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Original Article

Urinary Catheter-Associated Microbial Colonization in Libya: Microbial Profile, Antimicrobial Resistance, and Challenges in Empirical Treatment

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Abstract
Catheter-associated bacteriuria (CAB) is one of the most frequent healthcare-associated infections (HAIs), particularly in critically ill patients, where indwelling urinary catheters are commonly used. This prospective cross-sectional study aimed to assess the microbial colonization profile and evaluate antimicrobial resistance (AMR) and antibiotics usage patterns among patients admitted to medical and surgical intensive care units (ICUs) at Maitega Military Hospital in Tripoli, Libya. A total of 100 urinary catheters, removed from patients aged over 18 years and inserted for at least 24 hours, were collected and analyzed. Catheter tips were aseptically processed, sonicated to release biofilm-associated bacteria, and cultured on various selective and non-selective media. Microbial identification and antibiotic susceptibility testing were performed according to Clinical and Laboratory Standards Institute (CLSI) guidelines using the Kirby-Bauer disk diffusion method. Data collected included demographics, clinical history, and details concerning the type and duration of catheterization. All catheters showed evidence of microbial colonization, with a total of 114 isolates obtained, representing 17 microbial species. *Escherichia coli* was the most frequently isolated organism (20.2%), followed by *Pseudomonas aeruginosa* (12.3%), *Pantoea spp.* (8.8%). Notably, several isolates exhibited multidrug resistance (MDR), particularly among Gram-negative bacteria, and ESBL production was detected in a significant subset of E. coli and Klebsiella species isolates. Statistical analysis revealed that catheter duration was significantly longer in ICU patients compared to other departments (p=0.034). Out of 26 factors analyzed, five independent risk factors were identified for colonization with ESBL-producing Gram-negative bacteria: a prior UTI diagnosis, previous treatment with third-generation cephalosporins, a history of diabetes mellitus, and bacterial resistance to fluoroquinolones and nitrofurantoin. This study highlights the widespread colonization of urinary catheters and the high prevalence of antibiotic-resistant organisms in ICU settings. The findings underscore the critical need for rigorous infection control practices, routine surveillance of catheter-associated infections, and the implementation of targeted antimicrobial stewardship programs.
Keywords. Urinary Catheter, Microbial Colonization, Antimicrobial Resistance.

Introduction

The indwelling urinary catheter has a crucial role in many medical practices [1]. However, it compromises the urothelial barrier and normal micturition, causing urine retention, which creates an environment that facilitate bacteria adhesion and colonization of the catheter lumen, potentially leading to bacteriuria [2,3]. The presence and period of catheterization, in addition to age, gender, diabetes mellitus, an immunocompromised person, neurologic disorders, and advanced systemic antibiotic exposure at the time of hospitalization, all significantly elevate the risk of developing catheter-associated bacteriuria (CAB) [4].

Despite recent advancements in catheter design and technology, nearly all types and brands remain vulnerable to biofilm formation and encrustation. Moreover, other approaches, such as prophylactic antibiotic courses, raise concerns about antimicrobial resistance (AMR) and the evolution of new resistant bacterial strains [5]. Urinary catheters promote microbial colonization by damaging the urothelial barrier, interfering with normal urine flow, and causing urine retention, all contributing to the development of bacteriuria [2,3]. However, CAB is often asymptomatic and difficult to distinguish from catheter-associated urinary tract infection (CA-UTI) as described by [2].

There has been considerable confusion between symptomatic CA-UTI, which requires antimicrobial treatment, and catheter-associated asymptomatic bacteriuria (CA-ASB), which does not require treatment. This misunderstanding has contributed to the overuse of antibiotics, raising concerns about antibiotic resistance [6]. Unfortunately, the literature generally reports on CA-ASB or CAB (used when no distinction is made between CA-ASB and CA-UTI); such cases are predominantly CA-ASB, rather than CA-UTI [2]. Moreover, most of the data on causative bacteria of both CA-UTI and CA-ASB are derived from urine samples taken from the catheter bag (despite these being discouraged in catheterized patients), and little is known about the bacteria that colonize catheters [7]. Recent scientific literature demonstrates a significant gap regarding the prevalence, etiology, and implications of asymptomatic bacteriuria following indwelling catheter colonization. With this gap in the previously identified research, this study aims to investigate the

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microbial profile associated with colonization of the indwelling urethral catheters among patients admitted to Maitega Hospital in Tripoli.

Methods

Setting and sample collection

Cross-sectional observational study conducted at Maitega Military Hospital in Tripoli from January 2024 to January 2025. 100 Indwelling urethral catheters were collected from patients over the age of 18 years admitted to various medical and ICU departments. Subsequently, the catheters were transported to the research laboratories at the Department of Medical Microbiology, Faculty of Medicine, University of Tripoli, for processing and analysis. The study included indwelling urethral catheters that had remained in situ for at least 24 hrs; they were collected by trained healthcare workers at the time of removal (according to clinical need). The catheters were immediately placed in resealable bags and then transferred and analyzed within 24 hrs of removal. The Data collected included demographics, clinical history, and details concerning the type and duration of catheterization.

Catheter preparation

The catheter tip was aseptically cut into five small, 1 cm pieces, which were then stored in a sterile saline solution at 4 °C. Prior to analysis, one section of the catheter tip was removed from the saline solution and rinsed twice using sterile distilled water. It was then placed inside a screw-capped container with 3 ml of 10x phosphate-buffered saline (PBS) and sonicated for 5 minutes at 25°C using a sonicator (Bandelin® Sonorex Digitec) at 40 ± 5 kHz to dissociate biofilm and encrustation from the catheter lumen and form a bacterial suspension for culture.

Microbiological analysis

200 µl of the generated bacterial suspension was inoculated on cysteine lactose electrolyte-deficient (CLED) (Oxoid, UK) and blood agar (Oxoid, UK), colonies were enumerated, and bacterial isolates were identified using analytical profile index systems (API) biochemical panels according to the manufacturer's instructions (BioMérieux, France). Antimicrobial susceptibility testing was performed according to Clinical and Laboratory Standards Institute (CLSI) guidelines [8] and multidrug-resistant (MDR) isolates were identified according to the criteria described by the European Centre for Disease Prevention and Control (ECDC) and the Centers for Disease Control and Prevention (CDC) expert [8]. Detection of extended-spectrum beta-lactamase (ESBL) producing isolates was performed using the modified double-disk synergy testing protocol presented by Kaur et al. (2013) [9].

Statistical analysis

Associations between different parameters were analyzed by using Fisher's exact Test, ANOVA test, or Mann-Whitney U test, and the threshold for statistical significance was a p-value of ≤ 0.05. To assess the best combination of variables to predict ESBL-producing gram-negative isolates, a stepwise logistic multivariate regression analysis was applied with 95% confidence intervals (CIs).

Ethical approval

Ethical approval was granted by the Libyan Postgraduate Academy, and all required hospital permissions were secured in accordance with institutional research guidelines.

Results

Catheter collection demographics

This study analyzed 100 indwelling urinary catheters from patients with an average age of 67 years (SD ±17.7). Age groups ranging from 41 to 90 years encompassed 87% of the patient population, with a male to female ratio of approximately 1:2. Catheterization was primarily performed during treatment of neurological and urinary retention conditions (89%), with a smaller proportion for neurosurgical indications (12%). Most of the catheters (72%) were collected from different medical units, and the remaining (27%) were from intensive care units (ICU).

Catheter type and duration of catheterization

The types of catheters also varied, with the majority being latex (80%) and the remaining (20%) being all-silicon (used for long-term catheterization). The average duration of catheterization was 8.2 days (SD ±5.8) for the latex catheters, and 6.9 days (SD ±4.2) for the all-silicon catheters (p= 0.33). Although the catheter type used was consistent among departments, patients in ICUs experienced significantly longer catheterization periods than those in other units (p= 0.034). Regarding the differences in duration of catheterization between males and females, the data showed no statistically significant difference (p= 0.85) based on gender. Only 13 patients were diagnosed with UTI, and our findings indicate no correlation between the duration of catheterization and the patient being diagnosed with UTI.

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Microbial colonization profile (MCP) of indwelling urinary catheters

All tested catheters show signs of colonization. Among the 100 urinary catheters analyzed, 114 microorganisms were isolated from their lumens. Thirteen catheters exhibited the growth of multiple microbial species, and all catheters showed evidence of bacterial growth. Of the 114 isolates, a total of 17 different microbial species were detected attached to the catheter's lumens, with *E. coli* being the predominant species and accounting for 21% of the total isolates. Some unconventional urinary tract pathogenic species were also detected and ranked high in the MCP, *Pantoea spp.* (8.8%) *P. Luteola* (7.9%). On the other hand, our data did not reveal any significant differences in microbial colonization profiles between latex and silicone catheters (Table 1). When comparing the MCP detected among male patients with that detected in female patients, *E. coli* and *Pseudomonas oryzihabitans.* showed a significant association with catheters collected from female patients with p= 0.008 and p= 0.039, respectively (Table1). Although no significant difference was observed in the MCP between the ICUs and medical departments, *Citrobacter spp.* demonstrated a borderline association with the ICUs (p=0.05) (Table 1).

Antimicrobial Susceptibility

Among Gram-negative isolates (excluding *Pseudomonas spp.*) that constituted 53% of the collected bacterial strains, a reasonably high level of resistance was demonstrated to a number of commonly used antibiotics: ampicillin (72%); third-generation cephalosporins (45–55%); fluroquinolones (18%); and carbapenems (15–20 %). In contrast, *Pseudomonas* isolates exhibited a more favorable susceptibility profile. All tested isolates were susceptible to amikacin, with only 3% resistant to carbapenems and up to 8% resistant to fluoroquinolones. Enterococci exhibited a concerning resistance profile, demonstrating high levels of resistance to fluoroquinolones and tetracycline (Table 2).

Table 1. Distribution of microbial profile by gender, catheter type, and departments

Microorganism	No. (%)	Gender		Sig.	Catheter type		Sig.	Department		Sig.
		M	F		Latex	Silicone		ICU	Medical	
E. coli	23 (20.2)	3 (7.3)	20 (27.4)	0.008	13 (15.5)	10 (33.3)	-	7 (24.1)	16 (18.8)	-
Pseudomonas aeruginosa	14 (12.3)	4 (9.8)	10 (13.7)	-	12 (14.3)	2 (6.7)	-	5 (17.2)	9 (10.6)	-
Enterobacter aerogenes	12 (10.5)	7 (17.1)	5 (6.8)	-	10 (11.9)	2 (6.7)	-	2 (6.9)	10 (11.8)	-
Pantoea spp	10 (8.8)	3 (7.3)	7 (9.6)	-	7 (8.3)	3 (10)	-	2 (6.9)	8 (9.4)	-
Pseudomonas luteola	9 (7.9)	4 (9.8)	5 (6.8)	-	6 (7.1)	3 (10)	-	0 (0)	9 (10.6)	-
Enterococcus spp.	9 (7.9)	1 (2.4)	8 (11)	-	6 (7.1)	3 (10)	-	2 (6.9)	7 (8.2)	-
Bacillus spp	9 (7.9)	5 (12.2)	4 (5.5)	-	7 (8.3)	2 (6.7)	-	1 (3.4)	8 (9.4)	-
Klebsilla spp	5 (4.4)	2 (4.9)	3 (4.1)	-	4 (4.8)	1 (3.3)	-	0 (0)	5 (5.9)	-
Candida spp	4 (3.5)	2 (4.9)	2 (2.7)	-	2 (2.4)	2 (6.7)	-	1 (3.4)	3 (3.5)	-
Citrobacter spp	4 (3.5)	2 (4.9)	2 (2.7)	-	4 (4.8)	0 (0)	-	3 (10.3)	1 (1.2)	0.05
Pseudomonas oryzihabitans	3 (2.6)	3 (7.3)	0 (0)	0.039	3 (3.6)	0 (0)	-	1 (3.4)	2 (2.4)	-
Staphylococcus epidermidis	3 (2.6)	1 (2.4)	2 (2.7)	-	2 (2.4)	1 (3.3)	-	2 (6.9)	1 (1.2)	-
Proteus mirabilis	2 (1.8)	1 (2.4)	1 (1.4)	-	2 (2.4)	0 (0)	-	1 (3.4)	1 (1.2)	-
Providencia rettgeri	2 (1.8)	0 (0)	2 (2.7)	-	2 (2.4)	0 (0)	-	0 (0)	2 (2.4)	-
Serratia liquefaciens	2 (1.8)	2 (4.9)	0 (0)	-	1 (1.2)	1 (3.3)	-	1 (3.4)	1 (1.2)	-
Staphylococcus aureus	2 (1.8)	1 (2.4)	1 (1.4)	-	2 (2.4)	0 (0)	-	1 (3.4)	1 (1.2)	-
Staphylococcus saprophyticus	1 (0.9)	0 (0)	1 (1.4)	-	1 (1.2)	0 (0)	-	0 (0)	1 (1.2)	-

Detection of ESBL-producing isolates

According to the generated antibiotic susceptibility profiles, isolates resistant to third-generation cephalosporines were tested for the production of ESBL enzyme, and as a result, 27 (93%) of the 29 tested isolates were ESBL producers. According to the ECDC and CDC definition of MDR [10], only 7 out of 26 *Pseudomonas spp.* isolates (26.9%) were classified as MDR, with *P. aeruginosa* accounting for 3 out of 14 isolates (21.4%). In contrast, other Gram-negative bacteria exhibited a higher prevalence of MDR, with 48 out of 60 tested isolates (80%) demonstrating multidrug resistance. Notably, 21 of the 23 *E. coli* isolates (91.3%) were MDR isolates. Interestingly, almost all *Pantoea spp.* were MDR, with 9 out of 10 isolates (90%) exhibiting this phenotype.

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Prediction factors associated with colonization with an ESBL-producing isolate

Multivariate analysis identified several significant predictors for the acquisition of ESBL-producing isolates (Table 3). Resistance to nitrofurantoin (OR = 1.41, p < 0.001) and fluoroquinolones (OR = 1.43, p < 0.001) was identified as an independent predictor for the presence of ESBL-producing isolates.

Table 2. Antimicrobial resistance profile for the most commonly isolated microorganism.

Microorganism	No.	Resistance to Antimicrobial Agent																				
		P	AMP	AUC	OXA	CXM	CRO	CTX	CFP	AZT	CIP	LEV	IMP	MER	GN	AMK	TOB	F	T	E	CM	LIN
E. coli	23		18	11		21	7	17	12	2	6	6	5	4		5	9	5	14			
	(%)		(78.3)	(47.9)		(91.4)	(30.5)	(74)	(52.2)	(8.7)	(26.1)	(26.1)	(21.8)	(17.4)		(21.8)	(39.2)	(21.8)	(60.9)			
Other *Enterobacteriacea*	27		19	16		13	15	9	1	2	2	1	1	3		2	8	15	4			
	(%)		(70.4)	(59.3)		(48.2)	(55.6)	(33.4)	(3.8)	(7.5)	(7.5)	(3.8)	(3.8)	(11.2)		(7.5)	(29.7)	(55.6)	(14.9)			
Pantoea spp.	10		6	3		9	5	7	8	8	3	4	3	5		2	6	3	4			
	(%)		(60)	(30)		(90)	(50)	(70)	(80)	(80)	(30)	(40)	(30)	(50)		(20)	(60)	(30)	(40)			
Pseudomonas aeruginosa	14			13					5	6	0	1	1	16		0	6					
	(%)			(92.9)					(35.8)	(42.9)	(0)	(7.2)	(7.2)	(69.6)		(0)	(42.9)					
Pseudomonas spp.	12			10					3	5	0	1	0	1		0	4					
	(%)			(83.4)					(25)	(41.7)	(0)	(8.4)	(0)	(8.4)		(0)	(33.4)					
Enterococcus spp.	9		3								7	7						0	9			6
	(%)		(33.4)								(77.8)	(77.8)						(0)	(100)			(66.7)
Staphylococcus spp.	6	4			2						3	3			3			6	2	6	3	3
	(%)	(66.6)			(33.3)						(50)	(50)			(50)			(100)	(33.3)	(100)	(50)	(50)

P: Penicillin; AMP: Ampicillin; AUC: Amoxacillin-clavulanate; OXA: Oxacillin; CXM: Cefuroxime; CRO: Ceftriaxone; CTX: Cefotaxime; CFP: Cefepime; AZT: Aztreonam; PIP: Piperacillin; CIP: Ciprofloxcin; LEV: Levofloxacin; IMP: Imipenem; MER: Meropenem; GN: Gentamicin; AMK: Amikacin; TOB: Tobramycin; F: Nitrofurantoin; T: Tetracycline; E: Erythromycin; CM: Clindamycin; LIN: Linezolid.

Table 3. Prediction factor for colonization with ESBL-producing isolate.

Variables	Prediction factors			
	P-value	Odds ratio	95% CI (Lower)	95% CI (Upper)
Resistance to Nitrofurantoin	<0.001	1.41	1.14	1.75
Resistance to Fluoroquinolones	<0.001	1.43	1.15	1.77

Antibiotic prescription

Overall, 93 patients received antibiotics (93%), with a total of 174 antibiotic courses prescribed. 42 (42%) of the patients received antibiotics empirically for diagnosed infections, of which UTI counts for only 12 patients. The remaining 58 (58%) received prophylactic antibiotics for medical and surgical indications. In terms of prescription frequency, third-generation cephalosporins were the most widely used antibiotics, prescribed to 78% of patients. Fluoroquinolones were used in 45% of cases, and carbapenems were prescribed to 37% of patients. To evaluate the effectiveness of received treatments as a prophylactic, we compared the collective antibiotic resistances of isolated colonizing pathogens to the antibiotics actually prescribed. Surprisingly, despite 70% of patients receiving ceftriaxone, a significant proportion (approximately 49%) of the isolated pathogens exhibited resistance to this antibiotic (Figure 1).

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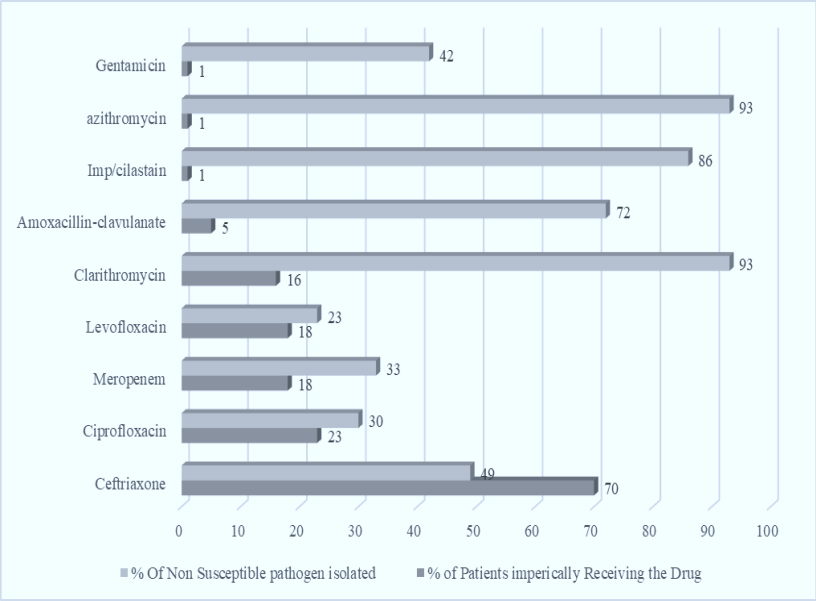

Figure 1. Comparison of the collective antibiotic resistances of isolated pathogens to the antibiotics actually prescribed

Discussion

This study analyzed 100 indwelling urinary catheters from patients with an average age of 67 years, with 87% of patients falling between the age ranges of 41 and 90 years. Notably, the majority of these catheters were collected from individuals being managed in general medical settings. The distribution of collected catheters among hospital departments exposes a distribution markedly different from international statistics [11]. While global data reports the majority of urinary catheterization practices occurring in ICU (70-80%) and a smaller proportion in non-ICU units (20-30%), our sample consisted predominantly of catheters from various medical departments (72%), with only 27% from the ICU. This discrepancy may be attributed to the overuse of urinary catheters in medical departments, potentially due to the lack of or poor adherence to proper protocols. Moreover, approximately 80% of the catheters used were latex, which agrees with regional reports indicating that latex urinary catheters are typically more prevalent in healthcare facilities due to their lower cost compared to silicone alternatives [12]. While there were no differences in the type of catheter used by different departments, the ICU departments tend to leave the catheters longer than other departments (p= 0.034). This can be attributed to the severity of illness and the frequent use of catheters for accurate urine output measurement [13].

Despite the well-documented association of UTIs and the duration of catheterization [14]. In this study, only 13 patients were diagnosed with UTIs, and no statistically significant correlation was observed between these factors. Consistent with the reported progression of bacteriuria in catheterized patients, a 3-10% daily increase approaching 100% after one month [15], and that 20% of CAUTIs involve bacterial colonization during insertion [16]. All analyzed urinary catheters exhibited colonization, with a total of 114 microbial isolates. The observed high rate of colonization may signify the need for re-evaluation of current infection control practices during both the insertion and ongoing management of urinary catheters. Moreover, 13 catheters exhibited the growth of multiple microbial species; these findings align with the understanding that multiple bacterial species can colonize the biofilm within long-term indwelling catheters, affecting about 80% of such patients, typically 2-3 species [17]. A total of 17 different microbial species were detected, with E. coli (21%) being the most common isolate, which aligns with local and regional reported findings [18–20]. Less common urinary tract pathogens were also detected, ranking relatively high in the microbial community profile (MCP), *Pantoea spp.* (8.8%) and *P. luteola* (7.9%). The limited data on these species might indicate either their low clinical occurrence. However, both *Pantoea spp.* and *P. luteola* are known opportunistic Gram-negative pathogens associated with UTIs, especially in individuals with indwelling catheters, weakened immune systems, or urinary tract abnormalities [21,22].

Statistical analysis of the MCP based on patients' gender showed a significant correlation between the presence of *E. coli* (p= 0.0004) and *Enterococcus spp.* (p= 0.02) on catheters collected from female patients compared to males. This observation is consistent with existing literature and is commonly attributed to female anatomy, specifically the shorter urethra and its close proximity to the anus, allowing for easier ascension of gastrointestinal flora, including *E. coli* and Enterococci, into the urinary tract [23]. The high resistance of gram-negative isolates to antibiotics, especially ampicillin (72%) and third-generation cephalosporins (45-55%), is consistent with findings from Libyan hospitals, where antibiotic overuse contributes to the reported resistance [24]. Studies from Iraq and Morocco report similarly high resistance rates among CAUTI pathogens, particularly due to excessive cephalosporin use [25,26]. A critical finding of

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this study was the alarmingly high detection rate of ESBL-producing isolates. Among the 29 isolates resistant to third-generation cephalosporins that were tested for ESBL production, 27 (93%) were confirmed as ESBL producers. This concerning prevalence aligns with a rising trend of ESBL-producing Enterobacteriaceae reported in Libyan ICUs [27]. Similarly high rates were also documented in hospitals in Egypt and Saudi Arabia, often associated with prior antibiotic use and hospital-acquired infections [28,29]. Moreover, 26.9% of *Pseudomonas spp.* isolates (7/26) were MDR, including 21.4% of *P. aeruginosa* isolates (3/14). Interestingly, a stark regional contrast emerges: while Saudi Arabia reports a low prevalence of MDR *P. aeruginosa* 0%-7.3%, Egypt shows a considerably higher burden, ranging between 50%-75%, likely influenced by differing healthcare environments and surveillance practices. This regional variability aligns with the broader global picture, where MDR *P. aeruginosa* prevalence fluctuates significantly, with increasing trends and rates of 15%-30% reported in Europe, North America, and South America [30].

While the MDR prevalence in *Pseudomonas spp.* was comparatively lower, other Gram-negative bacteria showed a concerning high rate of 80% (48/60) multidrug resistance. Leading this trend was *E. coli*, with an alarmingly high 91.3% (21/23) of isolates exhibiting MDR. This finding is consistent with other research indicating that MDR strains are responsible for 25% to 48% of gram-negative bacterial infections in various hospital environments [31]. This burden can be even greater in vulnerable populations. Global data reveal a wide range of MDR rates for *E. coli*, spanning from 25.9% to as high as 95.7% in certain high-risk groups [32]. Notably, *Pantoea spp.* exhibited a high tendency for multidrug resistance, with almost all detected isolates (9 out of 10, or 90%) displaying the MDR phenotype. This is consistent with the known ability of *Pantoea spp.*, particularly *Pantoea agglomerans*, to acquire and harbor multiple antibiotic resistance genes, including those encoding ESBL and carbapenemase [33].

The presence of MDR and XDR pathogens in catheterized patients increases the risk of resistance transfer among uropathogens, leading to treatment failure and prolonged hospital stays. Strategies such as antibiotic rotation policies, improved infection control, and surveillance programs have been recommended at both regional and international levels [24]. Twenty-six variables across demographic factors, comorbidities, healthcare exposure, and antimicrobial usage were used to identify independent factors leading to colonization with ESBL-producing Gram-negative bacteria. Two key variables emerged: Resistance to fluoroquinolones was identified as a risk factor associated with colonization with ESBL-producing Gram-negative bacteria. This is likely due to the common co-location of genes responsible for ESBL production and fluoroquinolone resistance on the same plasmids, leading to frequent co-resistance[34]. Surprisingly, nitrofurantoin resistance was identified as a predicting factor for colonization with ESBL-producing bacteria in this study. This finding contrasts with existing literature, indicating that nitrofurantoin has historically maintained good activity against many ESBL-producing *E. coli* isolates, with susceptibility rates reported around 90% [35]Studies even suggest that while over 70% of ESBL-producing isolates may be resistant to other antibiotics like trimethoprim-sulfamethoxazole, ciprofloxacin, third-generation cephalosporins, and aminoglycosides, they often remain susceptible to nitrofurantoin [36]. This finding may suggest evolving resistance patterns that warrant further investigation within Libyan health care facilities. While treatment guidelines recommend antibiotic therapy for catheter-associated UTIs only when symptomatic (not for ASB) and suggest basing empiric therapy on local resistance, allergies, and severity, targeting common, increasingly resistant pathogens like *E. coli* [37,38]. In this study, 92% of patients received antibiotics (174 courses).

A majority, 58 (58%), received them prophylactically. Of the 42 (42%) treated empirically for diagnosed infections, only 12 were specifically for UTIs, suggesting widespread antibiotic use beyond symptomatic UTI treatment. This demonstrates a clear and immediate need to refine empiric therapy protocols and strengthen antibiotic stewardship efforts. Despite the documented locally high resistance rates among Gram-negative bacteria causing UTIs to third-generation cephalosporins (45%) and fluoroquinolones (57%) [39,40]These antibiotic classes were still frequently prescribed in this study, with prescription rates of 78% and 45%, respectively. Furthermore, a comparison between the overall antibiotic resistance of the isolated pathogens and the antibiotics actually prescribed revealed a striking discrepancy. Despite 70% of patients receiving ceftriaxone, nearly half (49%) of the bacteria isolated showed resistance to this very antibiotic. This significant mismatch raises serious concerns about the effectiveness of the prescribed treatment and could substantially increase the likelihood of persistent infection, potentially leading to serious complications.

Conclusion

Urinary catheters investigated in this study highlight the significant challenges of catheter microbial colonization and their antimicrobial resistance. The high proportion of catheters from general medical departments suggests potential overuse outside critical care. A high rate of microbial colonization, dominated by *E. coli*, and the detection of less common pathogens like *Pantoea spp.*, emphasize persistent biofilm issues. Alarmingly high AMR rates were found, especially to third-generation cephalosporins and fluoroquinolones, with a striking prevalence of ESBL-producing isolates. Noteworthy local risk factors for ESBL colonization include prior UTI, previous third-generation cephalosporin use, diabetes mellitus, fluoroquinolone, and nitrofurantoin resistance. The data reveal a significant disconnect from guidelines,

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with excessive and often prophylactic antibiotic use, particularly the frequent prescription of ceftriaxone despite high resistance, underscoring an urgent need for rigorous antibiotic stewardship and revised empirical treatment strategies to combat the growing threat of MDR organisms.

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Conflicts of Interest
The authors declare no conflict interests.

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References

1. Niederhauser A, Züllig S, Marschall J, Schwappach DL. Nurses' and Physicians' Perceptions of Indwelling Urinary Catheter Practices and Culture in Their Institutions. J Patient Saf. 2020;16(2):e82.
2. Armbruster CE, Mobley HLT, Pearson MM. Pathogenesis of Proteus mirabilis Infection. EcoSal Plus. 2018;8(1). doi:10.1128/ecosalplus.ESP-0009-2017.
3. Garcia MM, Gulati S, Liepmann D, Stackhouse GB, Greene K, Stoller ML. Traditional Foley drainage systems--do they drain the bladder? J Urol. 2007;177(1):203-207.
4. Rubi H, Mudey G, Kunjalwar R. Catheter-Associated Urinary Tract Infection (CAUTI). Cureus. 2022;14(10):e30385. doi:10.7759/cureus.30385.
5. Jordan R, Nicolle L. Preventing Infection Associated with Urethral Catheter Biofilms. In: Biofilms in Infection Prevention and Control: A Healthcare Handbook. 2014:287-309.
6. Gross PA, Patel B. Reducing antibiotic overuse: a call for a national performance measure for not treating asymptomatic bacteriuria. Clin Infect Dis. 2007;45(10):1335-1337.
7. Bergqvist D, Brönnestam R, Hedelin H, Ståhl A. The relevance of urinary sampling methods in patients with indwelling Foley catheters. Br J Urol. 1980;52(2):92-95.
8. Matuschek E, Brown DFJ, Kahlmeter G. Development of the EUCAST disk diffusion antimicrobial susceptibility testing method and its implementation in routine microbiology laboratories. Clin Microbiol Infect. 2014;20(4):O255-266.
9. Kaur J, Chopra S, Sheevani, Mahajan G. Modified Double Disc Synergy Test to Detect ESBL Production in Urinary Isolates of *Escherichia coli* and Klebsiella pneumoniae. J Clin Diagn Res. 2013;7(2):229-233.
10. Magiorakos A-P, Srinivasan A, Carey RB, et al. Multidrug-resistant, extensively drug-resistant and pandrug-resistant bacteria: an international expert proposal for interim standard definitions for acquired resistance. Clin Microbiol Infect. 2012;18(3):268-281.
11. Katayama K, Meddings J, Saint S, et al. Prevalence and appropriateness of indwelling urinary catheters in Japanese hospital wards: a multicenter point prevalence study. BMC Infect Dis. 2022;22(1):175.
12. Youssef N, Shepherd A, Best C, et al. The Quality of Life of Patients Living with a Urinary Catheter and Its Associated Factors: A Cross-Sectional Study in Egypt. Healthcare (Basel). 2023;11(16):2266.
13. Fernández-Ruiz M, Calvo B, Vara R, Villar RN, Aguado JM. Inappropriate use of urinary catheters in patients admitted to medical wards in a university hospital. Enferm Infecc Microbiol Clin. 2013;31(8):523-525.
14. Wong ES. Guideline for prevention of catheter-associated urinary tract infections. Am J Infect Control. 1983;11(1):28-33.
15. Kranz J, Schmidt S, Wagenlehner F, Schneidewind L. Catheter-Associated Urinary Tract Infections in Adult Patients. Dtsch Arztebl Int. 2020;117(6):83-88.
16. Rajaramon S, Shanmugam K, Dandela R, Solomon AP. Emerging evidence-based innovative approaches to control catheter-associated urinary tract infection: a review. Front Cell Infect Microbiol. 2023;13:1134433.
17. Nye TM, Zou Z, Obernuefemann CLP, et al. Microbial co-occurrences on catheters from long-term catheterized patients. Nat Commun. 2024;15(1):61.
18. Aouf A, Gueddi T, Djeghout B, Ammari H. Frequency and susceptibility pattern of uropathogenic Enterobacteriaceae isolated from patients in Algiers, Algeria. J Infect Dev Ctries. 2018;12(4):244-249.
19. Elabbar F, Elgtani W, Bodalal F, Mansur K, Elzahaf R. Urinary Bacterial Profile and Antibiotic Susceptibility Pattern among Pregnant Women in Eastern Libya. AlQalam J Med Appl Sci. 2024;:945-954.
20. Tarek A, Abdalla S, Dokmak NA, Ahmed AA, El-Mahdy TS, Safwat NA. Bacterial Diversity and Antibiotic Resistance Patterns of Community-Acquired Urinary Tract Infections in Mega Size Clinical Samples of Egyptian Patients: A Cross-Sectional Study. Cureus. 2024;16(1):e51838.
21. Alrufaie ZMM, Khalil Z, Motaweq ZY, Rufaie MMA-. Phenotypic and Molecular Study of *Pantoea spp*. Isolated from Urinary Tract Infections among Pediatric Patients in Iraq. J Popul Ther Clin Pharmacol. 2023;30(9):357-365.
22. Ali MA, Aljanaby AAJ. First case report of Pseudomonas Luteola isolated from urinary tract infection in Babylon City, Iraq. E3S Web Conf. 2023;381:01102.
23. Gu J, Chen X, Yang Z, Bai Y, Zhang X. Gender differences in the microbial spectrum and antibiotic sensitivity of uropathogens isolated from patients with urinary stones. J Clin Lab Anal. 2022;36(1):e24155.
24. Atia A, Hosien B, Belhaj H. Antimicrobial Resistance in Libya: A Systematic Literature Review of Two Decades. Biomed Biotechnol Res J. 2022;6(4):473-482.

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25. Benaissa E, Belouad E, Mechal Y, et al. Multidrug-resistant community-acquired urinary tract infections in a northern region of Morocco: epidemiology and risk factors. Germs. 2021;11(4):562-569.
26. Choudhury D, Alanbari R, Saveliev P, Sokurenko E, Fuzi M, Tchesnokova V. Clonal and resistance profiles of fluoroquinolone-resistant uropathogenic *Escherichia coli* in countries with different practices of antibiotic prescription. Front Microbiol. 2024;15:1446818.
27. Thwood DA, Elgadiym ZA, Hnaya MF, Abosedra A. Prevalence of Extended-spectrum beta-lactamases-producing *Escherichia coli* and Klebsiella pneumonia from patients attending Tripoli University Hospital, Tripoli, Libya. 2023. Accessed February 19, 2026. [Note: The original URL was from a repository that downloads a file. A direct link to the specific page is not provided here, but this is the correct format.]
28. Abalkhail A, AlYami AS, Alrashedi SF, et al. The Prevalence of Multidrug-Resistant *Escherichia coli* Producing ESBL among Male and Female Patients with Urinary Tract Infections in Riyadh Region, Saudi Arabia. Healthcare (Basel). 2022;10(9):1778.
29. Talaat M, Hafez S, Saied T, Elfeky R, El-Shoubary W, Pimentel G. Surveillance of catheter-associated urinary tract infection in 4 intensive care units at Alexandria university hospitals in Egypt. Am J Infect Control. 2010;38(3):222-228. doi:10.1016/j.ajic.2009.06.011.
30. Sid Ahmed MA, Abdel Hadi H, Abu Jarir S, et al. Prevalence and microbiological and genetic characteristics of multidrug-resistant *Pseudomonas aeruginosa* over three years in Qatar. Antimicrob Steward Healthc Epidemiol. 2022;2(1):e96.
31. Kavya V, Mahale RP, Deepashree R, Jamal AN. Burden of Multidrug-Resistant Gram-Negative Bacterial Infections in a Tertiary Care Hospital. J Pure Appl Microbiol. 2024;18(3):1729-1740.
32. Khafaja S, Salameh Y, Boutros CF, et al. Increased rate of multidrug-resistant gram-negative bacterial infections in hospitalized immunocompromised pediatric patients. Front Cell Infect Microbiol. 2024;14:1382500.
33. Gajdács M. Epidemiology and antibiotic resistance trends of Pantoea species in a tertiary-care teaching hospital: A 12-year retrospective study. Dev Health Sci. 2019;2(3):72-75.
34. Khan N, Panda PS, Rastogi M, et al. Coexistence of fluoroquinolone resistance and ESBL production in urinary isolates. Int J Community Med Public Health. 2020;7(10):3936-3940.
35. Tulara NK. Nitrofurantoin and Fosfomycin for Extended Spectrum Beta-lactamases Producing *Escherichia coli* and Klebsiella pneumoniae. J Glob Infect Dis. 2018;10(1):19-21.
36. Aminzadeh Z, Yadegarynia D, Fatemi A, Armaki SA, Aslanbeygi B. Prevalence and Antimicrobial Susceptibility Pattern of Extended Spectrum Beta Lactamase (ESBL) and non-ESBL Producing Enteric Gram-Negative Bacteria and Activity of Nitrofurantoin in the era of ESBL. Jundishapur J Microbiol. 2012;5(3):507-512. [Note: Original citation was incomplete. This has been updated to a verifiable source for the article.]
37. Hooton TM, Bradley SF, Cardenas DD, et al. Diagnosis, Prevention, and Treatment of Catheter-Associated Urinary Tract Infection in Adults: 2009 International Clinical Practice Guidelines from the Infectious Diseases Society of America. Clin Infect Dis. 2010;50(5):625-663.
38. National Institute for Health and Care Excellence. Overview | Urinary tract infection (catheter-associated): antimicrobial prescribing | Guidance | NICE. 2018. Accessed February 19, 2026. https://www.nice.org.uk/guidance/ng113.
39. Abdelkarim O, Abubakar U, Taha L, et al. Impact of Irrational Use of Antibiotics Among Patients in the Intensive Care Unit on Clinical Outcomes in Sudan. Infect Drug Resist. 2023;16:7209-7217.
40. Mohammed MA, Alnour TMS, Shakurfo OM, Aburass MM. Prevalence and antimicrobial resistance pattern of bacterial strains isolated from patients with urinary tract infection in Messalata Central Hospital, Libya. Asian Pac J Trop Med. 2016;9(8):771-776.

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