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Reducing CAUTI Rates in a Transplant ICU: A Quality Improvement Initiative Using Female External Catheters

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Abstract

Catheter associated urinary tract infections (CAUTIs) are a leading cause of healthcare-associated infection, particularly in intensive care units (ICUs), where prolonged catheterisation and patient complexity increase risk. Reducing unnecessary catheter use and improving adherence to evidence-based practices are key priorities for patient safety. This case report describes a nurse-led, multidisciplinary quality improvement programme to reduce CAUTI rates in a transplant ICU through optimisation of catheter use and the introduction of non-invasive urinary management alternatives. Interventions included standardisation of catheter indication criteria, implementation of insertion, maintenance and early removal protocols, introduction of external urinary management devices and a structured staff education and audit programme. Performance was monitored using CAUTI incidence per 1,000 catheter days and compliance with catheter-related practices, supported by continuous audit and feedback. Following implementation, CAUTI rates decreased from a pre-intervention rate of 1.41 per 1,000 catheter days to sustained zero incidence between Q4 2018 and Q4 2024. Compliance with catheter care protocols improved, alongside increased documentation of indication for catheter use and earlier catheter removal. The adoption of external urinary catheter management devices contributed to reduced indwelling catheter use. In parallel, the unit reported zero device-related pressure injuries and improved patient comfort, as reflected in staff-reported patient feedback. This multifaceted approach achieved sustained elimination of CAUTI in a high-risk ICU setting, highlighting the effectiveness of nurse-led interventions, standardised practice, and non-invasive catheter alternatives in reducing device-associated harm.

Keywords: CAUTI, Foley catheter, PureWick, female external catheter, infection prevention, ICU, quality improvement.

INTRODUCTION

Urinary tract infections (UTIs) are among the most common healthcare-associated infections worldwide and represent a major source of preventable harm in hospitalised patients. (Flores-Mireles, Walker, Caparon, & Hultgren, 2015) UTIs contribute significantly to patient morbidity, prolonged hospital stays and increased utilisation of healthcare resources. Patients who develop UTIs frequently experience pain, discomfort, delayed recovery and secondary complications, particularly when underlying co-morbidities such as diabetes, kidney impairment or immunosuppression are present. (Hooton *et al*., 2010; Medina & Castillo-Pino, 2019)

From an organisational and financial perspective, UTIs present a significant burden through increased bed occupancy and length of stay, diagnostic tests, antimicrobial therapy, higher treatment costs and increased workload for healthcare professionals. (Broughton, Colosia, Bektas, Kuper, & Kotb, 2025) In addition, UTIs are a major driver of increased antimicrobial use in hospitals and as such, play a significant role in the development and spread of antimicrobial resistance (AMR), now regarded as a critical global threat with profound clinical and financial implications. (Meybodi *et al*., 2021; Tang, Millar, & Moore, 2023; Walsh, Gales, Laxminarayan, & Dodd, 2023) With over 35,000 deaths annually in Europe attributed to resistant infections, (E. C. f. D. P. a. C. ECDC, 2025) it has been predicted that AMR will be responsible for 10 million deaths per year globally by 2050. (Tang *et al*., 2023)

In Europe and the United States, UTIs represent 36% and 27% of all Healthcare Associated Infections (HCAI) respectively, with approximately 75% of these occurring in patients with an indwelling urinary catheter. (McCleskey *et al*., 2022)

A catheter-associated urinary tract infection (CAUTI) is defined as a symptomatic UTI occurring in a patient with an indwelling urinary catheter in place for more than two consecutive calendar days, where the catheter was present on the day of diagnosis or removed within the previous 2 calendar days, and where no alternative source of infection is identified. (ECDC, 2026; National-Healthcare-Safety-Network, 2026) Diagnosis also requires microbiological criteria of $\geq 10^5$ microorganisms per ml of urine, with no more than two species of microorganisms present. Microorganisms may originate from endogenous sources, such as periurethral, rectal or vaginal flora, or from exogenous contamination, most commonly via the hands of healthcare personnel during catheter insertion, or subsequent manipulation of the drainage system. (Maki & Tambyah, 2001; Werneburg, 2022) Established risk factors include female gender, older age, diabetes mellitus, renal dysfunction, urinary incontinence, immunosuppression, breaches in aseptic technique during catheter insertion, disruption of the closed drainage system, and prolonged catheterisation. (Letica-Kriegel *et al*., 2019) Recognition and understanding these risk factors underpins targeted and effective prevention strategies.

Surveillance data consistently demonstrate that CAUTI account for the majority of hospital acquired urine infections. European point-prevalence surveys report that up to 62% of healthcare associated UTIs are catheter related. (Carl Suetens, 2024) Each CAUTI is estimated to cost €800–€1,000 (Hollenbeak & Schilling, 2018) and extend hospital stays by 2–4 days contributing to a substantial economic burden. (Kelly, Ai, Jung, & Yu, 2024; Tambyah & Maki, 2000)

The burden of CAUTI is particularly pronounced in the hospital intensive care unit (ICU), where urinary catheterisation is frequently required for accurate urine output monitoring and peri-operative or haemodynamic management. Critically ill patients are more likely to experience prolonged catheter dwell times, placing them at substantially higher risk of infection, compared with patients in general wards. (ECDC, 2026; Maki & Tambyah, 2001; Werneburg, 2022)

Beyond infection, CAUTIs are associated with serious complications including urethral trauma, ascending infection, pyelonephritis, bacteraemia and long-term renal damage which may contribute to new or worsening complications, particularly in vulnerable ICU patients. They are also linked to increased antimicrobial use and resistance among common Gram-negative pathogens such as Escherichia coli and Klebsiella pneumoniae, adding to patient risk and healthcare costs. (Al Lawati, Blair, & Larnard, 2024; ECDC, 2026; Saint *et al*., 2018; Werneburg, 2022) From a nursing perspective, CAUTIs increase workload, disrupt continuity of care and negatively affect patient comfort, dignity and care experience, reflecting both infectious and non-infectious harm. (Huang *et al*., 2023)

These issues are of particular concern in Saudi Arabian ICUs where studies have consistently reported high CAUTI prevalence, higher than average urinary catheter use and a substantial burden of AMR Gram negative pathogens resulting in increased morbidity, prolonged ICU stay and increased costs. (Al-Amri, Almalhan, Alghamdi, & Ibrahim, 2025; Alhabdan, Alyaemni, Aljuaid, Baydoun, & Hamidi, 2023; Gaid, Assiri, McNabb, & Banjar, 2018; Obaid NA, 2023)

Despite these risks, indwelling urinary catheters remain widely used in ICUs. Evidence suggests that catheterisation is frequently initiated without clear clinical indication, and in many cases continues beyond the period of therapeutic benefit. (Gould, 2015; Meddings *et al*., 2014) In fact, evidence states that catheters inserted perioperatively, or at ICU admission can be safely removed within 24 hours, and that urinary catheters should not be used primarily for incontinence management. (HICPAC, 2009; Meddings *et al*., 2019) A range of alternative urinary management strategies are available, including condom-style external sheath catheters for men and non-invasive female external urinary collection devices such as the PureWick® system (Fig. 1). These devices have been shown to reduce indwelling catheter use, maintain skin integrity and improve patient comfort, whilst lowering infection risk. (Pryor *et al*., 2024)

Quality improvement approaches have proven effective in reducing CAUTI rates through the implementation of standardised care bundles, strict catheter indication criteria, early removal protocols and multidisciplinary staff engagement. (Meddings *et al*., 2014; Van Decker, Bosch, & Murphy, 2021)

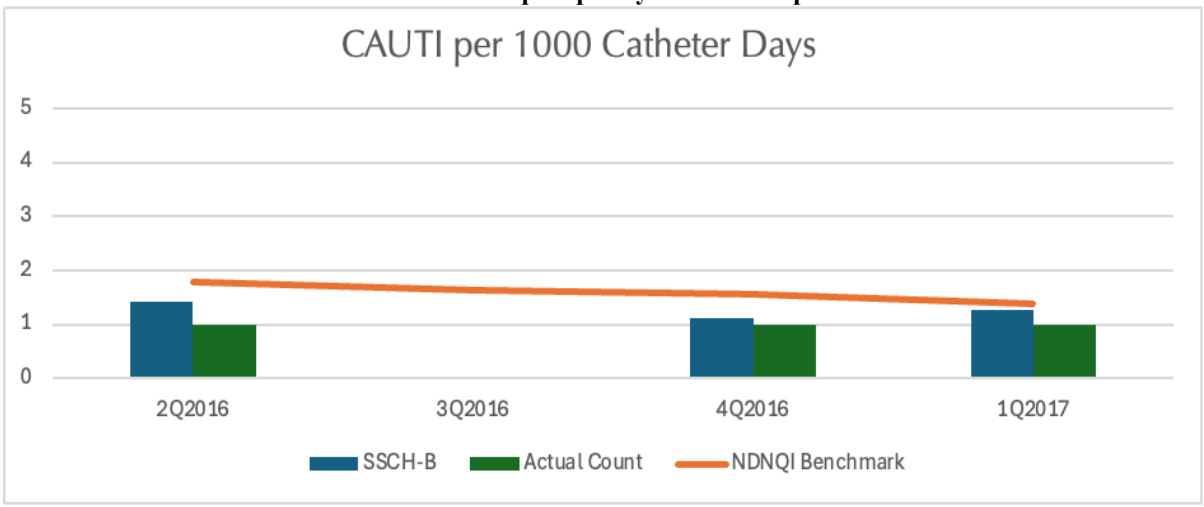
Clinical Context and Rationale for the Initiative

King Faisal Specialist Hospital & Research Centre (KFSHRC) is a leading tertiary care and research institution in the Middle East, providing highly specialised care for complex patient populations. The Surgical Special Care Unit (SSCU) transplant ICU comprises SSCU-B, with a capacity of 19 beds, and L10, with 34 beds. These units provide intensive care for male and female patients aged over 14 years, including both pre- and post-transplant patients (lung, liver, renal and small bowel), as well as post-surgical cases. The SSCU transplant ICU manages a high-risk patient population with an increased likelihood of device-associated complications, including renal transplant recipients and individuals with spinal trauma.

Based in aggregated data over the study period, the average monthly total catheter use was 270 days and 650 patient days, corresponding to a device utilisation ratio of 0.42 (42%).

In 2017, the unit identified elevated CAUTI rates (Table 1). Contributing factors included prolonged urinary catheterisation, the complex care needs and heightened risk of infection of the patient population, and inconsistent adherence to catheter care, insertion and removal protocols. (Hooton *et al*., 2010) This highlighted the need for a structured, multidisciplinary quality improvement initiative.

Table 1: CAUTI rates pre-quality initiative implementation



Aims

The primary aim of this quality improvement initiative was to reduce CAUTI rates in the SSCU transplant intensive care unit to 25% of the 2017 baseline.

Secondary aims included improving nursing compliance with evidence-based urinary catheter care, insertion and removal practices, and a multidisciplinary approach to reducing the use of indwelling Foley catheters through the promotion of appropriate alternatives, including the use of external urinary management devices.

METHODS

The quality improvement initiative was informed by an initial CAUTI-focussed SWOT analysis, which was undertaken to identify local strengths, weaknesses, threats and potential opportunities for improvement related to urinary catheter management within the unit. Findings from this analysis highlighted several practice-related contributing factors to ongoing CAUTI risk, including prolonged indwelling catheter use, variation in adherence to catheter care, insertion and removal protocols, and limited utilisation of non-invasive urinary management alternatives (Table 2).

Table 2: CAUTI SWOT analysis

Strengths	**Weaknesses**
High skill level of nursing staff	Lack of advocacy for catheter removal from RN and MD
Teamwork	Increased “float” nurses/cross training in unit
Positive support for evidence-based practice from leadership team	Delayed collaborative interdisciplinary decisions
Unit CAUTI taskforce	
Opportunities	**Threats**
Improve quality of patient care	100% bed occupancy with high patient acuity
Reduce CAUTI and urosepsis rates	Staff resistant to change
Reduce AMR	Time constraints
Improve patient satisfaction	Staff belief that changes will increase workload
Improve staff training and education	Non-compliance to Foley bundle

In parallel, a structured performance improvement (PI) framework was applied, incorporating a baseline assessment of CAUTI rates and catheter care practices within the unit. Baseline data were obtained from the National Database of Nursing Quality Indicators (NDNQI) for 2016, alongside routine surveillance of CAUTI bundle compliance. Ongoing monitoring included weekly assessment of a sample of

patients using taskforce data collection tools to evaluate adherence to catheter related care processes.

The intervention targeted multidisciplinary practice, including nurses, physicians and patients, with the aim of improving compliance with evidence-based catheter care bundles and enhancing collaboration between nursing and medical teams. A predefined improvement goal was established to reduce CAUTI rates within the SSCU by 25% over the study period. CAUTI was defined using the CDC/ECDC definition throughout the project.(ECDC, 2026)

Based on these findings, three key focus areas were identified:

- Implementation of a standardised urinary catheter use protocol
- Introduction of external urinary management devices.
- Staff education and engagement

1. Implementation of a standardised urinary catheter use protocol

The introduction of clearly defined indication criteria for indwelling urinary catheters was central to the approach (Fig. 1). Use was restricted to patients with appropriate clinical indications, such as the need for accurate urine output monitoring in critically ill patients and perioperative care. Use was minimised for all patients, particularly those at high risk of CAUTI and mortality e.g. female, elderly, immunosuppressed. Use was avoided for the management of incontinence.

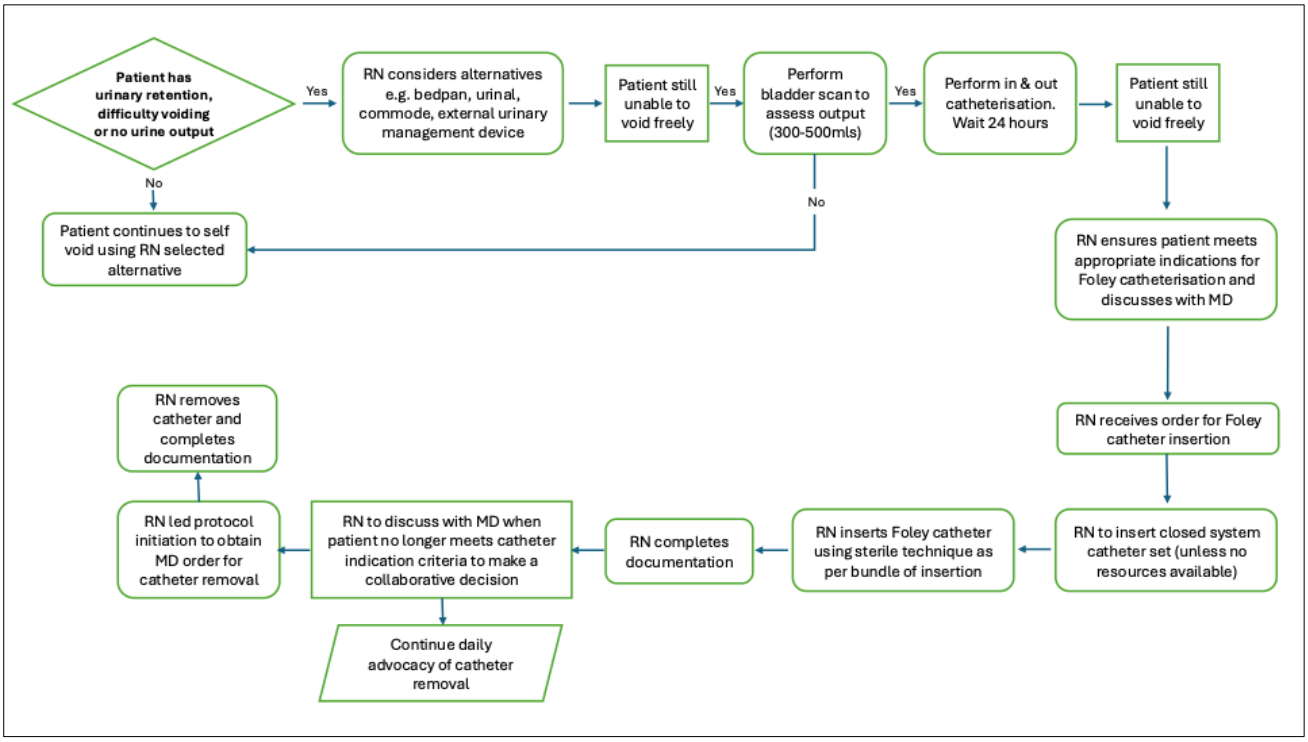


Figure 1: Foley catheter protocol

If the use of an indwelling catheter was indicated, insertion, maintenance and removal was guided by clearly documented standardised protocols. Only properly trained healthcare providers were permitted to insert and maintain catheters. Strict aseptic technique was used for all catheter care. Unobstructed urine flow was maintained at all times (Fig. 2), and a closed drainage system was used. This included the need to replace the catheter and closed system if breakage, disconnection or leakage occurred. Urine samples were collected aseptically and the Foley catheter changed before urine cultures were taken (Fig. 3).

Figure 2 Maintaining unobstructed urine flow

- Keep catheter and collection tubing free from kinks
- Keep collection bag below the level of the bladder at all times
- Do not rest the collection bag on the bed or the floor
- Empty collection bag when 2/3 full
- Empty collection bag completely before patient transferred out of unit or any external procedure
- Wipe the tip of the urometer with alcohol swab following bag emptying

Figure 2: Maintaining Unobstructed Urine Flow

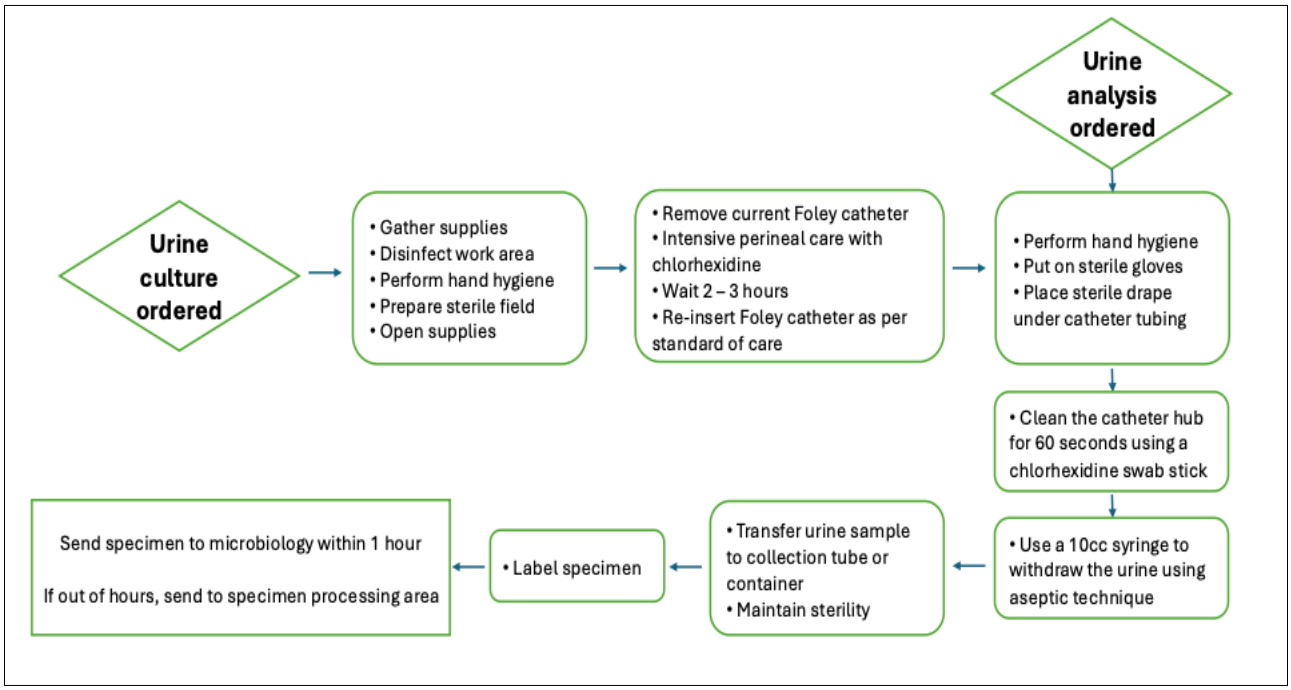


Figure 3: Urine culture collection protocol

To support timely discontinuation of catheter use, standardised catheter removal protocols were implemented. These emphasised the need for early removal once clinical indications were no longer present, preferably within 24 hours.

Routine daily catheter review and auditing formed an integral part of practice and nurses were empowered to recommend removal in accordance with agreed criteria, in collaboration with the multidisciplinary team. Ongoing indication for use or removal of catheters was documented in patient notes. Audit findings were used to reinforce practice changes, identify variation and support continuous improvement.

2. Introduction of external urinary management devices.

To reduce reliance on indwelling Foley catheters, external urinary management systems were used. This included the introduction of male urinary sheath condom catheters and the female external catheter and urine collection system (PureWick®).

PureWick® is a non-invasive system that uses a soft, wick-like pad and low-pressure suction to draw urine into a collection cannister (Fig 4). This technology provided an effective alternative to indwelling catheters with the potential to reduce the risk of infection and skin breakdown.

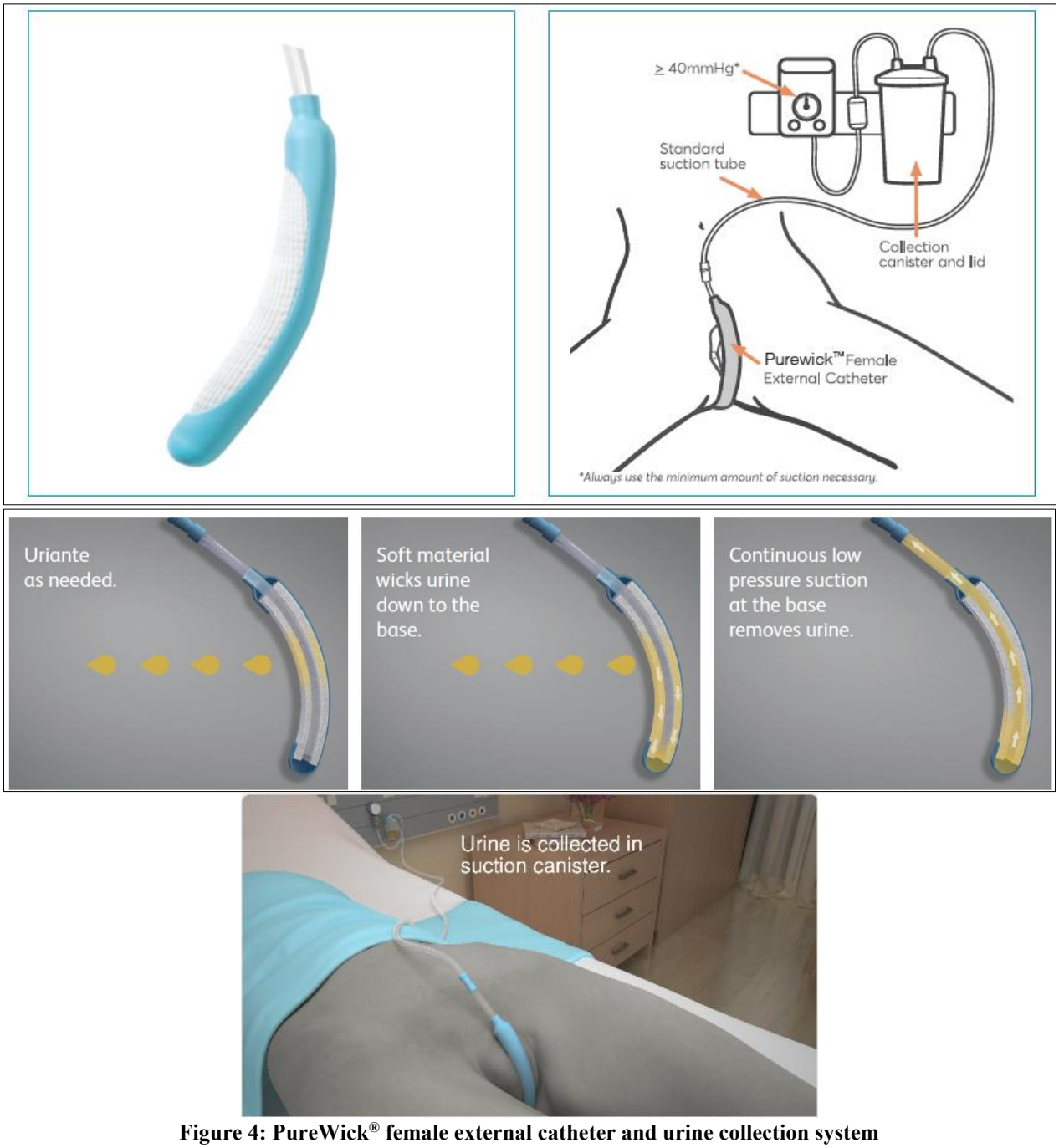


Figure 4: PureWick® female external catheter and urine collection system

Patients were assessed for suitability based on continence status, mobility and overall clinical condition. Skin integrity and patient comfort were key considerations in device selection and ongoing use. Nursing staff conducted regular skin assessments at two-hour intervals to monitor for skin breakdown, device-related pressure and patient tolerance. Where concerns were identified, patients were reassessed and escalated to the pressure-injury prevention team, with findings informing ongoing staff education and reinforcement of best practice. The use of non-invasive urinary collection devices enabled a reduction in the use of indwelling catheters, particularly amongst patients requiring urine containment, rather than invasive monitoring. The approach supported early catheter removal whilst maintaining effective urine management and urine output monitoring when required.

3. Staff education and engagement

Sustained improvement relied on comprehensive staff education and engagement. Awareness campaigns were conducted to reinforce CAUTI prevention principles, the rationale for reducing the use of indwelling catheters, and the role of external urinary management devices.

A structured, nurse-led education and training programme was implemented to improve catheter related practices across the unit. The initial education phase was conducted over approximately two months, during which a dedicated CAUTI committee and working group were identified and trained. Competency-based training, including formal "check-off" assessments, was completed for this core group, who subsequently led education and competency assessments for all unit staff, including newly hired personnel.

Education focussed on catheter indication criteria, insertion and maintenance best practice, timely removal, and the appropriate use of external urinary devices. This was delivered through a combination of unit-based presentations led by the nurse unit leader, practical demonstrations, and bedside teaching to support confidence and consistency in practice. All relevant guidelines and requirements were standardised and disseminated across the unt.

Ongoing reinforcement of learning was achieved through daily audits of catheter care practices, with feedback provided to staff, supported by quarterly education sessions and annual competency reassessment. Nursing leadership played a central role in maintaining focus on CAUTI prevention, fostering shared accountability and embedding all interventions into routine clinical care.

Outcomes

Following implementation of the quality improvement initiative, the SSCU transplant ICU demonstrated sustained improvement across multiple patient safety and care quality indicators summarised in Table 3.

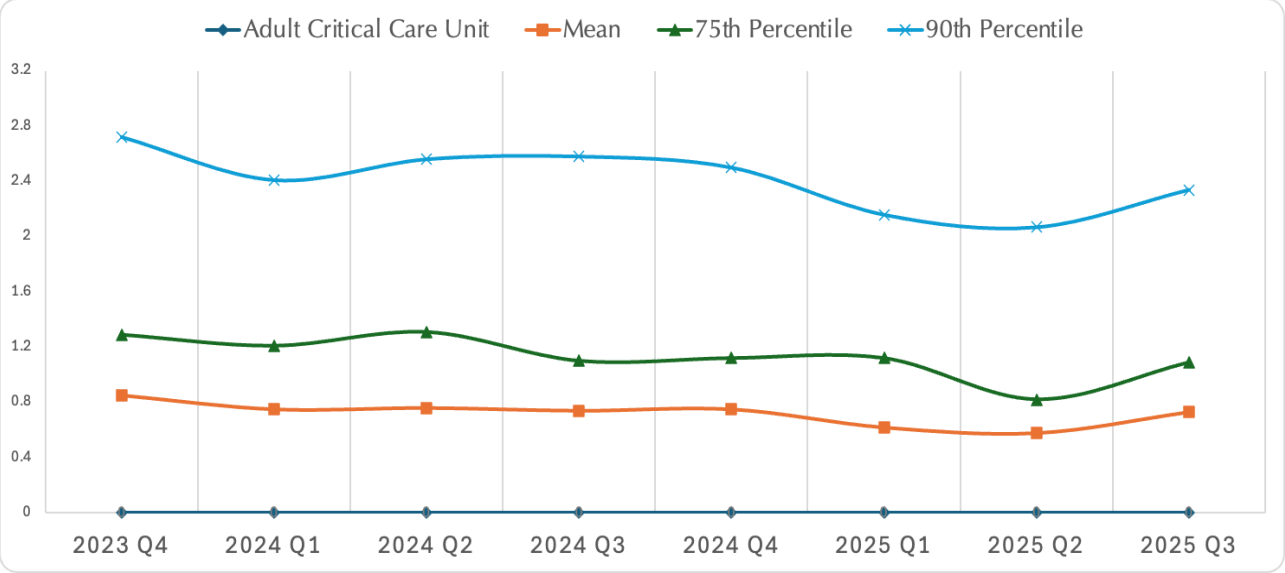
Table 3: Summary of outcomes pre- and post-implementation of the CAUTI quality improvement initiative

Outcome Measure	Pre-implementation	Post-implementation
CAUTI Incidence	Elevated CAUTI rates reported in 2017	Zero CAUTI cases reported Q4 2018 – Q4 2024
Compliance with catheter care protocols	Variable adherence to insertion, care and removal protocols	Improved compliance supported by daily review and audits
Indwelling catheter care utilisation	High utilisation, including prolonged catheterisation	Reduced Foley catheter use with increased adoption of external urinary collection devices
Unit-acquired pressure injuries	No data	Zero unit-acquired pressure injuries Q1 2023 – Q4 2024

Reduction in CAUTI incidence

Post implementation surveillance identified zero CAUTI cases within the unit between Q4 2018 and Q4 2024 compared to 1.41 per 1000 catheter days pre-implementation (Table 4). This represented a marked improvement from the 2017 baseline and indicated a successful reduction of device-associated infection risk through standardises catheter practices and the introduction of non-invasive management options.

Table 4: CAUTI Rates per 1,000 Catheter Days Post-Quality Initiative Implementation: Unit Performance vs Peer Benchmarks



Quarter	2023 Q4	2024 Q1	2024 Q2	2024 Q3	2024 Q4	2025 Q1	2025 Q2	2025 Q3	Average
Adult Critical Care Unit	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mean	0.85	0.75	0.76	0.74	0.75	0.62	0.58	0.73	0.72
Standard Deviation	1.52	1.35	1.34	1.32	1.46	1.10	1.23	1.47	1.35
10th Percentile	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
25th Percentile	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
50th Percentile (Median)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
75th Percentile	1.29	1.21	1.31	1.10	1.12	1.12	0.82	1.09	1.13
90th Percentile	2.72	2.41	2.56	2.58	2.50	2.16	2.07	2.34	2.42
# Units	660	651	656	660	660	667	661	650	658

These data were obtained from Press Ganey (NDNQI). When the number of reporting units or facilities is small, comparison data may be supressed to preserve confidentiality. Alanysis based n fewer than 20 contributing units may demonstrate increased variability over time and should terhefore be interpreeted with caution. Further methodological details are available in the relevant NDNQI documentaiton.

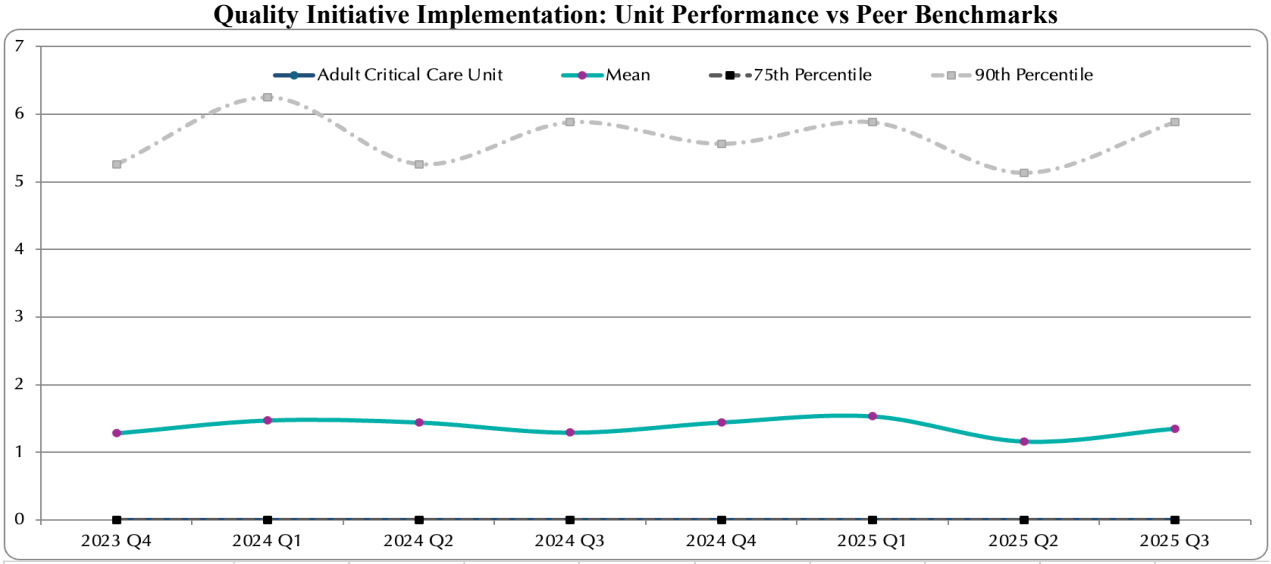
Improved compliance with catheter protocols

Compliance with indications for the use of urinary catheters, catheter care, insertion and removal protocols improved following the introduction of the intervention bundle. Daily catheter review, supported by nurse-led audits, contributed to more consistent documentation of catheter necessity and earlier removal when clinical indications were no longer present. Increased use of external urinary management devices further supported adherence to evidence-based catheter practices.

Reduction in pressure-related injuries

In parallel with the reduction in CAUTI, the unit also reported zero unit-acquired pressure injuries following implementation of the quality initiative (Table 5). The use of external management devices reduced prolonged exposure to moisture, maintaining skin integrity as supported by the evidence. (Pryor *et al*., 2024)

Table 5: Percentage of Surveyed Patients with Unit Acquired Medical Device Associated Pressure Injury Post-Quality Initiative Implementation: Unit Performance vs Peer Benchmarks



Quarter	2023 Q4	2024 Q1	2024 Q2	2024 Q3	2024 Q4	2025 Q1	2025 Q2	2025 Q3	Average
Adult Critical Care Unit	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mean	1.28	1.47	1.44	1.29	1.44	1.53	1.16	1.35	1.37
Standard Deviation	3.36	3.56	3.72	3.38	3.54	4.30	3.45	3.61	3.62
10th Percentile	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
25th Percentile	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
50th Percentile (Median)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
75th Percentile	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
90th Percentile	5.26	6.25	5.26	5.88	5.56	5.88	5.13	5.88	5.64
# Units	595	604	595	598	563	611	606	590	595

These data were obtained from Press Ganey (NDNQI). When the number of reporting units or facilities is small, comparison data may be supressed to preserve confidentiality. Alanysis based n fewer than 20 contributing units may demonstrate increased variability over time and should terhefore be interpreeted with caution. Further methodological details are available in the relevant NDNQI documentaiton.

Patient comfort and care experience

Feedback from nurses, supported by discussions directly with patients and their families, indicated improved patient comfort and dignity associated with reduced indwelling catheter use and increased use of external urinary devices. Patients reported less discomfort as there was no requirement for catheter insertion or maintenance. Non-invasive urinary management options enabled effective care without compromising comfort. From a nursing perspective, this supported more patient-centred care and reduced catheter related care burden.

DISCUSSION

This quality improvement initiative demonstrates that a multifaceted, nurse-led approach, incorporating standardised catheter practices and the use of external urinary management devices can result in meaningful reductions in CAUTI and related patient harms in a high-risk transplant ICU setting.

The success of the initiative can be attributed to the integration of multiple evidence-based strategies rather than reliance on a single intervention. Standardising the indications for use of urinary catheters and embedding routine reassessment into daily practice reduced unnecessary or prolonged catheter use, which are well established risk factors for CAUTI. (Letica-Kriegel *et al*., 2019) The introduction of external urine management devices provided a practical and acceptable alternative for urine containment, allowing indwelling catheters to be avoided or removed earlier without compromising patient care.

Importantly, these interventions were supported by consistent monitoring, audit and feedback, all of which reinforced practice change and facilitated sustained adherence. Addressing both infection and non-infection related harm, such as pressure-related skin injury and patient discomfort, further strengthened staff engagement and acceptance of the new approach.

Nursing leadership was essential and supported the design, implementation and sustainability of the initiative. All nursing staff played a role in the daily review of catheter use, device selection, patient monitoring and escalation of concerns. This placed nurses as the drivers of change rather than passive recipients of new protocols. Nurse-led audits and real time feedback increased accountability and ensured that catheter decisions were routinely reviewed with the multidisciplinary team.

Education and awareness activities, led by nursing staff, enhanced confidence in both catheter management and the use of external devices. This nurse-led model promoted shared ownership of CAUTI prevention and reinforced the role of nurses in patient safety and infection prevention within the ICU.

Relevance to practice

Urinary catheter use is common in ICU settings and patient vulnerability is high. Critically ill patients frequently require close fluid monitoring, experience limited mobility and have complex care needs, all of which contribute to prolonged use of urinary catheters and increased risk of infection. This initiative demonstrated that even in a high-acuity transplant ICU, urinary catheter use can be safely reduced through structured assessment, early removal protocols and alternative urine management strategies.

The reduction in pressure injuries and nurse-reported improvement in patient comfort underscore the wider benefits of optimising urine management practice in the ICU beyond infection prevention. Given the reported burden of CAUTI and AMR in Saudi Arabian ICUs, (Al-Amri *et al*., 2025; Gaid *et al*., 2018; Obaid NA, 2023) this model is readily transferrable to other high-risk units.

In addition, the approach aligns closely with established CAUTI prevention strategies, and the integration of external urinary management devices reflects the growing evidence supporting the use of non-invasive alternatives.

By embedding these strategies into routine practice rather than introducing parallel or resource intensive processes, the initiative achieved improvements that were both pragmatic and sustainable.

Limitations

This initiative has several limitations that should be considered when interpreting the findings. The project was conducted within a single transplant ICU in a tertiary centre, which may limit generalisability of the results to other care settings, patient populations or healthcare systems. The project was designed as a quality improvement initiative rather than a controlled research study and as such did not include a control group. It is therefore not possible to attribute the observed outcomes solely to this intervention as other patient safety or infection prevention initiatives may have contributed to improvements.

The outcome data focussed on process and patient safety indicators such as CAUTI, protocol compliance and pressure injury occurrence. There were no formal measures of patient comfort or staff experience collected and so these outcomes were assessed through clinical observation and nursing feedback.

CONCLUSION

This quality improvement project demonstrates that a nurse-led, multifaceted approach can successfully reduce CAUTI in a transplant ICU. By standardising practice, promoting early catheter removal and integrating non-invasive urine management alternatives into routine care, the initiative achieved zero CAUTI cases whilst also improving skin integrity and patient comfort. These findings highlight the critical role of nurse leadership in infection prevention and support the broader adoption of structured, evidence-based urinary management strategies across ICU settings.

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