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Evaluating the outcomes of evidence-based catheter care bundles on reducing CAUTIs

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Abstract
Catheter-associated urinary tract infections (CAUTIs) continue to be a pressing healthcare concern, accounting for a significant proportion of hospital-acquired infections (HAIs). With urinary catheters often necessary for critically ill or post-operative patients, the potential for infection increases substantially with duration, improper insertion techniques, poor maintenance, or delays in catheter removal. Evidence-based catheter care bundles have emerged as an effective preventive strategy to standardize nursing practices and minimize these risks. This study aims to evaluate the outcomes of implementing an evidence-based catheter care bundle in reducing the incidence of CAUTIs within an intensive care unit (ICU) setting of a tertiary hospital.
A quasi-experimental research design was adopted to assess the effect of a structured intervention over six months. Eighty patients requiring urinary catheterization in a surgical ICU were observed and divided into control (routine care) and intervention (care bundle) groups. Additionally, thirty ICU nurses were trained on standardized catheter care practices based on the bundle, which included strict aseptic insertion, proper catheter maintenance, documentation protocols, and timely removal criteria. Data were collected using patient monitoring forms, laboratory reports, and nursing practice observations. Pre- and post-implementation CAUTI rates were compared.
The results demonstrated a statistically significant reduction in CAUTI incidence in the intervention group. The post-intervention group recorded an 85% reduction in infection rate, supported by better nursing compliance with care practices, as evident in improved hand hygiene, appropriate catheter stabilization, and regular documentation. Furthermore, qualitative feedback from nurses indicated a greater sense of accountability and confidence in maintaining catheter hygiene.
These findings reinforce the value of structured catheter care bundles in clinical settings. Their implementation not only reduces infection rates but also enhances nursing practice and patient safety culture. The study emphasizes the need for institutional support, continuous training, and performance monitoring to ensure sustainability of such interventions. Overall, evidence-based bundles present a practical, low-cost solution to a widespread healthcare challenge, making them vital to infection control programs worldwide.

Keywords: ICU, CAUTIs, catheter care bundles, worldwide, healthcare challenge, catheter hygiene

Introduction
Catheter-associated urinary tract infections (CAUTIs) represent a significant burden in clinical healthcare, particularly within intensive care units where catheter use is frequent and prolonged. According to the Centers for Disease Control and Prevention (CDC), CAUTIs are among the most common types of healthcare-associated infections (HAIs), accounting for approximately 40% of all nosocomial infections. The frequent use of indwelling urinary catheters, often for convenience rather than medical necessity, places patients at elevated risk for infection. It is estimated that the risk of developing CAUTI increases by 3-7% for each day a catheter remains in place, making duration a critical factor in infection risk.
The pathogenesis of CAUTI is complex. The catheter acts as a conduit for microbial entry into the bladder, bypassing natural defenses. Microorganisms, especially biofilm-forming bacteria such as *Escherichia coli*, *Pseudomonas aeruginosa* and *Klebsiella pneumoniae*, adhere to the catheter surface and colonize the urinary tract. Once established, these infections are challenging to treat, often requiring prolonged antibiotic therapy and, in severe cases, leading to urosepsis. The associated outcomes are longer hospital stays, increased healthcare costs, and considerable morbidity among vulnerable populations.

Over the years, multiple interventions have been proposed to address this problem, ranging from advanced catheter materials to antimicrobial coatings and prophylactic antibiotic regimens. However, inconsistent adherence to catheter maintenance protocols continues to hinder progress. The introduction of evidence-based care bundles marks a shift from isolated interventions to an integrated approach. These bundles comprise a set of practices proven to improve outcomes when implemented together. For CAUTIs, the bundle typically includes proper hand hygiene, aseptic catheter insertion, maintenance of a closed drainage system, positioning of the drainage bag below bladder level, and timely catheter removal.

Despite the theoretical appeal of catheter care bundles, questions remain about their practical efficacy and sustainability in real-world settings. There is a lack of large-scale randomized trials, and many studies rely on single-center observational data. However, available evidence increasingly suggests that these bundles, when implemented with training and compliance monitoring, significantly reduce CAUTI rates. The present study contributes to this growing body of knowledge by evaluating the implementation of an evidence-based catheter care bundle in a surgical ICU of a tertiary care hospital. The study not only assesses the clinical outcomes but also explores changes in nursing practice behavior and protocol adherence following bundle introduction.

The primary objective is to determine whether a structured catheter care bundle can reduce the incidence of CAUTIs among ICU patients. Secondary objectives include assessing nurse compliance with the bundle protocols and identifying barriers and facilitators of implementation. The study also examines changes in clinical indicators, such as the rate of positive urine cultures and documentation practices. The underlying hypothesis is that implementation of the care bundle will lead to a statistically significant reduction in CAUTI incidence and improvement in nursing practices related to catheter management.

In developing countries, where surveillance mechanisms and resources for infection control may be limited, cost-effective and behavior-driven interventions such as bundles can have significant impact. This study, situated in a Saudi Arabian healthcare setting, provides insights that may be applicable to similar contexts in the Middle East and globally. By highlighting both clinical outcomes and process improvements, the study aims to inform policy and protocol revisions for CAUTI prevention at institutional and national levels.

Methods

The study employed a quasi-experimental design with a pre- and post-intervention comparison to assess the effect of a catheter care bundle on CAUTI incidence in a surgical ICU. The setting was King Fahad Hospital in Madina, Saudi Arabia, a tertiary-level public hospital with approximately 500 inpatient beds and a dedicated ICU unit.

A total of 80 adult patients requiring urinary catheterization for over 48 hours were enrolled using purposive sampling. The patients were divided into two groups of 40 each. Group A (control) received routine catheter care, while Group B (intervention) received catheter care in accordance with the implemented bundle. The study was conducted over six months, from April to September 2018.

Thirty ICU nurses responsible for catheter insertion and maintenance were also included. Prior to intervention, baseline data on CAUTI rates, nursing practices, and compliance with infection control protocols were collected. Nurses were then trained over a one-week period using a structured educational module based on CDC guidelines and recent literature on CAUTI prevention.

The catheter care bundle implemented consisted of the following core elements: strict aseptic technique during catheter insertion, use of silver alloy-coated catheters, secure fixation of catheter to avoid movement, positioning the catheter bag below bladder level at all times, regular hand hygiene, avoidance of catheter irrigation unless medically indicated, and documentation of clinical justification for catheter continuation beyond 24 hours post-operation.

Data collection tools included three main instruments. First, a patient assessment form documented demographic details, duration of catheterization, symptoms, and urine culture results. Second, an observational checklist captured nursing behaviors during catheter care procedures. Third, a compliance monitoring tool was used weekly to assess adherence to the bundle components.

The primary outcome was the incidence of CAUTIs, defined using CDC/NHSN criteria: a positive urine culture of $\geq 10^5$ CFU/mL with no more than two species of microorganisms, accompanied by symptoms such as fever, urgency, or suprapubic tenderness in catheterized patients. Secondary outcomes included changes in compliance rates, documentation practices, and urine output quality.

Statistical analysis was performed using SPSS version 23. Descriptive statistics summarized demographic and clinical characteristics. Inferential statistics, including chi-square and paired t-tests, were used to compare pre- and post-intervention CAUTI rates and compliance scores. A p-value of less than 0.05 was considered statistically significant.

Results

Following the implementation of the evidence-based catheter care bundle, significant changes were observed in both clinical outcomes and nursing practices. The comparison between the control group (routine care) and the intervention group (care bundle) revealed substantial improvements.

CAUTI Incidence

The overall CAUTI incidence rate in the control group was markedly higher than that in the intervention group. Among the 40 patients in the control group, 17 developed confirmed CAUTIs, resulting in an incidence rate of 42.5%. In contrast, only 4 patients (10%) in the intervention group developed CAUTIs. This represents a 76.5% relative reduction in infection rates post-intervention, which was statistically significant ($\chi^2 = 14.89$, $p<0.001$).

Table 1: CAUTI Incidence Comparison

Group	Total Patients	CAUTI Cases	Incidence Rate
Control (Routine Care)	40	17	42.5%
Intervention (Care Bundle)	40	4	10%

Urine Culture Results

Positive urine cultures corroborated the above findings. In the control group, the most commonly isolated pathogens were E. coli (41%), Klebsiella spp. (29%), and

Pseudomonas spp. (18%). The intervention group showed a marked decrease in microbial colonization, with lower counts and fewer polymicrobial infections. This suggests that the bundle not only reduced infection rates but also influenced pathogen load and diversity.

Nurse Compliance and Practice Behavior

Prior to the intervention, compliance with catheter care best practices was inconsistent. Post-training and implementation, nursing performance scores increased significantly. The mean score for adherence to aseptic insertion techniques improved from 65% to 92%, hand hygiene compliance rose from 61% to 90%, and daily documentation of catheter necessity improved from 50% to 95%.

Table 2: Nursing compliance scores before and after intervention

Practice Area	Pre-Intervention Compliance	Post-Intervention Compliance
Hand hygiene	61%	90%
Aseptic insertion	65%	92%
Catheter fixation	72%	96%
Drainage bag positioning	60%	89%
Daily necessity documentation	50%	95%

The above line graph demonstrates the consistent downward trend in monthly CAUTI rates following intervention. July showed the most dramatic drop, coinciding with completion of staff training.

Qualitative Feedback

Nurse feedback collected through structured interviews indicated improved confidence in infection prevention, a stronger sense of accountability, and increased engagement with patient safety protocols. Nurses reported that the use of securement devices and catheter positioning reminders were particularly effective.

Discussion

This study highlights the considerable impact that evidence-based catheter care bundles can have on reducing CAUTI rates and improving clinical practices in ICU settings. The findings align with global research advocating for structured and standardized protocols to manage indwelling urinary catheters, especially in high-risk environments like intensive care units.

The dramatic reduction in CAUTI incidence-by nearly 77%-underscores the effectiveness of the bundle approach. Previous studies have shown similar outcomes. For instance, Apisarnthanarak *et al.* (2007) [1] demonstrated a 60% CAUTI rate reduction after implementing a urinary catheter protocol in a Thai hospital. In a U.S.-based study by Fakih *et al.* (2012) [10], catheter bundle adherence was associated with a 50% decrease in infection rates. This study supports such findings in a Middle Eastern context, adding to the international body of evidence.

The significant improvements in nursing compliance and practice behavior also illustrate how targeted training and monitoring can bring about sustainable change. Catheter management, often viewed as a routine or low-priority task, became a focal point of nursing care due to enhanced awareness and accountability. The use of compliance audits and performance feedback played a key role in maintaining adherence.

One of the most crucial aspects of the intervention was the focus on reducing unnecessary catheter use. The care bundle emphasized regular review of catheter necessity, leading to early removal when appropriate. This strategy alone is known to significantly reduce infection risk. Furthermore, the promotion of aseptic techniques and securement practices prevented micro trauma and minimized bacterial ascension.

Although the results are encouraging, certain limitations must be acknowledged. The study was confined to a single ICU within a specific hospital, limiting generalizability. Additionally, while the bundle was strictly followed during the study period, long-term adherence and institutionalization of these practices require ongoing training and leadership commitment. Resistance to change, workload pressures, and staffing constraints can all hinder consistent bundle use.

Despite these challenges, the intervention proved to be both cost-effective and replicable. The materials used, including securing devices and silver-coated catheters, were readily available and did not significantly increase expenditure. The primary investment was in human capital-training, monitoring, and reinforcement of behavior, which yielded substantial returns in terms of patient safety.

Future research should explore the scalability of such bundles across departments and evaluate their long-term impact on CAUTI rates. Randomized controlled trials and multi-center studies could further validate these results. Incorporating electronic health record prompts and automated reminders may enhance sustainability and compliance.

In conclusion, this study reaffirms that targeted, evidence-based interventions can profoundly reduce hospital-acquired infections when effectively implemented. The catheter care bundle provides a practical and low-cost solution to a pervasive clinical problem, especially in resource-limited settings.

Conclusion

This study demonstrates the significant impact of implementing an evidence-based catheter care bundle in reducing catheter-associated urinary tract infections (CAUTIs) in a surgical intensive care unit. The bundle approach not only lowered infection rates but also improved nursing adherence to best practices in catheter management, highlighting the value of structured interventions in clinical care.

The reduction in CAUTI rates from 42.5% in the control group to 10% in the intervention group confirms the hypothesis that coordinated efforts and adherence to evidence-based protocols can dramatically improve patient outcomes. Importantly, these improvements were achieved without the need for expensive technologies or advanced infrastructure. The key elements included staff training, standardized documentation, proper aseptic technique, and ongoing compliance monitoring-all of which are feasible in various healthcare settings.

The success of the care bundle was also evident in the behavioral change among nursing staff. Improved hand hygiene, accurate documentation, and timely catheter removal became embedded practices due to focused education and supportive supervision. This transformation in the safety culture of the ICU represents an essential step

toward broader quality improvement initiatives.

While challenges remain-such as sustaining compliance over time and addressing systemic issues like staff shortages-the study provides a strong argument for making catheter care bundles a standard of care in hospitals. Future efforts should prioritize embedding these protocols into hospital policies and electronic medical systems to ensure continuity and adherence.

In essence, this intervention has demonstrated that when evidence-based practices are implemented consistently and supported institutionally, the burden of preventable infections like CAUTI can be substantially reduced. The lessons from this study are not only applicable to ICUs but can be extended to medical wards, surgical units, and long-term care facilities. As healthcare systems increasingly focus on quality and patient safety, interventions like the catheter care bundle offer a pathway to safer, more efficient care delivery.

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