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Original Research Article

Healthcare Professionals' Compliance With Preventive Guidelines for Catheter-Associated Urinary Tract Infection at the Intensive Care Unit of a Tertiary Care Hospital

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Abstract: *Catheter-associated urinary Tract Infection (CAUTI) is a substantial cause of morbidity, mortality and healthcare costs in ICUS. Adhering to the CDC's CAUTI prevention recommendations is essential for reducing the risk of infection. The present study assessed HCPS' perception and compliance with the CAUTI prevention guidelines and their relationship with rates of CAUTI in the ICU of Nishtar Hospital, Multan.* ***Objectives:*** *To evaluate the HCPS' adherence to the CDC guidelines using the "observation checklist," to determine HCPS' self-perception and the factors influencing compliance and examine the association between compliance and CAUTI rates during the six-month surveillance period.* ***Methods:*** *The current study used a descriptive cross-sectional design over six months in the ICU of Nishtar Hospital, Multan. Convenient sampling was used to select participants. Data were collected by a "checklist" through direct observation of HCPS' adherence to CDC's recommendations, and their perception of CDC guidelines and factors influencing adherence. The Chi-square test was used to analyze the association between adherence and CAUTI incidence.* ***Results:*** *82% of respondents demonstrated good compliance, and 86% self-perception of the HCPS was good. 94% of HCPS reported that barriers were present which affected their compliance. The observed CAUTI rate was 60 per 1,000 catheter days, which exceeds the recommended threshold. A significant association was found between HCPS' compliance and rates of CAUTI.* ***Conclusion:*** *These findings underscore the need to enhance adherence to the CDC's CAUTI preventive guidelines for reducing CAUTI rates in the ICU setting. Implementing recommended protocols and overcoming obstacles leads to improved patient outcomes.*

Keywords: Catheter-associated urinary Tract Infection (CAUTI), Center for Disease Control Health Care Professionals (HCPS), Intensive Care Unit

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Introduction

Healthcare-associated infections (HAIS) are Hospital-acquired or nosocomial infections that are substantial problems that threaten patient safety and require global attention. These infections are not usually evident or incubating at the time of admission. These infections are typically acquired upon hospitalization and manifest 48 hours after admission Hernandez, King. (1). Universally, the healthcare-associated infection rate is 0.14%, increasing by 0.06% annually. The World Health Organization (WHO) stated that the rate of HAI is 5–15% in developed countries and 25% in developing countries. An important risk factor for HAIS is using invasive devices, e.g., vascular catheters, artificial airways, and urinary catheters. (2).

Moreover, the 5th most common type of healthcare-related infection is urinary tract infection. (3). About 75% of healthcare-associated UTIS are related to an indwelling urinary catheter. Nearly 100 million indwelling urinary catheters (IUCS) are utilized each year globally, as almost all patients admitted to the ICU have passed a catheter, and 16-33% of patients which hospitalized need a Foley catheterization at least once during their hospitalization. (4).

Indwelling urinary catheterization is necessary in hospitals, particularly in ICUS. Foley catheters are classified as short-term (less than 30 days) or long-term (more than 30 days). Acute care facilities typically utilize indwelling catheters for short periods, while long-term care facilities commonly use catheters for long periods. (5). CAUTI, purulent urethritis, non-bacterial urethral inflammation, urethral strictures, mechanical trauma, prostatitis, and bladder urolithiasis are among the infectious and non-infectious side effects of a Foley catheter (6).

Universally, CAUTI is the most prevalent healthcare-associated infection. (1). The rise in morbidity and mortality, increased medical expenditures, and hospital stays have all been associated with CAUTI. (7). CAUIT is defined as a UTI in a patient with catheterization for more than 48 hours and has a minimum of one unique symptom. UTTI symptoms include temperature (> 38°C), suprapubic tenderness, pain located at the costovertebral angle, and a positive urine culture for no more than 2 microorganisms (1).

Worldwide, the CAUTI rates vary; every year, more than 150 million people suffer from CAUTI globally. An estimated 500,000 CAUTIS occur in the United States annually, resulting in nearly 13,000 deaths each year. (8). Furthermore, prior studies revealed that CAUTI incidence differs by location. According to the survey, the CAUTI burden is higher in low-income countries than in high-income ones. (9).

In Pakistan, CAUTI is a significant burden and public health concern as it accounts for almost 80% of all nosocomial infections. Due to the high frequency of CAUTI, the usage of intrusive medical equipment raises the risk of severe complications, particularly in IUC. (10) (12). Rise in antibiotic resistance, lack of resources and funding and inadequate infection control practices cause problems for the healthcare system and promote the spread of CAUTI (11).

Nearly 70-80% of CAUTI cases are due to improper catheterization and non-compliance with CDC guidelines (12). According to a comprehensive survey, the approximate incidence of CAUTI in low-income countries was predicted to be 8.8 per 1000 catheter days and in high-income countries, it is 4.1 per 1000 catheter days (6).

Furthermore, CAUTI is the most prevalent hospital-acquired infection in chronically sick patients with bladder blockage, urine incontinence, spinal

cord injuries and hip fractures (12). There are several risk factors for CAUTI, including prolonged catheterization, immunocompromised status, female gender, urinary retention, advanced age or geriatric and pediatric age group, urinary tract abnormalities, poor hygiene, contamination of the catheter insertion site, comorbidities like diabetes, hypertension, and obesity(13) (15). Microbial colonization associated with the drainage bag, catheter, and periurethral section is an additional risk factor (6) (16). More than 25% of patients who use a catheter for longer than seven days get bacteriuria, which lengthens hospital stays and increases treatment expenses(14).

Hence, catheterization and the length of catheterization in ICU patients are risk factors for CAUTI, which can increase by 5% daily. Both infectious and non-infectious problems can arise from an IUC. These include purulent urethritis, urethral strictures, prostatitis, mechanical trauma, nonbacterial urethral inflammation, bladder urolithiasis, and catheter-associated urinary tract infections (CAUTI) (7).28 days after catheterization, this risk is thought to increase to 100%, resulting in approximately 4% of patients evolving from secondary sepsis to infection, and an estimated 30% fatality rate(15) (18). Untreated CAUTI can lead to serious complications in all patients, including endocarditis, meningitis, septic arthritis, pyelonephritis, vertebral osteomyelitis, gram-negative bacteremia, and cystitis. These conditions cause discomfort for the patient and have a surplus mortality rate of 23 per 1000 inpatients(16). Evidence-based clinical guidelines recommend the use of established measures to prevent CAUTI. Implementation of the preventive guidelines leads to a substantial reduction in CAUTI rates. The development of CAUTI is facilitated by inadequate adherence to evidence-based preventative guidelines, and discourages the significant work done to reduce iatrogenic infections (4).

Furthermore, a patient with bacteriuria and signs of UTI, along with a catheter inserted or removed within the previous forty-eight hours, is diagnosed with CAUIT (17). Additionally, the Hospital Infection Control Committee (HICC) is to diagnose CAUTI, the patient must fulfill the requirements as the CDC Atlanta recommends. A catheterized patient fulfilled the criteria if they had a temperature (>38℃), soreness in the suprapubic area, and a positive urine culture found a minimum of ten colony-forming units per milliliter, and only two micro-organisms were isolated (18). Urine testing for culture in a lab is necessary to diagnose CAUTI. Urine samples should be aseptically collected for laboratory examination to prevent contamination and needless antibiotic therapy (3). Moreover, CAUTI patients are identified by surveillance systems that monitor positive urine culture results from the laboratory. CAUTI surveillance aids in monitoring trends, identifying epidemics, and assessing the efficacy of preventative initiatives. Effective execution of infection control measures to prevent more CAUTI cases is possible. CAUTI monitoring ought to follow the guidelines of local regulatory authorities and according to the hospital's risk assessment policies. To establish an efficient surveillance system, the hospital administration should determine the at-risk patient group and units for CAUTI based on the frequency of catheterization and other variables such as critical care, obstetrics, and genitourinary surgery (3).

However, following and applying the preventive guidelines for healthcare professionals may be challenging in busy ICU settings. Planning interventions and enhancing patient safety and infection prevention efforts should start with determining insertion of the Foley catheter only when appropriate, use of aseptic technique at insertion time, proper maintenance care, and removal of the Foley catheter on time, which suggests CAUTI preventive strategies are presently being employed and to what extent. This information also helps identify gaps in clinical practice. Studies examining the extent to which healthcare facilities implement the preventive measures suggested by the guidelines are scarce (19). Only a few prior comparable studies were carried out locally or regionally. Thus, the present study aimed to determine the degree of HCPs' compliance at the ICU in Nishtar Hospital Multan with the preventive guidelines for CAUTI during the aseptic insertion of the indwelling urinary catheter (IUC), maintenance care, and catheter removal protocols (20).

The healthcare sector and professionals are under immense pressure to provide standardized, high-quality, evidence-based care that prioritizes patient safety and improves patient outcomes (21). Compliance with infection prevention and control measures by healthcare professionals (HCPs) is essential for preventing healthcare-associated infections (HAIs), particularly CAUTIs (1).

The objectives of this study were to assess healthcare professionals' compliance with CDC guidelines for CAUTI prevention through observation, evaluate their self-perceptions and influencing factors, and analyze the association between compliance and CAUTI incidence rates.

Methodology

A descriptive cross-sectional design was employed to assess healthcare professionals' (HCPs) adherence to the CDC guidelines for the prevention of catheter-associated urinary tract infections (CAUTIs) in the intensive care unit (ICU) of Nishtar Hospital, Multan, Pakistan. The study was conducted over six months, from March 2024 to August 2024, following ethical approvals from the Institutional Ethical Review Board (IERB Ref. No. 6994, dated 30-03-2024) and the Board of Advanced Studies and Research (BASR No. 701/NMU-Reg., dated 05-06-2024) of Nishtar Medical University, Multan. The setting included the College of Nursing in collaboration with the ICU department of Nishtar Hospital. The target population comprised all HCPs, including doctors and nurses directly involved in patient care in the ICU, and adult patients aged 18–40 who were catheterized for more than 48 hours. 50 HCPs meeting the inclusion criteria were enrolled using a non-probability convenience sampling technique. For the patient population, a priori sample size estimation was conducted using G*Power 3.1.9.2, assuming a significance level of 0.05 and study power of 95%. The required sample size was calculated as 42 patients, which was adjusted to 50 after accounting for a 19% anticipated attrition rate.

Three tools were used for data collection: (i) a demographic data form, (ii) a structured observation checklist based on CDC guidelines, and (iii) a self-administered questionnaire designed to assess self-perception and perceived barriers to adherence. The observation checklist assessed compliance in five key domains: appropriate catheter indications, hand hygiene, aseptic insertion technique, maintenance, and timely removal. Compliance was rated on a dichotomous scale (Yes = 2, No = 1), with scores above 70 considered good compliance. The self-perception tool included 12 Likert-scale items based on CDC guidelines and 8 dichotomous items identifying perceived barriers. Perception scores were interpreted using Bloom's cut-off point: <60% as poor, 60–79% as satisfactory, and ≥80% as good. Observations were conducted covertly by trained intern nurses during three ICU shifts, using standardized checklists to minimize observer bias and Hawthorne effect. Each HCP was observed at least three times, and those who complied with CDC recommendations twice were classified as adherent. Only the first valid observation per participant was retained in the analysis to prevent duplication.

Surveillance of CAUTI incidence among ICU patients was performed by monitoring for symptoms consistent with CDC/NHSN diagnostic criteria and confirmed via microbiological urine culture. Urine samples were aseptically collected from the catheter access port after 48 hours of catheterization, avoiding contamination from the drainage bag. The rate of CAUTI was calculated using the formula: (Number of new CAUTI cases ÷ Total catheter days) × 1000. Catheter days were determined by summing the number of patients with Foley catheters recorded at the same time each day. Reliability testing of the tools was conducted through a pilot study with 10% of the sample, yielding Cronbach's alpha values of 0.844, 0.930, and 0.928 for the observation checklist, self-perception

scale, and barrier identification scale, respectively. Content validity was established through expert review by six professionals from diverse disciplines. The Content Validity Index (CVI) for the tools ranged from 0.83 to 0.87, confirming the tools' appropriateness for the study.

Data were analyzed using SPSS version 26. Descriptive statistics were used to summarize demographic variables and outcomes, while the Chi-square test was applied to explore associations between HCP compliance and CAUTI incidence. A p-value <0.05 was considered statistically significant. Ethical considerations adhered to the principles of the Declaration of Helsinki. Participants provided written informed consent after being informed about the study's objectives, benefits, and their right to withdraw at any time. Confidentiality and anonymity were ensured through coded data and secure data handling protocols. Administrative approvals were also obtained from the ICU department. No risks were associated with participation in the study, and all procedures were conducted with strict adherence to institutional ethical guidelines.

Results

Among the 50 HCPs surveyed, the majority (64%) were between the ages of 21 and 30, with a mean age of 31.92 ± 7.26 years. Regarding ICU experience, 58% of the professionals had 1–5 years of experience, with a mean of 6.00 ± 4.54 years. The patient sample also comprised 50 individuals, predominantly in the 33–37 years age group (28%), with a mean age of 31.60 ± 6.40 years. (Table 1).

Table 2 summarizes healthcare professionals' compliance with CDC-recommended CAUTI prevention guidelines based on direct observation. The table outlines practices related to catheter indication, hand hygiene, aseptic technique, maintenance, and removal. High compliance was observed in areas like catheter size selection and documentation, while poor adherence was noted for hand hygiene before insertion and peri-urethral cleaning.

Table 3 shows the levels of self-perception among healthcare professionals regarding their adherence to the CDC's CAUTI guidelines. The majority (86%) had a good perception, while only 8% rated their self-perception as poor, indicating a generally positive outlook towards compliance practices. (Table 3).

Table 4 lists institutional and operational factors that influence compliance. The most commonly cited barriers include lack of training (92%), absence of regular CDC training programs (100%), and insufficient staffing (82%). These findings highlight the need for systematic institutional support to enhance adherence. (Table 4).

Table 5 presents the calculated CAUTI rate over a six-month surveillance period. Among 250 catheter-days, 15 cases of CAUTI were confirmed, yielding a rate of 60 per 1000 catheter-days or 6%, categorizing the ICU as a high-risk area for CAUTI based on CDC thresholds. (Table 5). The association between healthcare professionals' compliance with CDC guidelines for the prevention of catheter-associated urinary tract infections (CAUTIs) and the actual incidence of CAUTI was assessed using the Pearson Chi-Square test. The results are presented in Table 6.

Table 1: Demographic Characteristics of Study Participants (HCPs and Patients)

Category	Group	Frequency	Percentage (%)
Age Group (HCPs)	21-30	32	64
	31-40	13	26
	41-50	4	8
	51-60	1	2
Experience (Years, HCPs)	1-5	29	58
	6-10	11	22
	11-15	8	16
	16-20	2	4
Age Group (Patients)	18-22	6	12
	23-27	8	16
	28-32	10	20
	33-37	14	28
	38-40	12	24

Table 2: Assessment of HCPs' Compliance with CDC Guidelines

Component	Yes (n)	No (n)	Yes (%)	No (%)
Indications for Catheterization	50	0	100	0
Hand Hygiene Before Insertion	18	32	36	64
Hand Hygiene After Insertion	44	6	88	12
Use of Appropriate Catheter Size	50	0	100	0
Perineal Care and Asepsis	39	11	78	22
Use of Sterile Gloves & Equipment	42	8	84	16
Single-use Lubricant	39	11	78	22
Aseptic Technique with Drainage	40	10	80	20
Documentation of Insertion Date	48	2	96	4
Urine Bag Below Bladder Level	47	3	94	6
Check for Tubing Kinks	45	5	90	10
Closed Drainage System	47	3	94	6
Empty Bag When 3/4 Full	44	6	88	12
Separate Urine Collection Jars	43	7	86	14
Routine Peri-urethral Cleaning	3	47	6	94
Urine Culture After 48 Hrs	43	7	86	14
Catheter Removal Assessment	35	15	70	30
Documentation of Removal Date	39	11	78	22

Table 3: Self-Perception of HCPs Regarding CDC Guidelines

Category	Frequency	Percentage (%)
Good	43	86
Satisfactory	3	6
Poor	4	8

Table 4: Factors Affecting HCPs' Compliance with CDC Guidelines

Factor	Yes (n)	No (n)	Yes (%)	No (%)
Received Training on CDC Guidelines	4	46	8	92
Regular Training Courses Offered	0	50	0	100
Standardized Protocols Available	3	47	6	94
Adequate ICU Staffing	9	41	18	82
Supplies for Aseptic Catheter Insertion	44	6	88	12
Administrative Support for Guidelines	6	44	12	88
Evidence-Based CAUTI Practices	24	26	48	52

Table 5: CAUTI Rate During Surveillance Period

Parameter	Value
Diagnosed CAUTI Cases	15
Total Catheter Days	250
CAUTI Rate (per 1000)	60
CAUTI Rate (%)	6
CDC Categorization	High (5.0 – 9.9)

As shown in Table 6, the Pearson Chi-Square value was 11.931 with a p-value of 0.002, indicating a statistically significant association between the level of compliance with preventive guidelines and the rate of CAUTI incidence. Given that the p-value is below the significance threshold of 0.05, the null hypothesis is rejected, and the alternative hypothesis is accepted. This confirms a significant relationship between compliance to CDC guidelines and lower incidence of CAUTI. (Table 6)

Table 6: Association Between HCPs' Compliance with CDC Guidelines and CAUTI Incidence (n = 50)

Compliance Level	CAUTI Positive (n)	CAUTI Negative (n)	Pearson Chi-Square	*p*-value
Good Compliance	8	33		
Poor Compliance	7	2	11.931	0.002*
Total	15	35		

$p \leq 0.05$ considered statistically significant

Discussion

This study assessed healthcare professionals' compliance with CDC guidelines for CAUTI prevention in the ICU of Nishtar Hospital, Multan. The chapter presents key findings, conclusions, limitations, recommendations, and implications for future research, structured around five sections: participant demographics, HCPs' compliance, self-perception and influencing factors, CAUTI surveillance, and the association between compliance and infection rates. The demographic profile of ICU staff revealed that most participants were young, with ages ranging from 24 to 57 years and a mean of 31.92 ± 7.26 years. Notably, 64% were between 21 and 30 years. This youthful workforce may enhance adaptability to evidence-based practices and digital health technologies. These findings are consistent with studies conducted in Karachi and Lahore, which also reported a predominance of participants in the 20–30 age group.(13). Another study conducted at Jinnah Hospital Lahore revealed that most of the participants fall in the same age group (22). Moreover, a study conducted in Mangaluru, India, found the same results, with most participants aged between 20 and 30 years (23).

The gender distribution showed a significant majority of 74% females and 26% males. Findings may suggest that female healthcare professionals often exhibit strong collaborative skills and a patient-centred approach, which can enhance team dynamics and improve quality care. According to a related study, women comprised the majority of participants (64%) at Embu Level 5 Hospitals in Embu County, Kenya. The high number of female healthcare professionals in the ICU aligns with a study conducted in the USA, which revealed that women made up 26% of ICU doctors and 33% of critical care trainees. This suggests a steady rise in female representation in critical care roles (24).

In the current study, the researcher deliberately included doctors and nurses as HCPs because they were directly involved in patient care in the ICU, of which a significant majority (72%) were charge nurses, while 28% were doctors. This distribution highlights the critical role of nursing staff, particularly charge nurses, in CAUTI prevention in the ICU. Congruent with the current study's findings, a survey conducted in Sana City, Yemen, found that 76.8% of the respondents were nurses, while only 23% were doctors working in the ICU (38). In contrast to the findings of the current study, findings of a study on safe urinary catheterization practices among HCPs in Rawalpindi, Pakistan's public and private hospitals, revealed that doctors made up the majority of respondents (54.3%), while nurses made up 42% (11).

According to the survey (Figure 4.3), 46% of nurses held a BSN and 16% had a diploma, while 8% of doctors had an MBBS and 16% held an FCPS qualification. The high proportion of BSN-qualified nurses indicates a well-educated workforce, which is essential for applying evidence-based practices in ICU settings. Similarly, the presence of MBBS and FCPS-qualified doctors reflects a typical tertiary care team structure. These findings align with a Zonguldak Bulent Ecevit University Hospital study, which reported a similar mix of qualifications among healthcare professionals. (25).

The findings (Table 4.2) showed varied ICU experience among participants: 50% had 1–5 years, 30% had 6–10 years, 16% had 11–15 years, and 4% had 16–20 years, with a mean of 6.00 ± 4.54 years. This suggests a moderately experienced workforce, predominantly of relatively new professionals. While early-career HCPs bring adaptability and energy, limited clinical exposure may affect complex decision-making in critical care. In contrast, an ICU study from Australia reported participants with broader experience, ranging from 7 to 35 years, highlighting a more seasoned workforce.(26). According to another study's findings conducted at Zonguldak Bulent Ecevit University Hospital, Turkey, doctors and nurses who took part in the study had an average of 12.5 years of experience (25). The study found that 82% of healthcare professionals complied with CDC guidelines for CAUTI prevention in the ICU, while 18% showed poor compliance. All respondents adhered to proper indications for catheterization, reflecting strong awareness of clinical necessity in critically ill patients. However, only 36% followed hand hygiene protocols before insertion, compared to 88% after, indicating a critical gap likely influenced by workload, limited resources, or time constraints. While universal compliance was observed in choosing appropriate catheter sizes, there were inconsistencies in maintaining aseptic technique, perineal care, and sterile equipment, often due to time pressures in emergency settings. Maintenance practices such as proper bag positioning, tubing checks, and timely urine cultures showed high compliance. Still, peri-urethral cleaning was notably low at 6%, suggesting it is deprioritized during high workload. Catheter removal was reassessed in 70% of cases and documented in 78%, with hesitancy likely due to patients' critical condition. These findings indicate good adherence to infection prevention protocols, supported by adequate supplies and senior supervision. Similar patterns were reported in a Yemeni study, which found a 71% compliance rate.(4). According to the current study findings, studies conducted in North West Ethiopia showed that despite high CAUTI prevention awareness, adherence to the preventive measures was low (27).

Per the current study's results, a study was carried out to evaluate the understanding and practices of HCPs on CAUTI prevention recommendations in a tertiary care hospital in Chennai, Tamil Nadu, India. 95.8% of respondents followed CAUTI prevention measures properly, whereas 4.2% did so moderately per their practice evaluation (12).

Contrary to the current study's findings, a study was carried out at King Abdulaziz Hospital, Saudi Arabia, to evaluate the knowledge and practices for the prevention of CAUTI. According to the findings, 83.94% of nurses had poor adherence, and 16.1% had effective practices (28). Furthermore, according to the findings of another study done in India, 78.26% of HCPs moderately followed the CAUTI care bundle, 25.54% practiced well, and 12.5% had poorly practiced (29).

According to the current study, 86% of ICU healthcare professionals demonstrated good knowledge of CDC guidelines for CAUTI prevention, reflecting a workforce that is generally informed and motivated to maintain infection control standards. This may be supported by regular infection control team visits that provide feedback and reinforce best practices. However, a small proportion of respondents (6% satisfactory, 8% poor knowledge) likely includes newer staff or those from non-ICU departments, who lack formal training. Despite the high self-reported knowledge, certain practices revealed gaps in compliance. While most participants recognized the importance of documentation (92%), aseptic techniques (94%), appropriate catheter size (94%), and positioning of urine bags (88%), hand hygiene before catheter insertion remained inconsistent—possibly due to workload, misconceptions about glove use, or prioritization of critical care tasks. Additionally, although 76% acknowledged the need for urine cultures after 48 hours, some may skip this step due to concerns about antibiotics affecting test accuracy. These findings underscore the importance of continuous education in bridging the gap between perceived knowledge and actual practice.

According to the current study, a study was conducted in a tertiary care teaching hospital in Chennai, Tamil Nadu, India, to evaluate HCPs' knowledge and practices regarding CAUTI prevention. According to the research participants' knowledge level assessment, 28.4% had relatively adequate knowledge, and 71.6% had sufficient knowledge regarding CAUTI prevention (12).

Additionally, research at Jinnah Hospital in Lahore, Pakistan, also found similar results, stating that although 75% of respondents thought they followed the recommendations, actual compliance rates were lower, especially in areas like documentation and hand cleanliness (22).

Contrary to the current study findings, according to a study conducted at the University of Gondar in Ethiopia, most respondents (63.04%) had poor knowledge about CAUTI prevention. Their practice was also below acceptable levels, as evidenced by their score of 52.17% for good practice, which was also below the knowledge level, especially in areas like aseptic technique and hand hygiene, appropriate indication for catheterization, and changing the Foley catheters at regular and fixed intervals (30). Moreover, another study was conducted in Maharashtra to evaluate the practices and knowledge related to CAUTI care packages. The findings of the study revealed that, concerning the CAUTI care bundle, 54.89% of respondents had moderate knowledge, 36.95% had inadequate information, and 8.15% had adequate understanding (29).

Evaluating factors affecting HCPs' adherence to the CDC's CAUTI prevention guidelines revealed significant challenges. Only 6% of respondents reported no barriers to compliance, while 94% acknowledged facing obstacles, underscoring the urgent need to address these issues. A key concern was the lack of formal training—92% of HCPs had not received instruction on CDC protocols, likely due to the absence of targeted educational programs. Additionally, 94% reported the unavailability of written hospital policies on CAUTI prevention. Inadequate staffing emerged as a major barrier, with 82% of HCPs citing high patient loads and low staff-to-patient ratios as impediments to effective catheter care. Nishtar Hospital, like many tertiary care centers in Pakistan, struggles with limited personnel and brain drain, further complicating compliance. Although 88% of staff had access to essential supplies, 12% faced shortages, indicating inconsistency in resource provision. Only 12% felt supported by hospital management, citing limited audits and feedback. The focus on managing critically ill patients often overshadows routine catheter care. Despite these barriers, HCPs showed a reasonable understanding of CAUTI prevention. Still, systemic issues—including resource constraints, lack of training, and administrative gaps—continue to hinder full adherence, reflecting broader challenges within Pakistan's healthcare infrastructure. In line with the results of the current study, a survey carried out in Kenya found low levels of knowledge and compliance, emphasizing the presence of personal factors, inconsistent resource availability, and insufficient workers with greater workloads as the primary obstacles to following the CDC's CAUTI prevention guidelines (31).

Another study conducted in Massachusetts, USA, revealed that long-term catheterization is a well-known risk factor for CAUTI; other factors also play a critical role. In addition, many risk factors are linked to CAUTI, including prolonged catheterization with higher rates observed after 7 days of catheter use, female gender, advanced age, diabetes or chronic kidney disease, immunocompromised status, urinary tract abnormalities, co-morbidities, critical illness, ICU setting, urinary retention, poor hygiene, and patient immobility and unconsciousness can also contribute to the risk of CAUTI (32). The CAUTI rate from March to August 2024 during the surveillance period was 4.0%, indicating a moderate level of infection among catheterized ICU patients. This figure suggests that while infection control measures are partially in place, considerable room remains for improvement. In high-income countries, the CDC recommends a CAUTI rate of less than 1.0 per 1,000 catheter days; however, rates in low- and middle-income countries (LMICs) are often three times higher. The observed rate at Nishtar Hospital reflects this global disparity and raises concerns about the effectiveness of current preventive strategies. Data from the International Nosocomial Infection Control Consortium (INICC) support this trend, showing that while average CAUTI rates in LMICs have declined—from 8.9 to 2.91 per

1,000 catheter days—they still exceed ideal benchmarks. Although the CAUTI rate in this study is lower than previous INICC figures, it remains a significant concern, highlighting the need for enhanced training, stricter protocol adherence, and continuous monitoring to reduce infection risk in ICU settings. (33).

Moreover, a study evaluated several findings on CAUTI incidences from other studies conducted in Makkah, Saudi Arabia. A CAUTI rate of 3.2 per 1000 catheter days was reported by two surveillance and observational studies conducted in three GCC nations – Bahrain, Oman, and Saudi Arabia. The rate of CAUTI ranged from 2.3 to 4.4 in twelve Saudi Arabian hospitals under the Ministry of Health. Another prospective surveillance research found the high CAUTI rate of 8.18 per 1000 catheter days. The average CAUTI rate was 5.1 per 1000 catheter days, as determined by pooled surveillance data from forty-five nations, including Saudi Arabia, while other research revealed a lower rate of 1.7 per 1000 catheter days. Furthermore, a surveillance study found a CAUTI rate 4.7 per 1000 catheter days in seven ICUs in Saudi Arabia. Moreover, an Indian study found a CAUTI rate of 7.03 per 1000 catheter days (34) (35). Likewise, a study identified key barriers to monitoring HAIs in Low and Middle-Income (LMIC) nations conducted in Sri Lanka. The key obstacles were the shortage of HCPs, including infection control staff, the absence of an integrated healthcare system with effective data flow and the lack of adequate diagnostic facilities. A significant limitation in the clinical laboratories of LMIC is their capacity to detect microbes resistant to antibiotics. These all have an impact on the surveillance of infection and antibiotic resistance (36).

Conversely, a cross-sectional study examined the risk factors and CAUTI prevalence in hospitalized patients in Karachi, Pakistan. The study found a low CAUTI of 27% in tertiary care hospitals. But it also noted that comorbidities like hypertension, diabetes, and being woman were risk factors (37).

The association between HCPs' compliance and CAUTI rates is discussed in this section. A statistically significant association was found between the CAUTI rates and HCPs' compliance, as evidenced by the Chi-Square value of 8.672 and a p-value of 0.010, which < 0.05. This suggests that adhering to CAUTI prevention protocols is associated with lower CAUTI rates, while non-compliance is associated with higher rates. So, the researcher rejected the Null Hypothesis and accepted the alternative or Research Hypothesis.

The current research findings are consistent with findings from various studies and have demonstrated similar relationships between compliance and infection rates. The results of this study are also consistent with a survey conducted in Omaha, US, which showed the association between implementing CAUTI prevention protocols and a significant decrease in CAUTI rates from 4.8 per 1,000 catheter days to 0.8 (38). The findings from Table 6 demonstrate a statistically significant association between healthcare professionals' compliance with CDC guidelines and the incidence of catheter-associated urinary tract infections (CAUTIs), as indicated by the Pearson Chi-Square value of 11.931 and a p-value of 0.002. This suggests that higher compliance with infection control practices is strongly associated with reduced rates of CAUTI.

These results are consistent with existing literature emphasizing the role of adherence to evidence-based guidelines in minimizing healthcare-associated infections. Studies have shown that interventions such as proper hand hygiene, aseptic catheter insertion, and timely removal significantly reduce infection risk (8,12). The high incidence of CAUTI in the poor compliance group underlines the need for continuous training, monitoring, and reinforcement of preventive protocols to ensure patient safety.

Studies that yielded contradictory results were nonexistent. Nonetheless, the difficulties that healthcare facilities in low-income nations encounter, such as inadequate resources and lack of training, standardized protocols, supplies, and support from the administration, can hinder compliance with CAUTI prevention protocols.

Conclusion

The statistically strong association between CAUTI rates and compliance with the CDC's CAUTI preventive guidelines highlights the importance of compliance. Additionally, it evaluated how HCPs see these standards and looked at variables that affect compliance. Better compliance leads to better patient outcomes, according to local and international studies, which are supported by the findings from Nishtar Hospital. Healthcare facilities must prioritize continued education and training sessions, establish standardized protocols, and promote a culture of patient safety and accountability among staff so that CAUTI rates can be reduced. The present study addressed substantial issues in enhancing adherence to the CDC's CAUTI prevention protocols, such as inadequate training and a lack of procedures and policies.

Declarations

Data Availability statement

All data generated or analysed during the study are included in the manuscript.

Ethics approval and consent to participate

Approved by the department concerned. (IRBEC-MMNCS-0331d-24)

Consent for publication

Approved

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Conflict of interest

The authors declared the absence of a conflict of interest.

Author Contribution

YT (MSN Scholar)
Manuscript drafting, Study Design,
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Review of Literature, Data entry, Data analysis, and drafting article.
SA (Principal)
Conception of Study, Development of Research Methodology Design,
QUN (Principal/Dean)
Study Design, manuscript review, critical input.
Review of Literature, Data entry, Data analysis, and drafting article.

All authors reviewed the results and approved the final version of the manuscript. They are also accountable for the integrity of the study.

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