

Entering a No Diaper Zone: Rethinking Prevention of Catheter-Associated Urinary Tract Infection

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BACKGROUND Catheter-associated urinary tract infections are a leading hospital-acquired infection and are a major cause of increased morbidity, mortality, and health care costs, with 83% of pediatric cases occurring in pediatric intensive care units. Indwelling urinary catheters are widely used in adult and pediatric patients to accurately monitor urine output and manage fluid balance.

LOCAL PROBLEM Staffing challenges and high nurse turnover in a 56-bed pediatric intensive care unit led to inconsistencies in practices to prevent catheter-associated urinary tract infection. Stool contamination from diapers used alongside indwelling urinary catheters increased the risk of infection.

METHODS An interprofessional team designed a comprehensive catheter-associated urinary tract infection prevention strategy through plan-do-study-act cycles. Compliance was tracked through electronic surveys during catheter-associated urinary tract infection huddles, bedside infection prevention rounds, and bundle audits, with statistical process control charts used to measure infection rates before and after implementation of interventions. Interventions consisted of introduction of an exploratory no-diapering protocol, use of an advanced indwelling urinary catheter drainage system, and consistent staff reeducation.

RESULTS The rate of catheter-associated urinary tract infection decreased from 3.13 to 0 per 1000 catheter days, with 527 event-free days (about 1.5 years).

CONCLUSION The combination of an advanced indwelling urinary catheter drainage system, elimination of diapers, and structured staff reeducation reduced the rate of catheter-associated urinary tract infection in the pediatric intensive care unit. This approach has potential for application in both pediatric and adult critical care settings to reduce infection rates and improve patient outcomes. (*Critical Care Nurse*. 2025; 45[4]:21-28)

Hhealth care–associated infections (HAIs) are acquired during hospitalization and substantially increase morbidity, mortality, length of stay, and antibiotic use while costing US health systems more than \$28 billion annually.^{1,3} Surveillance by the National Healthcare Safety Network of the Centers for Disease Control and Prevention has indicated that catheter-associated urinary tract infections (CAUTIs) are the second most common type of HAI occurring in adults and the third most common

in children, with 83% of pediatric CAUTI cases occurring in pediatric intensive care units (PICUs).^{2,4-6} In PICUs, CAUTI rates range from 1.4 to 3.1 per 1000 catheter days, comparable to those in adult ICUs. However, given that the rate of use of indwelling urinary catheters is lower in pediatric patients than in adult patients, the relative burden of CAUTIs in the pediatric population is high.⁷ National guidelines for prevention of HAIs, particularly CAUTIs, are based largely on data from adult populations, highlighting the need for pediatric-specific strategies.^{1,4,5}

In ICUs, indwelling urinary catheters are essential for precisely monitoring urine output, which is vital for assessing kidney function, guiding fluid therapy, and managing electrolyte imbalances in conditions such as acute kidney injury, diabetes insipidus, sepsis, and major surgery.^{8,9} However, these devices are also a major source of infection. CAUTIs occur when pathogens such as stool-borne *Escherichia coli* enter the urinary tract via

the catheter; the resulting infections may involve antibiotic-resistant bacteria

and severe complications such as pyelonephritis and urosepsis.¹⁰ Urine stasis and reflux, which occur with gravity-based drainage systems because of positioning, dependent loops, or transport, may contribute to bacterial colonization and CAUTI development.¹¹ Although

CAUTI prevention strategies include care bundles that emphasize aseptic catheter insertion, proper maintenance, and regular assessment of necessity.

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pediatric-specific case-fatality data are limited, studies in adults have indicated urosepsis case-fatality rates as high as 32%, demonstrating the seriousness of CAUTI-related complications and the importance of robust prevention strategies.¹²

Pediatric patients, defined by the American Academy of Pediatrics as individuals from birth up to age 21 years,¹³ require careful consideration with regard to CAUTI prevention. Diapers are commonly used in both adult and pediatric ICUs to manage stool for incontinent and sedated patients; however, the warm, moist environment of a diaper can promote the growth of bacteria such as *E coli*.^{10,14} Traditional CAUTI prevention strategies often fail to address contamination risks from stool exposure, particularly with diaper use. Although direct evidence linking diaper use to CAUTI incidence is limited, studies suggest that prolonged diaper use may increase UTI risk in pediatric populations, highlighting the need for strategies to minimize bacterial contamination of urinary catheters.¹⁵⁻¹⁷

Standard CAUTI prevention strategies include care bundles that emphasize aseptic catheter insertion, proper maintenance, regular assessment of necessity, timely removal, securement, and ensuring that the collection bag remains below the bladder level.^{1,17} Reactive measures, such as CAUTI huddles, involve case reviews, real-time data analysis, and a root-cause analysis to identify lapses and develop targeted interventions after a CAUTI occurs.¹⁸ Despite these efforts, high CAUTI rates remain a persistent problem, highlighting the need for additional strategies. The challenge is particularly acute in the pediatric population, for which guidelines are rarely validated.¹⁹

The importance of nursing care to prevent CAUTIs through evidence-based practices and a culture of safety has been well established.^{2,20} Yet the shifting circumstances throughout the COVID-19 pandemic, including staffing shortages, nurse burnout, and high turnover, further compounded CAUTI prevention challenges.²¹ Hospitals have relied on implementing care bundles and educational initiatives to change practice, but given the increasing complexity of patient conditions combined with staffing challenges, innovative strategies in addition to care bundles and education are warranted.²²

Local Problem

During the COVID-19 pandemic, our institution, like many others, experienced staffing challenges.²³ High nurse turnover and an influx of less experienced staff members

unfamiliar with CAUTI protocols led to inconsistencies in care practices. Concurrently, the combined use of indwelling urinary catheters and diapers increased the risk of stool contamination, a well-documented contributor to CAUTIs.¹⁴ In 2020, the annual CAUTI rate in the PICU rose to 3.13 per 1000 catheter days, culminating in a peak rate of 4.47 per 1000 catheter days in the first quarter of 2021 (see Table). Recognizing these challenges, health care system leaders formed a CAUTI task force to reevaluate prevention strategies and explore innovative approaches to infection control.

Methods

This quality improvement (QI) project was conducted in a 56-bed PICU within a 370-bed tertiary care children's hospital in a metropolitan area of the southeastern United States. The hospital serves a diverse population of critically ill pediatric patients with high-acuity medical and surgical conditions, including acute respiratory failure, sepsis, neurologic impairment, and trauma-related injuries. The project was guided by an interprofessional CAUTI task force composed of PICU nursing leaders, physicians, epidemiologists, supply chain specialists, informatics experts, and QI staff members. The task force met every 6 weeks to review progress, address challenges, and refine strategies as needed. These reviews incorporated data from post-CAUTI huddles and other QI measures to inform the design and sustainment of targeted interventions. The plan-do-study-act (PDSA) framework was used to implement and refine interventions, targeting identified gaps in practice and potential sources of catheter contamination.^{17,24} These interventions included the removal of diapers for patients with urinary catheters, the implementation of an advanced indwelling urinary catheter drainage system (Accuryn Monitoring System; Accuryn Medical), and comprehensive education efforts to reinforce CAUTI prevention protocols.^{24,25}

Established practices in the PICU included CAUTI maintenance care bundles, routine hygiene practices, post-CAUTI huddles, an early removal protocol, and weekly infection prevention rounds.²⁶ Post-CAUTI huddles were conducted after each CAUTI event, which was identified using the National Healthcare Safety Network CAUTI module.²⁷ These huddles brought together task force members to perform a root-cause analysis, involving a detailed review of the incident, bedside nurse surveys,

Table Quarterly and annual breakdown of catheter-associated urinary tract infections (CAUTIs) by catheter days, events, and rates in the pediatric intensive care unit

| Year | Quarter | Catheter days | CAUTI events | Rate per 1000 catheter days |
|------|---------------------|---------------|--------------|-----------------------------|
| 2020 | 1 | 278 | 1 | 3.60 |
| | 2 | 256 | 1 | 3.91 |
| | 3 | 383 | 1 | 2.61 |
| | 4 | 360 | 1 | 2.78 |
| | Annual total | 1277 | 4 | 3.13 |
| 2021 | 1 | 447 | 2 | 4.47 |
| | 2 | 347 | 0 | 0.00 |
| | 3 | 494 | 1 | 2.02 |
| | 4 | 351 | 1 | 2.85 |
| | Annual total | 1639 | 4 | 2.44 |
| 2022 | 1 | 410 | 0 | 0.00 |
| | 2 | 456 | 0 | 0.00 |
| | 3 | 393 | 2 | 5.09 |
| | 4 | 341 | 0 | 0.00 |
| | Annual total | 1600 | 2 | 1.25 |
| 2023 | 1 | 440 | 0 | 0.00 |
| | 2 | 431 | 0 | 0.00 |
| | 3 | 372 | 0 | 0.00 |
| | 4 | 575 | 0 | 0.00 |
| | Annual total | 1818 | 0 | 0.00 |

and record audits to identify contributing factors and lapses in care. The early removal protocol required reassessment of catheter necessity every 12 hours, with timely removal of catheters when they were no longer indicated. Health care professionals placed standing orders for early catheter removal, empowering nurses to act independently within established criteria. Patients needing prolonged catheterization, such as those undergoing genitourinary surgery, extracorporeal membrane oxygenation, or anticoagulation therapy, were excluded. By integrating the key targeted interventions with established practices and reinforcing them through continuous QI measures, we sought to address persistent CAUTI challenges and create a sustainable framework for infection prevention.

Interventions

During post-CAUTI huddles, the task force identified a recurrent pattern of documented liquid stool occurrences among patients with CAUTI, leading to the hypothesis that catheter contamination from stool was contributing to infection rates. In March 2021, as part of a PDSA cycle, the epidemiologist proposed complete removal of diapers for PICU patients with indwelling urinary catheters. The

No Diaper Zone intervention was a new approach aimed at addressing a gap in CAUTI prevention strategies not commonly discussed in existing guidelines.^{4,6} To manage stool, patients were placed on highly absorbent pads, which were changed daily with linens. Monitoring for stool every 2 hours during vital sign checks and position changes enabled prompt recognition and cleaning, reducing prolonged exposure. Nurses maintained patient privacy and dignity with strategic use of blanket draping, positioning

Staff member reeducation efforts were conducted at the bedside during weekly infection prevention rounds, where they received real-time teaching.

techniques, and ensuring minimal exposure during care. Although evidence supporting diaper removal for CAUTI prevention is limited, this intervention was implemented to address a plausible risk based on observed patterns of fecal contamination. This proactive and innovative addition to existing CAUTI prevention practices combined vigilant nursing care, standards for pad changes, and consistent monitoring as a flexible method of reducing catheter contamination risk.

In April 2021, following approval by the organization's value analysis team, a PDSA cycle was instituted in the PICU and cardiac ICU to trial the Accuryn Monitoring System.^{28,29} The devices were provided by the manufacturer for the duration of the trial, along with educational support. Manufacturer representatives conducted hands-on training sessions during day and night shift nursing huddles, supplemented by training materials, which featured step-by-step instructions, frequently asked questions, visuals, and a reference guide.²⁸ The Accuryn system was chosen because of its ability to address known CAUTI risk factors, such as urine backflow and stagnation, and replace traditional gravity-dependent urine collection bags. Through the use of gentle suction and 3 one-way valves, it maintains continuous urine flow and prevents urinary reflux.^{24,25,29} Additionally, its integrated sensors provide accurate hourly urine output data, displayed digitally. After the receipt of positive staff feedback on ease of use and improved urine output monitoring, the system was implemented in August 2021 in the PICU, cardiac ICU, and operating room. The task force established criteria for use: patients with urinary catheters in place for more than 72 hours were transitioned to the Accuryn system. The decision was

guided by internal huddle data that identified increased CAUTI risk after 3 days of indwelling catheterization. The Accuryn system remains in continuous use to date, with ongoing reinforcement during infection prevention rounds to ensure proper adherence to protocols.

In response to the continued influx of new staff members, another PDSA cycle was implemented in 2022 that focused on educating and reeducating new and existing staff members on CAUTI prevention practices. This cycle focused on reinforcing the critical aspects of the No Diaper Zone initiative and the consistent use of the Accuryn system. Staff member reeducation efforts were conducted at the bedside during weekly infection prevention rounds, where they received real-time teaching on rationale and proper technique. This hands-on approach allowed for immediate feedback, clarification of gaps in practice, and reinforcement of best practices.³⁰ To ensure that new staff members were appropriately trained from the beginning, CAUTI prevention strategies were integrated into orientation programs. Parent education surrounding the No Diaper Zone began with the initial removal of diapers in 2021. Parent reeducation emphasized a collaborative approach to discontinuing the use of diapers in the presence of urinary catheters, the importance of reducing contamination risks, and parents' role in supporting care. This multifaceted education process was vital in maintaining adherence to best practices and ensuring the effectiveness of the prevention strategies despite the challenges posed by staff turnover.

Measures

To monitor adherence to key interventions and track their consistent use in practice, process measures were defined as compliance with Accuryn system use and adherence to CAUTI bundle elements. Compliance rates, expressed as percentages, represented the proportion of patients observed or audited who met the criteria for each intervention. Process measures were tracked through REDCap (Research Electronic Data Capture) surveys completed during both observational CAUTI maintenance bundle audits and weekly infection prevention rounds. CAUTI maintenance bundle audits used direct peer observation, electronic medical record system review, and audit bundle cards and were then recorded in a REDCap survey to ensure standardized and objective data collection. However, observer variability was acknowledged as a potential limitation.

In 2022, the REDCap survey used during infection prevention rounds was updated as part of a PDSA cycle to incorporate questions specifically assessing staff adherence to the implemented intervention. The updated survey included the following questions: (1) Has the catheter been in place for more than 72 hours? (2) Is the Accuryn drain in place? (3) Is the Foley catheter still necessary? (4) Is the early removal protocol in place? (5) Are there alternatives to the catheter? (6) What concerns for CAUTI does the bedside nurse have?

To facilitate these rounds, a customized electronic medical record system report was created to help identify patients who were at an elevated risk of infection based on clinical indicators. Because these rounds occurred only once weekly, the data collected were limited and might not fully represent overall unit compliance. Compliance with the No Diaper Zone intervention was assessed qualitatively during infection prevention rounds and through CAUTI huddle data collected for patients with an identified CAUTI. CAUTI huddles included assessment of stool management strategies, with a specific focus on whether diapers were removed. However, systematic tracking of diaper protocol compliance was not included in the infection prevention rounding REDCap survey because of its unit-specific implementation. The primary outcome measure for this project was the incidence of CAUTIs, expressed as number of infections per 1000 catheter days. The secondary outcome was the number of days between CAUTI incidences.

Data collection tools included REDCap, a secure, web-based platform hosted at our institution. It is designed to facilitate data capture for research, offering an easy-to-use interface for validated data collection, audit trails for tracking data handling, automated export options for seamless data downloads to statistical software, and integration capabilities with external sources.³¹ Results from CAUTI maintenance bundle audits were integrated into Qlik Analytics, a platform designed for the acquisition of business intelligence, which provided real-time visualization of compliance trends through a customized HAI dashboard.³² The dashboard displays overall compliance percentages for CAUTI bundle adherence, as well as breakdowns of individual bundle components to identify areas needing additional improvement.

Analysis

To evaluate the impact and sustainability of the interventions, we performed statistical process control analysis,

with data plotted on a process control chart (u-chart), using QI Macros, Lean Six Sigma, and statistical process control chart Microsoft Excel add-on software. This project was reviewed by the Children's Healthcare of Atlanta institutional review board and determined to be non-human subjects research.

Results

The PDSA reporting period spanned 4 calendar years (January 2020 through December 2023), capturing more than 16 quarters of CAUTI outcome and compliance data. In 2020, the PICU baseline CAUTI rate was 3.13 per 1000 catheter days, with a total of 4 events and an average of 92 days between events. A special cause decrease in catheter days was observed during this period. In 2021, when interventions including the No Diaper Zone and the Accuryn Monitoring System were initiated, the CAUTI rate decreased by 22% to 2.44 per 1000 catheter days, with an average of 129 days between CAUTI events. A special cause variation occurred in the second quarter, with no CAUTI events recorded. An event-free period of approximately 240 days followed, from November 2021 to July 2022, after which 2 CAUTI events occurred within 8 days during July 2022. In 2022, the CAUTI rate further declined to 1.25 per 1000 catheter days, which is a statistically significant improvement.

During 2023, the postintervention period, the PICU achieved a rate of 0 per 1000 catheter days (Figure 1). A further illustration of the long-term impact of interventions appears in Figure 2, which shows an increase in days between CAUTI events, culminating in 527 event-free days.

Compliance with CAUTI maintenance bundle elements remained stable throughout the intervention period, averaging 93% from 2020 to 2023, as determined by peer observations. Use of the Accuryn system was tracked beginning in August 2022, with 70% (n = 20) compliance through December 2022 and 69% (n = 117) in 2023.

Discussion

This QI project highlights the vital role of nursing innovation in implementing tailored, unit-specific interventions to reduce CAUTI rates in the PICU. The combined

The primary outcome measure for this project was the incidence of CAUTIs; the secondary outcome was the number of days between CAUTI incidences.

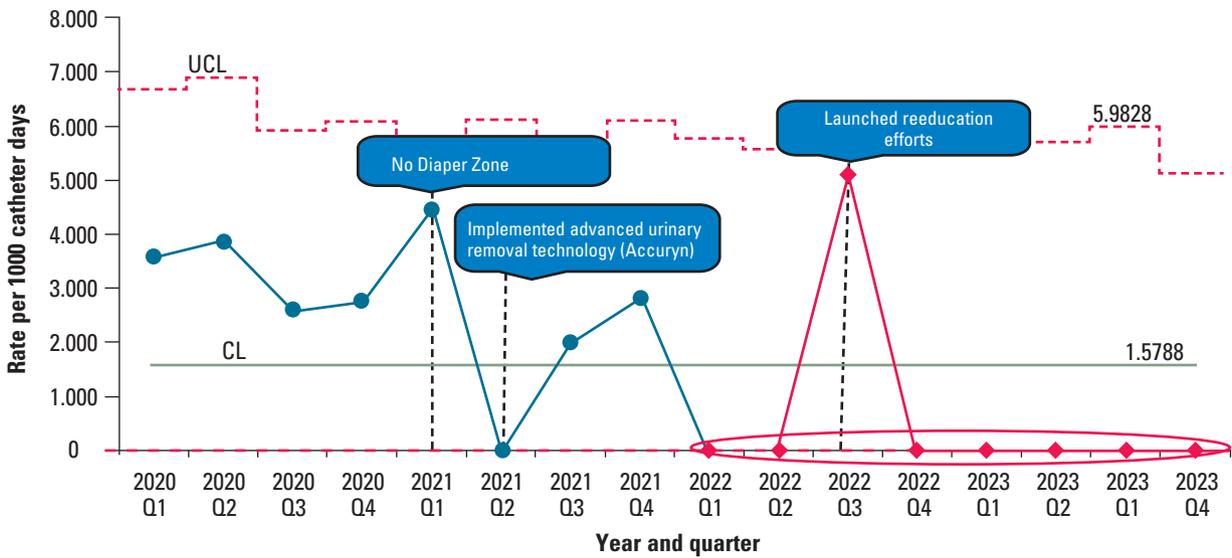


Figure 1 Catheter-associated urinary tract infection (CAUTI) rates in the pediatric intensive care unit from 2020 to 2023. This statistical process control chart displays quarterly CAUTI rates per 1000 catheter days, annotated with intervention milestones. The chart highlights the sustained reduction in CAUTI rates, with a center line (CL) of 1.58 and an upper control limit (UCL) demonstrating process variation over time. The effectiveness of the interventions is reflected in the prolonged event-free periods after the intervention.

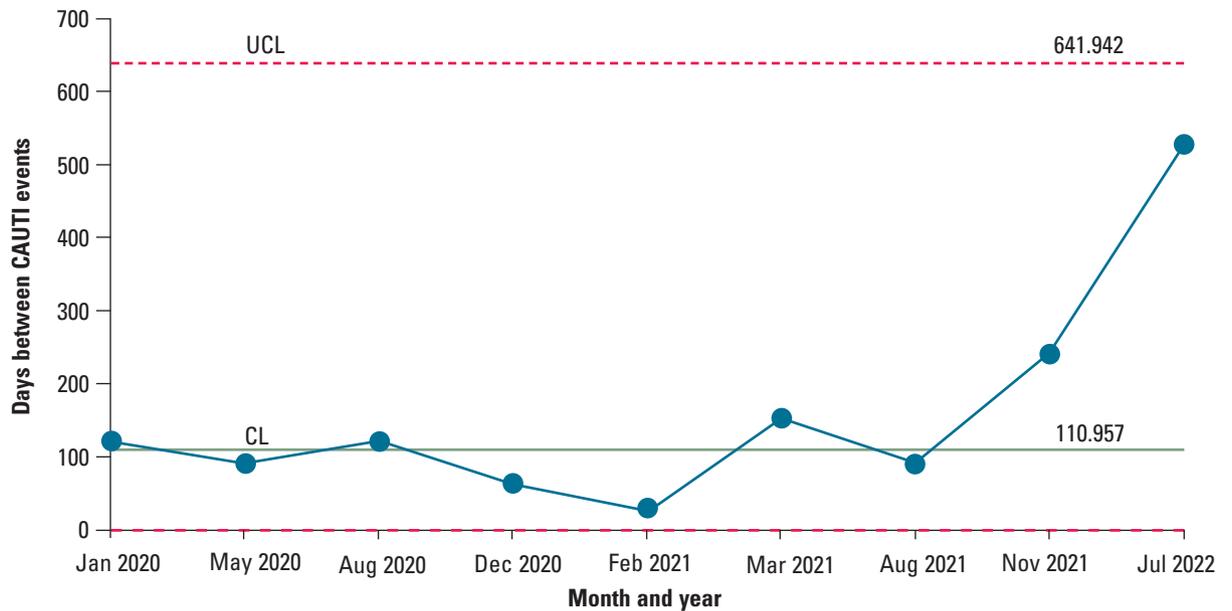


Figure 2 Days between catheter-associated urinary tract infection (CAUTI) events from January 2020 through July 2022. The chart demonstrates an increase in the time between events following key interventions, with a sustained event-free period beginning in July 2022. The chart does not extend into 2023 because no CAUTI events occurred during this period, reflecting 527 consecutive event-free days.

Abbreviations: CL, center line; UCL, upper control limit.

strategies of the No Diaper Zone and the Accuryn Monitoring System directly addressed key gaps in traditional CAUTI prevention methods, achieving a sustained CAUTI rate of 0 per 1000 catheter days for 2023 and 527 consecutive event-free days. Compliance with CAUTI maintenance bundles remained consistently high throughout the project period, with an average of 93%, and Accuryn use had a compliance rate of 70%. Although systematic tracking of diaper removal compliance was not conducted, qualitative assessments provided valuable insights and opportunities for refinement.

The No Diaper Zone minimized stool-related contamination, addressing a plausible pathway for bacterial migration to urinary catheters. Although direct evidence linking diaper removal to CAUTI rates is limited, this intervention aligns with literature emphasizing the role of stool management in infection prevention.^{10,14} Complementing this approach, the Accuryn Monitoring System's advanced design features—preventing urinary backflow and providing continuous urinary drainage—addressed additional risk factors for CAUTI. Although there is limited evidence linking use of the system to CAUTI prevention, our results align with findings from a recent retrospective observational study in a burn ICU, which showed a decrease in CAUTI rates following the use of a similar urinary catheter drainage system.²⁴ These findings suggest that technologies designed to eliminate standing urine and prevent urine reflux can contribute to CAUTI reduction. The education and reeducation efforts were crucial in mitigating challenges caused by high turnover and varying levels of experience among PICU staff members. By integrating infection prevention strategies into orientation and conducting weekly hands-on bedside training during infection prevention rounds, the task force emphasized consistent compliance despite these systemic challenges.

Real-time, data-driven adjustments further strengthen intervention sustainability. For example, the 2 CAUTI events in 2022 occurred in patients not using the Accuryn system, highlighting the importance of consistent use of this technology. In response, the infection prevention REDCap survey was updated to better track compliance. These iterative processes, combined with proactive education and feedback, fostered a culture of accountability and continuous improvement among staff members. Critical care nurses were integral to these efforts, ensuring the sustainability of changes through their ownership of

prevention strategies, aligning with evidence that nursing engagement drives positive outcomes.³³

Between August 2022 and December 2023, 608 REDCap surveys were completed during infection prevention rounds, providing a robust dataset to support the qualitative assessment of the no-diaper intervention. Although this intervention is well suited for ICU settings, its application in non-ICU environments, such as long-term and acute care, may face challenges related to patient mobility and staffing. Expanding the scope of this project to include multicenter studies could further validate the effectiveness of the interventions and help determine generalizability of the results, particularly in adult ICUs, where catheter use and patient profiles differ substantially from those in pediatric populations. Our findings contribute to this emerging evidence base, emphasizing the importance of advanced urinary drainage technologies and nurse-led innovations in complementing traditional CAUTI prevention practices.

Limitations

This project was limited by its single-center design, which may affect the generalizability of results to other pediatric or adult ICUs. Variations in nursing practice and inconsistent compliance with interventions, particularly with 70% Accuryn use, may have influenced the outcomes. The lack of systemic tracking for the No Diaper Zone intervention limited the ability to quantify its direct impact on CAUTI rates. Additionally, observer variability during CAUTI maintenance bundle audits may have introduced inconsistencies in compliance data accuracy. Finally, lower pediatric patient census during the COVID-19 pandemic may have influenced baseline CAUTI rates, potentially affecting the measured improvements.

Conclusion

This QI project underscores the importance of nursing innovation, teamwork, and persistent educational efforts in achieving sustainable health care improvements. The combination of the No Diaper Zone intervention and use of the Accuryn Monitoring System effectively addressed gaps in traditional CAUTI prevention strategies, resulting in a sustained CAUTI rate of 0 per 1000 catheter days in a high-acuity PICU. The success of this project was driven by ongoing educational efforts, nursing engagement, and interprofessional collaboration. These findings highlight the potential for tailored, unit-specific interventions to

complement traditional CAUTI prevention practices and provide a framework for replication in other ICUs. **CCN**

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None reported.

See also

To learn more about pediatric critical care, read “Central and Peripheral Medication Administration Practices in Pediatric Patients” by Sanchez and Campbell in *AACN Advanced Critical Care*, 2024;35(1):55-65. <https://doi.org/10.4037/aacnacc2024906>. Available at www.aacnconline.org.

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