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ORIGINAL ARTICLE

Frequency of catheter associated urinary tract infections in PICU of NICH, Karachi, Pakistan.

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ABSTRACT… Objective: To determine the frequency of catheter associated urinary tract infections (CAUTI) in children admitted to pediatric intensive care unit (PICU). **Study Design:** Cross-sectional study. **Setting:** The PICU of National Institute of Child Health, Karachi, Pakistan. **Period:** 10th July 2025 to 25th November 2025. **Methods:** A total of 158 children aged 1 month to 12 years who underwent urinary catheterization for ≥1 week were enrolled through consecutive sampling. Demographic and clinical data, catheter duration, and outcomes were recorded. Data were analyzed using SPSS v26.0, applying chi-square, Fisher's exact, t-test, or Mann–Whitney U test, with p<0.05 considered significant. **Results:** Among 158 children, 92 (58.2%) were males, and 66 (41.8%) females, with a median age of 3.4 years (IQR 1.2–7.8). Respiratory diseases were observed in 104 (65.8%), neurological disorders in 22 (13.9%), and cardiac disorders in 16 (10.1%). CAUTI developed in 31 (19.6%) children after a median of 10 days (IQR 9–13). Malnutrition (22.6% vs. 8.7%, p=0.029). and sepsis (19.4% vs. 6.3%, p=0.022) were significantly associated. E. coli (45.2%), and K. pneumoniae (29.0%) were common isolates with highest sensitivity to meropenem (80.6%) and resistance to ciprofloxacin (71.0%). CAUTI cases had longer catheterization (12.7 vs. 9.2 days, p<0.001), PICU stay (14.2 vs. 10.5 days, p=0.004), and higher mortality (35.5% vs. 16.5%, p<0.001). **Conclusion:** Catheter-associated urinary tract infection was identified in nearly one-fifth of critically ill children admitted to the PICU. Prolonged catheterization, malnutrition, systemic infection, and mechanical ventilation significantly increased CAUTI risk.

Key words: Catheterization, Children, E. Coli, Mortality, Sepsis.

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INTRODUCTION

Urinary tract infections (UTIs) are among the most frequent types of healthcare-associated infections (HAIs), with a burden between 35-40% cases.[1,2,3] Catheter-associated urinary tract infections (CAUTI) are the largest HAIs around the world, affecting around 35% cases.[4] Indwelling urinary catheters can be associated with 70-80% of complications in UTIs.[5] According to CDC, each patient using a catheter for 48-hour and infected by a UTI has CAUTI.[6] Every tube that enters the bladder through the urethra is included in indwelling catheters except the suprapubic catheter and nephrostomy tube.[6]

CAUTI may occur due to biofilm that gathers bacteria in and outside of catheter surface right after the catheter entrance.[7] Insertion of catheter also hinders body's ability to eliminate bacterial from the lower urinary tract.[8] Employment of multiple invasive devices and procedures, increased contact with the healthcare staff and hospitalization are some of the most common factors behind CAUTI.[9,10]

Monitoring CAUTI rates can serve as a key quality indicator for healthcare institutions and supports targeted interventions aimed at reducing infection rates and associated adverse outcomes.[11] This study was planned with the objective of determining the frequency of CAUTIs in children admitted to PICU.

METHODS

This cross-sectional study was performed at the PICU of the National Institute of Child Health (NICH), Karachi, Pakistan, from 10th July 2025 to 25th November 2025. Approval from the institutional ethical review board was obtained before the study commenced (Letter number: IERB-29/2024, dated: 8th July, 2025). A sample size of 158 was calculated using the online OpenEpi sample size software, taking the anticipated prevalence of

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CAUTI as 18%[13], with a 95% confidence level and a 6% margin of error. Children aged 1 month to 12 years, admitted to the PICU and underwent urinary catheter insertion within 48-hour of admission were analyzed. Those who had a duration of urinary catheter ≥ 1 week were included in this study.

The exclusion criteria were children with diagnosed UTI at the admission time (as per medical record and history) or who develop UTI in the first 2 days following urinary catheter insertion (as per medical record). Children with immunocompromised disorders or taking immunosuppressive drugs, any kind of trauma, or planned to undergo any kind of surgery, or those who left against medical advice (LAMA) were not enrolled for this study. Sample selection was carried out employing a non-probability, consecutive sampling technique. Parents/legal guardians were briefed about the objective and safety of the study before obtaining informed and written consent from them.

The enrolled subjects went through documentation of their demographic and clinical information. The duration of catheterization (days) and any catheter replacement during the stay (yes/no) were also documented. All enrolled patients were prospectively monitored for the duration of their PICU stay. Urinalysis (urine D/R), along with urine culture and sensitivity (urine C/S), was performed at baseline (within 24 hours of catheter insertion) to exclude pre-existing UTI and repeated whenever a patient developed clinical features suggestive of CAUTI during catheterization. The patients who fulfilled all of the following criteria were considered to have acquired CAUTI.[12] i) the patient has had an indwelling urinary catheter in place for more than two consecutive days in the hospital and was either still catheterized or had the catheter removed within the previous 48 hours, ii) the patient exhibited at least one of the following signs or symptoms: fever (body temperature >38°C), suprapubic tenderness, costovertebral angle pain or tenderness, new or worsening urgency, frequency, or dysuria (if the child is developmentally able to report these symptoms), signs of systemic illness (such as unexplained lethargy or irritability in infants and young children), iii) the patient had a urine culture that grows at least one bacterial species at ≥10^5 colony-forming units per milliliter (CFU/mL). The duration of catheterization, total length of PICU stay, overall hospital stay, requirement for mechanical ventilation, and final patient outcomes (discharge or death) were noted.

Data were analyzed using "IBM-SPSS Statistics" version 26.0. The categorical variables were summarized as frequencies and percentages. For the continuous variables, means and standard deviations (SD) were computed for normally distributed data, or medians and interquartile ranges (IQR) for non-normally distributed data, after applying the Shapiro-Wilk test. Associations between CAUTI and categorical data were performed using chi-square test or Fisher's exact test. The independent samples t-test or Mann-Whitney U test was employed for continuous variables, as appropriate. A p-value <0.05 was considered statistically significant.

RESULTS

In a total of 158 children, 92 (58.2 %) were males. The median age, weight, and height at admission were 3.4 years (IQR 1.2 to 7.8), 13.8 kg (IQR 9.5 to 18.6), and 93.0 cm (IQR 78.0 to 110.0), respectively. The underlying diagnosis on admission was respiratory disease in 104 (65.8 %) patients, neurological disorder in 22 (13.9 %), and cardiac disorder in 16 (10.1 %) patients. Malnutrition was present in 18 (11.4 %), sepsis or systemic infection in 14 (8.9 %), congenital heart disease in 7 (4.4 %), chronic kidney disease in 4 (2.5 %), and cerebral palsy in 1 (1.9 %) patients.

Overall, 31 (19.6 %) children developed CAUTI during their PICU stay, and the median time to onset of infection was 10 days (IQR 9 to 13) after catheter insertion. Children with CAUTI were more frequently malnourished than those without CAUTI (22.6% vs. 8.7%, p=0.029), and had sepsis or systemic infection (19.4 % vs 6.3 %, p=0.022), and the details are shown in Table-I.

Among 31 (19.6%) children who developed CAUTI during their PICU stay, urine cultures yielded a single bacterial species in each case. Escherichia coli was isolated in 14 (45.2%) cases, Klebsiella pneumoniae in 9 (29.0%), Pseudomonas aeruginosa in 5 (16.1%), and Enterococcus spp. in 3 (9.7%).

The antibiotic sensitivity profile showed the greatest susceptibility to meropenem (25 isolates, 80.6%), followed by piperacillin–tazobactam (21, 67.7%), amikacin (19, 61.3%), and nitrofurantoin (16, 51.6%). Sensitivity to ceftriaxone (12, 38.7%) and ciprofloxacin (9, 29.0%) was low. Resistance to 3rd-generation cephalosporins, and fluoroquinolones was observed in 61.3%, and 71.0% of isolates, respectively. Resistance to nitrofurantoin was seen in 48.4% of isolates, and carbapenem resistance was reported in 6 (19.4%) cases.

The median duration of catheterization was 12.7 days (IQR 10.3 to 14.5) for those with CAUTI, and 9.2 days (IQR 8.1 to 11.4) for those without (p<0.001). Mechanical ventilation was required in 98 (62.0 %) patients overall, including 27 (87.1%) with CAUTI, and 71 (55.9%) without CAUTI (p<0.001). The total median duration of PICU stay was 11.5 days (IQR 8.6 to 15.3), and 14.2 days (IQR 10.4 to 18.6) in the CAUTI cases, and 10.5 days (IQR 7.1 to 13.3) without CAUTI (p=0.004). The total duration of hospitalization was 16.6 days (IQR 12.4 to 21.5) overall, 20.4 days (IQR 15.5 to 25.0) for patients with CAUTI, and 15.6 days (IQR 12.9 to 19.4) without CAUTI (p=0.002). A total of 126 (79.7%) patients survived and discharged, whereas mortlaity was noted in 32 (20.3%). Mortality occurred in 11 (35.5 %) children with CAUTI and 21 (16.5 %) without infection, demonstrating a statistically significant association between CAUTI and in-hospital death (p<0.001), as shown in Table-II.

DISCUSSION

The frequency of CAUTI among children admitted to the PICU in this study was 19.6%. This finding is close to the incidence reported by Nazir et al.[14], from Fatima Memorial Hospital, Lahore, where 27.3% of catheterized children developed CAUTI. In contrast, lower rates were described by Lalitha et al.[15], in India, who reported an occurrence rate of 7.2 per 1000 catheter-days, and by Haque et al.[16], in Bangladesh, with a rate of 0.24 per 1000 urinary catheter-days.

TABLE-I

Association of CAUTI with demographic, and clinical characteristics of patients admitted to the PICU (N=158)

	Characteristics	Total Yes (n=31)	CAUTI No (n=127)		P-Value
Gender	Male	92 (58.2%)	20 (64.5%)	72 (56.7%)	0.428
	Female	66 (41.8%)	11 (35.5)	55 (43.3%)	
Age (years)		3.4 (1.2-7.8)	4.2 (1.5-8.1)	3.0 (1.0-7.0)	0.118
Residence	Urban	103 (65.2%)	18 (58.1%)	85 (66.9%)	0.364
	Rural	55 (34.8%)	13 (41.9%)	42 (33.1%)	
Weight (kg)		13.8 (9.5-18.6)	14.9 (10.0-20.8)	13.5 (9.0-18.1)	0.264
Height (cm)		93.0 (78.0-110.0)	96.0 (81.0-115.0)	92.4 (76.3-108.7)	0.307
Primary underlying diagnosis	Respiratory diseases	104 (65.8%)	22 (71.0%)	82 (64.6%)	0.833
	Neurological disorders	22 (13.9%)	5 (16.1%)	17 (13.4%)	
	Cardiac disorders	16 (10.1%)	4 (12.9%)	28 (22.0%)	
	Gastrointestinal diseases	6 (3.8%)	2 (6.5%)	4 (3.1%)	
	Renal disorders	5 (3.2%)	1 (3.2%)	4 (3.1%)	
	Hematological disorders	3 (1.9%)	1 (3.2%)	2 (1.6%)	
	Metabolic disorders	2 (1.3%)	-	2 (1.6%)	
Comorbidities	Malnutrition	18 (11.4%)	7 (22.6%)	11 (8.7%)	0.029
	Sepsis / systematic infection	14 (8.9%)	6 (19.4%)	8 (6.3%)	0.022
	Congenital heart disease	7 (4.4%)	3 (9.7%)	4 (3.1%)	0.113
	Chronic kidney disease	4 (2.5%)	2 (6.5%)	2 (1.6%)	0.121
	Cerebral palsy	1 (1.9%)	1 (6.5%)	1 (0.8%)	0.276

TABLE-II

Association of CAUTI with outcome variables (n = 158)

Characteristics		Total	CAUTI		P-Value
			Yes (n=31)	No (n=127)	
Duration of catheterization (days)		9.0 (8.0-12.2)	12.7 (10.3-14.5)	9.2 (8.1-11.4)	<0.001
Mechanical ventilation required		98 (62.0%)	27 (87.1%)	71 (55.9%)	<0.001
Duration of PICU stay (days)		11.5 (8.6-15.3)	14.2 (10.4-18.6)	10.5 (7.1-13.3)	0.004
Total duration of hospitalization		16.6 (12.4-21.5)	20.4 (15.5-25.0)	15.6 (12.9-19.4)	0.002
Final outcome	Discharged	126 (79.7%)	10 (64.5%)	106 (83.5%)	<0.001
	Mortality	32 (20.3%)	11 (35.5%)	21 (16.5%)	

The discrepancy in frequency between studies conducted in South Asian PICUs may reflect variability in infection surveillance systems, catheter care protocols, and the threshold for performing urine cultures. Higher rates in local data may also be attributed to limited staffing, reduced compliance with aseptic protocols, and longer catheter use due to a lack of non-invasive monitoring alternatives in resource-limited facilities.

This study found that the median duration of catheterization was significantly higher in cases having CAUTI, and this association aligns with the observations of Rikos et al.[17], who observed prolonged catheterization beyond 5 days to markedly increased the likelihood of developing CAUTI (p=0.001). Lalitha et al.[15], calculated each additional day of catheterization to increase the adjusted odds of CAUTI by 14%. Minimizing the catheter duration through daily assessment may significantly reduce the infection risk. A study from Lebanon observed CAUTI rate of 3.2 / 1000 catheter-days, and attributed the persistent burden to sustained catheter utilization ratios despite preventive measures.[18,19]

The microbiological spectrum dominated by Gram-negative organisms, and this pattern corresponds with Shmoury et al.[18], who observed E. coli and K. pneumoniae as the leading isolates, accounting for nearly half of all CAUTI cases. Lakoh et al.[20], found E. coli in 23.7%, and K. pneumoniae in 17% isolates with CAUTI. The predominance of Gram-negative organisms reflects the fecal and perineal origin of colonization in catheterized patients. Antimicrobial susceptibility in this study showed meropenem to retain the highest sensitivity (80.6%), followed by piperacillin–tazobactam (67.7%) and amikacin (61.3%). High resistance was documented to ceftriaxone, and ciprofloxacin. These findings parallel those of Shmoury et al.[18], and Lakoh et al.[20], both of whom reported extensive resistance to 3rd-generation cephalosporins and fluoroquinolones. Implementation of antibiotic stewardship programs focusing on culture-based therapy and judicious carbapenem use remains essential to prevent the emergence of pan-resistant strains.[21,22] Children with CAUTI had significantly extended PICU stay. Similar patterns have been reported previously by Samraj et al.[23], as CAUTI cases had markedly longer PICU and hospital lengths of stay. Rikos et al.[17], exhibited a mean hospital stay of 22.9 days in CAUTI cases compared with 8.6 days in non CAUTI cases. Prolonged hospitalization is both a cause and a consequence of infection, creating a cycle that exacerbates morbidity and delays turnover in critical care units.[24]

Mortality was seen to be significantly increased in children with CAUTI, and comparable patterns have been documented by others.[15,23] While the present study does not establish causality, the association between CAUTI and mortality likely reflects a combination of infection severity, antimicrobial resistance, and prolonged exposure to invasive devices. These observations underscore the importance of CAUTI prevention as an integral component of pediatric critical care.[25]

The single-center design limits generalizability, as CAUTI incidence and microbial profiles may differ across hospitals with varying infection control resources. The observational nature precludes establishing causal relationships between individual

risk factors and infection occurrence. The study did not assess bundle adherence or catheter utilization ratios, which are critical indicators of preventive practice compliance.

CONCLUSION

CAUTI was identified in nearly one-fifth of children admitted to the PICU. Prolonged catheterization, malnutrition, systemic infection, and mechanical ventilation significantly increased CAUTI risk. CAUTI was associated with longer hospitalization and higher mortality. Gram-negative organisms predominated and exhibited high resistance to 3rd-generation cephalosporins and fluoroquinolones.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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1	**Sadia Qadir:** Data collection.
2	**Murtaza Ali Gowam:** Study concept and design.
3	**Hira Nawaz:** Proof reading.
4	**Ghazala Jamal:** Critical revision.
5	**Bakhtawar Chandio:** Data anlaysis.
6	**Anmol:** Data entry.