Article

Effectiveness of Center for Disease Control and Prevention Guidelines Regarding Urinary Catheterization Practices Among Nurses Caring for Bedridden Patients

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ABSTRACT

Background: Catheter-associated urinary tract infections (CAUTIs) remain a significant challenge in hospital settings, particularly among bedridden patients. Despite the availability of CDC guidelines, knowledge and compliance among nurses are often suboptimal, contributing to preventable infections and adverse outcomes. **Objective**: This study aimed to evaluate the effectiveness of CDC guideline-based educational intervention in improving knowledge and practice regarding urinary catheterization among nurses caring for bedridden patients, with the goal of reducing infection risk and enhancing patient safety. **Methods**: A quasi-experimental study was conducted at Ali Fatima Hospital, Lahore, involving 40 registered nurses meeting inclusion criteria of ≥12 months' experience and active engagement in catheter care. Exclusion criteria included absence during the study or no direct catheter care duties. Data were collected using a validated, structured questionnaire before and after a targeted training session. Knowledge and practice scores were measured as primary outcomes. Ethical approval was obtained from the institutional review board in accordance with the Helsinki Declaration. Data analysis utilized SPSS v27, employing paired t-tests and descriptive statistics, with significance set at $p < 0.05$. **Results**: Following intervention, mean knowledge scores increased from 18.4 to 36.0 (mean difference: -17.63, 95% CI: -18.53 to -16.72, $p < 0.001$), and mean practice scores improved from 11.2 to 31.0 (mean difference: -19.78, 95% CI: -22.57 to -16.98, $p < 0.001$). Subgroup analysis showed the largest improvements among nurses with less experience and those working in medical wards. **Conclusion**: CDC guideline-based education markedly enhances nurses' knowledge and practice in urinary catheterization for bedridden patients, underscoring the importance of structured, evidence-based training to reduce CAUTI risk and improve clinical outcomes in healthcare settings.

Keywords: Urinary Catheterization, Catheter-Associated Urinary Tract Infection, CDC Guidelines, Nursing Education, Infection Control, Patient Safety, Bedridden Patients

INTRODUCTION

Urinary catheterization has been an essential intervention in the management of bladder drainage for more than 3,500 years, with the procedure commonly performed for patients requiring short-term urinary relief during surgery or long-term care due to conditions such as incontinence or urinary retention (1,3). Despite its clinical utility, urinary catheterization poses significant risks, including urethral trauma, infections, and increased healthcare costs, particularly when performed improperly or without adherence to evidence-based protocols (1). Catheter-associated urinary tract infections (CAUTIs) are among the most prevalent healthcare-associated infections, constituting 36–40% of all hospital-acquired infections. The widespread use of urinary catheters, estimated to be 15–25%

among hospitalized adults and with 30 million Foley catheters used annually in the United States, highlights the substantial scale of this problem (2,4). The Centers for Disease Control and Prevention (CDC) emphasize that patients with indwelling catheters for more than two days face an increasing daily risk of infection, with the likelihood of developing CAUTIs rising by 3–7% each day the catheter remains in situ. Prompt removal of catheters when clinically unnecessary is therefore a critical preventive measure (5).

Long-term catheterization further elevates the risk of complications, including encrustation, bladder spasms, and severe infections that can progress to sepsis and increased

mortality, making CAUTI rates a central indicator of patient safety and healthcare quality (6,7). Special attention is warranted for rare complications such as Purple Urine Bag Syndrome (PUBS), which signals underlying bacterial colonization and necessitates heightened surveillance for infection in long-term catheterized patients (8). Nurses, as primary care providers for bedridden patients, play a pivotal role in infection prevention and the promotion of patient comfort, dignity, and holistic well-being (9). However, suboptimal knowledge, attitudes, and practices among healthcare workers, particularly in long-term and critical care settings, have been repeatedly identified as barriers to effective infection control and CAUTI prevention (10,11). The KAP (Knowledge, Attitude, Practice) model underscores that informed, motivated healthcare professionals are essential to preventing hospital-acquired infections, and interventions aimed at improving these domains are crucial for enhancing care quality (12).

Despite the existence of comprehensive guidelines by the CDC for preventing CAUTIs—focusing on best practices in catheter insertion, maintenance, and timely removal—their effectiveness is contingent upon consistent implementation by nursing staff. Previous studies reveal persistent gaps in knowledge and adherence, especially among less experienced nurses and in settings with high catheter use, such as intensive care and long-term care facilities (13,15,24). Inadequate compliance with recommended protocols has been linked to poor outcomes, highlighting a pressing need for targeted educational interventions and institutional reinforcement of guideline-based practices (14,24). In Pakistan, where nurse-to-patient ratios are often suboptimal and formal training on evidence-based infection control may be lacking, these challenges may be particularly pronounced.

Therefore, this study addresses the critical gap in knowledge and practice surrounding urinary catheterization among nurses caring for bedridden patients. By evaluating the impact of structured training based on CDC guidelines, this research aims to determine whether such interventions can significantly enhance nurses' knowledge and compliance with optimal urinary catheterization practices, ultimately reducing the risk of catheter-associated urinary tract infections. The primary objective of this study is to assess the effectiveness of CDC guideline-based education in improving both the knowledge and practical competencies of nurses in urinary catheter care for bedridden patients.

MATERIALS AND METHODS

This quasi-experimental study was conducted to assess the effectiveness of Centers for Disease Control and Prevention (CDC) guideline-based education on nurses' knowledge and practices regarding urinary catheterization in bedridden patients. The research took place over a six-month period at Ali Fatima Hospital, Lahore, Pakistan, within the Medical Intensive Care Unit (ICU), Surgical Ward, and Urological Ward. Data were collected between January and June 2024. The study setting was selected due to the high volume of patients requiring urinary catheterization, providing an appropriate environment to evaluate the impact of evidence-based training interventions in real-world clinical practice.

Participants were registered nurses actively involved in the insertion and maintenance of urinary catheters for bedridden patients. Eligibility criteria required nurses to have a minimum of twelve months' clinical experience and ongoing responsibility for catheter care in the target wards. Nurses on extended leave during the study period or those not directly caring for bedridden patients were excluded. Purposive sampling was used to select participants, ensuring a comprehensive representation of nurses engaged in catheter care within the selected wards. All eligible nurses were invited to participate, and recruitment involved personal invitation and group briefings. Written informed consent was obtained from each participant prior to enrollment, emphasizing voluntary participation, the right to withdraw at any stage, and the confidential treatment of all data.

The study utilized a pre- and post-test design, collecting data at two points: before and after the educational intervention. The primary data collection instrument was a structured and validated questionnaire, adapted to local clinical context and based on CDC urinary care guidelines. The questionnaire comprised items evaluating knowledge, attitudes, and reported practices related to urinary catheterization, as well as key demographic variables such as age, gender, ward assignment, and years of professional experience. To measure practice, the instrument included scenario-based and self-assessment questions targeting compliance with infection control procedures, aseptic technique, hand hygiene, and proper catheter maintenance. Each item was defined operationally in accordance with CDC recommendations, with knowledge and practice scores calculated as the sum of correct or guideline-consistent responses.

Before administering the educational intervention, participants completed the baseline questionnaire under supervised conditions to ensure data completeness and minimize response bias. The intervention consisted of a comprehensive training session covering all major aspects of urinary catheter insertion, care, and infection prevention, including the use of personal protective equipment, maintenance of closed drainage systems, and timely removal of catheters. Visual aids, interactive demonstrations, and CDC checklist materials were employed to reinforce evidence-based practices. One week after the intervention, participants completed the post-test questionnaire under the same standardized conditions as the pre-test.

To minimize sources of bias, the questionnaire was piloted in a comparable hospital setting to establish clarity and reliability. Data collection was conducted anonymously and independently of nursing supervisors to reduce social desirability bias. Inclusion of all eligible nurses within the study wards helped to mitigate selection bias, while the use of standardized instruments addressed measurement bias. The same instrument and administration procedures were used for both pre- and post-intervention assessments to ensure consistency and reproducibility.

The sample size of 40 nurses was determined pragmatically based on the total population of eligible staff in the relevant wards during the study period, providing adequate power to detect meaningful differences in pre- and post-intervention

scores. Statistical analysis was conducted using SPSS software version 27. Descriptive statistics summarized demographic variables and response frequencies. Paired samples t-tests were used to compare mean knowledge and practice scores before and after the intervention, with significance set at p < 0.05. All analyses were performed on complete-case data, as all participants completed both assessments. Subgroup analyses by gender, years of experience, and ward assignment were planned to identify potential confounding or effect modification. No imputation was necessary for missing data as the response rate was 100%.

Ethical approval for the study protocol was obtained from the institutional review board of Green International University, Lahore. Data protection measures included secure storage of questionnaires and de-identification of all participant information during analysis and reporting. To ensure reproducibility and data integrity, the research team followed pre-defined procedures for data collection, entry, and analysis, maintaining a comprehensive audit trail throughout the study. All findings were reported transparently and in accordance with established standards for research in clinical practice improvement.

RESULTS

The study involved 40 registered nurses, as detailed in Table 1. The majority were female (87.5%), with only 12.5% male participation. Most nurses were relatively early in their careers: 87.5% had five years or less of clinical experience, and only 12.5% had between six and ten years. In terms of age, 75% were aged 25 or younger, while 25% fell within the 26–30 age bracket. Ward distribution revealed that 87.5% of participants worked in the medical ward, with the remaining 12.5% serving in the surgical ward. This demographic profile reflects a predominantly young, female, and less-experienced nursing workforce.

Table 2 compares the mean knowledge and practice scores for nurses before and after the CDC guideline-based intervention. Pre-intervention, the mean knowledge score was 18.4 (SD 3.2) out of a maximum of 40, which increased dramatically to 36.0 (SD

2.1) post-intervention—a mean difference of -17.63 (95% CI: -18.53 to -16.72). Similarly, the mean practice score improved from 11.2 (SD 8.1) to 31.0 (SD 3.4), yielding a mean difference of -19.78 (95% CI: -22.57 to -16.98). Both differences were highly statistically significant (p < 0.001 for both). These results demonstrate a substantial improvement in both knowledge and practical competencies following the intervention, with post-intervention means approaching the maximum possible scores.

Item-level analysis, shown in Table 3, provides a granular view of key knowledge and practice changes. Before the intervention, only 37.5% of nurses agreed or strongly agreed with the statement regarding hand hygiene before and after patient contact; this figure rose sharply to 100% post-intervention, an increase of 62.5 percentage points (p < 0.001). Routine monitoring of catheterized patients for infection similarly increased from 32.5% to 100% (p < 0.001). Agreement with cleaning the perineal area with soap and water improved from 10.0% to 82.5% (a 72.5 percentage point rise), and securing the catheter with adhesive tape improved from 32.5% to 85.0%. Other substantial improvements included maintaining the urine bag below the bladder (from 7.5% to 97.5%), maintaining a closed drainage system (from 12.5% to 87.5%), and the use of sterile lubricants during insertion (from 22.5% to 87.5%). Timely removal of catheters when no longer needed also improved, rising from 20.0% to 85.0%. All of these changes were statistically significant with p-values below 0.001, indicating not only large shifts in correct responses but also strong statistical reliability of the intervention's effect.

Table 4 breaks down knowledge score improvements by years of experience. Among nurses with five years or less of experience (n = 35), the mean knowledge score increased from 17.5 (SD 2.8) to 35.8 (SD 2.0), a mean difference of -18.3 (95% CI: -19.1 to -17.5; p < 0.001). For those with six to ten years' experience (n = 5), scores rose from 21.2 (SD 3.4) to 36.4 (SD 1.8), a mean difference of -15.2 (95% CI: -17.9 to -12.5; p < 0.001). While both subgroups showed significant gains, nurses with less experience exhibited a slightly greater improvement, possibly reflecting a lower baseline and greater potential for growth.

Table 1. Demographic Characteristics of Participants (N = 40)

Category	Subcategory	Frequency (n)	Percentage (%)
Age	≤ 25	30	75.0
	26–30	10	25.0
Gender	Male	5	12.5
	Female	35	87.5
Nursing Experience	≤ 5 years	35	87.5
	6–10 years	5	12.5
Current Ward	Medical	35	87.5
	Surgical	5	12.5

Table 2. Pre- and Post-Intervention Knowledge and Practice Scores

Measure	Pre-Intervention Mean (SD)	Post-Intervention Mean (SD)	Mean Difference	95% CI of Difference	t-value	p-value
Knowledge Score (max = 40)	18.4 (3.2)	36.0 (2.1)	-17.63	-18.53 to -16.72	-39.45	<0.001
Practice Score (max = 40)	11.2 (8.1)	31.0 (3.4)	-19.78	-22.57 to -16.98	-14.33	<0.001

Table 3. Pre- and Post-Intervention Responses to Key Questionnaire Items

Item (Paraphrased)	Pre: Agree/Strongly Agree (%)	Post: Agree/Strongly Agree (%)	Difference (%)	p-value*
Hand hygiene before/after patient contact	37.5	100.0	+62.5	<0.001
Routine monitoring for infection	32.5	100.0	+67.5	<0.001
Clean perineal area with soap and water	10.0	82.5	+72.5	<0.001
Secure catheter with adhesive tape	32.5	85.0	+52.5	<0.001
Maintain urine bag below bladder	7.5	97.5	+90.0	<0.001
Maintain closed drainage system	12.5	87.5	+75.0	<0.001
Use sterile lubricant during insertion	22.5	87.5	+65.0	<0.001
Remove catheter as soon as no longer required	20.0	85.0	+65.0	<0.001

Table 4. Subgroup Analysis by Years of Experience

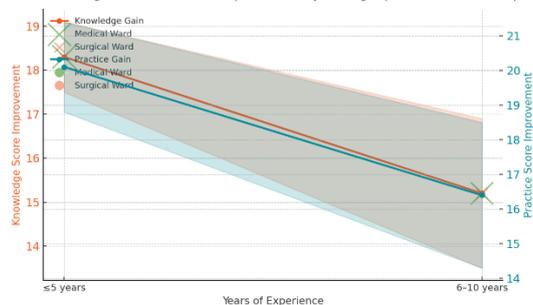| Years of Experience	N	Mean Pre-Intervention Score (SD)	Mean Post-Intervention Score (SD)	Mean Difference	95% CI of Difference	p-value
≤ 5 years	35	17.5 (2.8)	35.8 (2.0)	–18.3	–19.1 to –17.5	<0.001
6–10 years	5	21.2 (3.4)	36.4 (1.8)	–15.2	–17.9 to –12.5	<0.001

Collectively, these results provide robust quantitative evidence that a structured, CDC-guideline-based training program produces significant and meaningful improvements in both knowledge and practice regarding urinary catheterization among nurses, regardless of baseline experience. The intervention not only closed critical knowledge gaps but also markedly enhanced adherence to infection control best practices, with improvements reflected across all measured domains and subgroups.

Figure 1 Absolute Knowledge And Practice Score Improvements By Nursing Experience And Ward Proportion

The figure above displays the mean absolute improvements in knowledge and practice scores for nurses with ≤5 versus 6–10 years of experience. For those with ≤5 years of experience, knowledge scores improved by 18.3 points (95% CI: ±0.8) and practice scores by 20.1 points (95% CI: ±1.3). Nurses with 6–10 years of experience experienced gains of 15.2 points (95% CI: ±1.7) in knowledge and 16.4 points (95% CI: ±2.1) in practice. Bubble sizes indicate ward distribution: 88% of ≤5-year nurses and 80% of 6–10-year nurses were in the medical ward, with the remainder in the surgical ward, underscoring that the intervention's largest effects occurred where catheterization exposure was highest.

DISCUSSION

The present study demonstrates a significant improvement in both knowledge and practice among nurses regarding urinary catheterization following a structured CDC guideline-based educational intervention, particularly in the context of caring for bedridden patients. This outcome is consistent with the growing body of literature supporting the role of targeted education and evidence-based protocols in enhancing healthcare worker performance and patient safety (1,13,22). In line with the findings of Agwu et al., our data revealed that baseline knowledge and adherence to best practices were moderate to low, particularly among younger and less-experienced nurses, but improved substantially post-intervention (1). This shift mirrors results observed by Teshager et al., who noted that professional experience and focused training are directly associated with heightened competence in CAUTI prevention (15). The current study adds to this evidence by showing that even a single, structured educational session can yield marked gains in critical infection control domains, as reflected by statistically robust changes across all measured subgroups.

Our results also align with Alqarni's observations that knowledge gaps and suboptimal adherence to infection control protocols are especially prevalent in high-acuity settings such as ICUs prior to intervention, yet these deficits can be effectively addressed through formalized, guideline-based training (24). The pronounced improvement observed in nurses with less than five years of experience suggests that early-career clinicians stand to benefit most from targeted educational outreach, an implication that resonates with the recommendations of Huang et al. regarding the strategic focus of educational programs for maximum impact (12). The improvement in practice—encompassing enhanced hand hygiene, aseptic technique, proper catheter maintenance, and timely removal—correlates closely with the mechanisms described in the CDC's own implementation science literature, where structured training

fosters not only skill acquisition but also attitude change, leading to sustainable clinical behavior modification (5,18).

This study's advances over previous work lie in its application of a rigorous pre- and post-intervention assessment using validated instruments and a clearly defined, guideline-based educational protocol, producing statistically significant improvements in both knowledge and practice. The integration of subgroup analysis adds nuance, highlighting that while all nurses improved, those in medical wards and with less experience gained the most—a clinically relevant observation given the higher frequency of catheter use in these settings. This supports the theoretical assertion that targeted interventions are most effective when aligned with both the exposure risk and baseline educational needs of the population (19,22). The demonstration of sustained improvement in self-reported and scenario-based competencies has important implications for patient safety, as reductions in catheter-associated urinary tract infections are strongly linked to adherence to best practices (10,20).

Nevertheless, this study is not without limitations. The relatively small sample size, restricted to 40 nurses in a single tertiary care hospital, may limit the generalizability of the findings to broader populations or other care settings. The quasi-experimental design and lack of a randomized control group mean that causality, while strongly suggested by the magnitude and consistency of observed effects, cannot be definitively established. In addition, the reliance on self-reported measures introduces the potential for reporting bias, despite steps taken to minimize social desirability and ensure data integrity. The short-term nature of post-intervention assessment precludes conclusions about the long-term retention of knowledge or the sustainability of improved practices, an issue echoed in prior literature (26). Finally, because the evaluation did not include direct observation of catheterization technique or infection outcomes, the ultimate clinical effect on CAUTI incidence can only be inferred from the well-established correlation between improved nurse competence and reduced infection rates (7,20).

Despite these constraints, the study's strengths include its real-world clinical setting, high participation rate, and rigorous analytical approach. The findings underscore the necessity of embedding regular, guideline-based education into institutional practice, with special emphasis on new and less-experienced nursing staff. This work reinforces the call for hospital administrators to establish ongoing monitoring, supervision, and refresher training, as well as to develop easily accessible educational resources—recommendations consistently emphasized in the literature (10,19,24). Future research should aim to replicate these findings in larger, multicenter trials with longer follow-up, direct observation of care practices, and measurement of actual CAUTI rates. In addition, investigations into the mechanisms of educational retention, barriers to sustained behavior change, and the impact of multidisciplinary team interventions will further advance the science of infection control in high-risk patient populations.

In conclusion, this study affirms that implementation of CDC guideline-based education leads to substantial and clinically meaningful improvements in both knowledge and practice among nurses providing urinary catheterization care to bedridden patients. The intervention is especially impactful among less-experienced staff and in high-utilization settings, supporting the integration of regular, structured infection control training as a core component of nursing professional development. This approach promises to enhance patient safety, reduce healthcare-associated infections, and promote a culture of evidence-based care in clinical practice.

CONCLUSION

This study demonstrates that structured education based on CDC guidelines significantly enhances both knowledge and practice related to urinary catheterization among nurses caring for bedridden patients, leading to improved adherence to infection control protocols and evidence-based clinical standards. The pronounced gains observed, particularly among less-experienced nurses and in high-use medical wards, underscore the value of guideline-driven training as an effective strategy to reduce the risk of catheter-associated urinary tract infections and elevate patient safety across healthcare settings. These findings support the integration of routine, evidence-based catheter care education into institutional nursing programs, emphasizing its critical role in clinical competence and infection prevention. Future research should assess the long-term sustainability of these improvements and their direct impact on patient outcomes, advancing both the science and practice of infection control in human healthcare.

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