a relationship between infection rates and bundle compliance; as bundle compliance increased, CAUTI rates decreased.^{14,15} After completing daily targeted rounds for a full year, we identified eliminating dependent loops in the drainage tubing as a consistent area for improvement. This bundle component was also a factor in a recent study in which 85% of patients with an IUC had a dependent loop in the drainage tubing.¹⁶ According to the results of our quality improvement project and those of other studies,^{12,17} engaging multidisciplinary team members and leaders from all levels is vital to the sustained success of CAUTI prevention. We attribute our success in increasing compliance with the bundle element of avoiding dependent tubing loops on real-time training and adding pictures of proper drainage gradients to our nursing procedures.

The generalizability of targeted rounding as an intervention to reduce CAUTIs may be limited because this quality improvement project was conducted in only 1 PICU. However, the ease of implementation for this intervention lends itself to generalizability within other populations. Targeted rounding was a feasible intervention for our team because it was not time intensive, it focused on a small population of patients, and

many team members could share the responsibility of conducting rounds.

Conclusions

Lowering CAUTI rates requires an interdisciplinary approach to implement a care bundle aimed at reducing unnecessary catheter use, maintaining high standards of urinary catheter care, and ensuring prompt removal of the IUC when it is no longer needed. In addition to the bundle, conducting targeted rounds for patients with an IUC is an effective and sustainable strategy to reduce the most prevalent HAI in the United States. Implementing this quality improvement project, which combines targeted rounds with attention to care bundle compliance, can help achieve and sustain a reduction in CAUTI rates. **CCN**

Financial Disclosures
None reported.

See also

To learn more about catheter-associated urinary tract infections, read “Zeroing in on Safety: A Pediatric Approach to Preventing Catheter-Associated Urinary Tract Infections” by Williams in *AACN Advanced Critical Care*, October-December 2016;27:372-378. Available at **www.aacnconline.org**.

References

1. Dudeck MA, Edwards JR, Allen-Bridson K, et al. National Healthcare Safety Network report, data summary for 2013, device-associated module. *Am J Infect Control*. 2015;43(3):206-221.

2. The Joint Commission. National Patient Safety Goals. The Joint Commission 2016. https://www.jointcommission.org/assets/1/6/2016_NPSG_HAP_ER.pdf. Accessed November 11, 2019.
3. Sönmez Düzkaaya D, Bozkurt G, Uysal G, Yakut T. The effects of bundles on catheter-associated urinary tract infections in the pediatric intensive care unit. *Clin Nurse Spec*. 2016;30(6):341-346.
4. Klevens RM, Edwards JR, Richards CL Jr, et al. Estimating health care-associated infections and deaths in U.S. hospitals, 2002. *Public Health Rep*. 2007;122(2):160-166.
5. Hollenbeak CS, Schilling AL. The attributable cost of catheter-associated urinary tract infections in the United States: a systematic review. *Am J Infect Control*. 2018;46(7):751-757.
6. Patrick SW, Kawai AT, Kleinman K, et al. Health care-associated infections among critically ill children in the US, 2007-2012. *Pediatrics*. 2014;134(4):705-712.
7. Davis KF, Colebaugh AM, Eithun BL, et al. Reducing catheter-associated urinary tract infections: a quality-improvement initiative. *Pediatrics*. 2014;134(3):e857-e864. doi:10.1542/peds.2013-3470
8. Lake JG, Weiner LM, Milstone AM, Saiman L, Magill SS, See I. Pathogen distribution and antimicrobial resistance among pediatric healthcare-associated infections reported to the National Healthcare Safety Network, 2011-2014. *Infect Control Hosp Epidemiol*. 2018;39(1):1-11.
9. Resar R, Pronovost P, Haraden C, Simmonds T, Rainey T, Nolan T. Using a bundle approach to improve ventilator care processes and reduce ventilator-associated pneumonia. *Jt Comm J Qual Patient Saf*. 2005; 31(5):243-248.
10. Meddings J, Rogers MA, Krein SL, Fakh MG, Olmsted RN, Saint S. Reducing unnecessary urinary catheter use and other strategies to prevent catheter-associated urinary tract infection: an integrative review. *BMJ Qual Saf*. 2014;23(4):277-289.
11. McNair PD, Luft HS, Bindman AB. Medicare's policy not to pay for treating hospital-acquired conditions: the impact. *Health Aff (Millwood)*. 2009;28(5):1485-1493.
12. Krein SL, Kowalski CP, Harrod M, Forman J, Saint S. Barriers to reducing urinary catheter use: a qualitative assessment of a statewide initiative. *JAMA Intern Med*. 2013;173(10):881-886.
13. Purvis S, Kennedy GD, Knobloch MJ, et al. Incorporation of leadership rounds in CAUTI prevention efforts. *J Nurs Care Qual*. 2017;32(4):318-323.
14. Kachare SD, Sanders C, Myatt K, Fitzgerald TL, Zervos EE. Toward eliminating catheter-associated urinary tract infections in an academic health center. *J Surg Res*. 2014;192(2):280-285.
15. Conway LJ, Pogorzelska M, Larson E, Stone PW. Adoption of policies to prevent catheter-associated urinary tract infections in United States intensive care units. *Am J Infect Control*. 2012;40(8):705-710.
16. Danek G, Gravenstein N, Lizdas DE, Lamptang S. Prevalence of dependent loops in urine drainage systems in hospitalized patients. *J Wound Ostomy Continence Nurs*. 2015;42(3):273-278.
17. Zavalkoff S, Korah N, Quach C. Presence of a physician safety champion is associated with a reduction in urinary catheter utilization in the pediatric intensive care unit. *PLoS One*. 2015;10(12):e0144222.