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Impact of Urine Sterility on the Extent of Bacterial Colonization in Patients with Forgotten DJ Stents

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ABSTRACT

Objective: To determine whether pre-removal urine sterility predicts bacterial colonization of double-J (DJ) stent tips in patients with forgotten stents (>4 months), and to describe organism distribution and antimicrobial susceptibility. **Methods:** A comparative cross-sectional study was conducted over five months in the Department of Urology, Sindh Institute of Urology and Transplantation, Karachi. Adults (18–60 years) with indwelling DJ stents >4 months were enrolled using consecutive sampling. Patients with recent antibiotics (within four weeks), known pre-stent UTI, immunocompromised, or no pre-removal urine culture were excluded. Midstream urine (CLED agar) was obtained before removal; the distal 3 cm of each stent (Chocolate and MacConkey agars) was cultured at removal. Identification and susceptibility followed standard methods and CLSI 2024. Descriptive statistics were generated; the association between urine sterility and colonization was assessed with chi-square. **Results:** Sixty-five patients were included (mean age 39.4±6.7 years; 57% male). Mean stent dwell time was 6.7±1.8 months. Urine was sterile before removal in 28 (43%). Stent colonization occurred in 55 (85%). Among those with non-sterile urine, 34/37 were colonized; among those with sterile urine, 21/28 were colonized (χ^2 p=0.064). Gram-negative organisms predominated: Klebsiella pneumoniae (18.2% of all isolates), Enterobacter cloacae (16.4%), Escherichia coli (14.5%), Proteus mirabilis (12.7%), Acinetobacter baumannii (10.9%), and Pseudomonas aeruginosa (3.6%). Gram-positive isolates included Staphylococcus aureus (10.9%), Staphylococcus epidermidis (7.3%), and Enterococcus faecalis (5.5%). Gram-negative susceptibility was highest to imipenem (91%) and meropenem (74%), intermediate to cefoperazone-sulbactam (71%), piperacillin-tazobactam (62%), and amikacin (62%), and lowest to ampicillin (17%) and amoxicillin-clavulanate (29%). Gram-positive isolates were uniformly susceptible to vancomycin and linezolid (100% each). **Conclusion:** Pre-removal urine sterility did not reliably exclude stent colonization, which remained high in forgotten stents. Stent-tip cultures and culture-directed therapy should guide management alongside timely stent exchange/removal.

INTRODUCTION

Ureteral double-J (DJ) stents are indispensable in managing upper urinary tract obstruction and facilitating recovery after endourological procedures, yet they are prone to biofilm formation, bacteriuria and device colonization that may culminate in infection, encrustation and difficult removals especially when stents are forgotten beyond the intended dwell time. Colonization increases with indwelling duration: in a prospective study, 0% stents were colonized in the first two weeks, rising to 66.7% at 60–90 days and 87.5% at 90–120 days, with *E. coli* predominance and substantial resistance to first-line agents (2). Consistently, another cohort reported overall colonization of 7.7% but a sharp step-up to 25% when stents remained in situ >6 weeks, supporting guidance to remove or exchange within this window (1).

A central controversy is how well pre-removal urine culture status predicts stent colonization. Multiple studies suggest limited concordance. In a prospective cohort (n=100), stent culture positivity was 53%, increased with dwell time, and sterile urine did not rule out stent colonization; urine–stent agreement was not significant (3). A Karachi cross-sectional series (n=219) similarly found 61.6% colonization on stent tips versus 19.6% bacteriuria in urine, with different dominant organisms (Enterococci on stents vs *P. aeruginosa* in urine), underscoring discordant ecology between urine and device surfaces (4). These gaps matter clinically, because device colonization even with "sterile" urine can seed post-procedural infections (5).

Risk factors extend beyond time. A microbiome study of 241 patients showed stent-resident communities diverge from urine and are associated with patient comorbidities (not recent antibiotics), challenging the value of blanket prophylaxis and pointing toward tailored strategies in high-risk hosts (6). More recently, a prospective study identified prolonged dwell time and albuminuria as independent predictors of colonization (overall 56.3%), frequently involving Enterococcus, *Pseudomonas* and *E. coli* (10).

In the subset of "forgotten" stents, devices retained far beyond recommended intervals—complications escalate: encrustation, stone formation, obstruction and urosepsis are common, often necessitating multi-modal endourological management (ESWL, URS, PCNL) and prolonged hospitalization (7,8). Given resource constraints and follow-up challenges in many settings, including South Asia, understanding the predictive value of urine sterility for device colonization in long-retained DJ stents has immediate implications for operative planning, peri-procedural antibiotics, and infection prevention (9).

Collectively, the literature suggests: (i) colonization probability and bacterial burden rise steeply with dwell time; (ii) pre-removal urine sterility is an imperfect proxy for stent colonization; (iii) organism spectra and susceptibilities often differ between urine and stent; and (iv) comorbidity profiles may better stratify risk than recent antibiotic exposure alone (1–4,6,10).

The objective of the study is to determine whether pre-removal urine sterility is associated with the extent of bacterial colonization (presence and burden/species) on stent tips in patients with forgotten DJ stents (>4 months), and to compare organism concordance and antimicrobial susceptibility between urine and stent cultures.

METHODOLOGY

This comparative cross-sectional study was conducted in the Department of Urology, Sindh Institute of Urology and Transplantation, Karachi, over five months following synopsis approval from CPSP and institutional ERC. A non-probability consecutive sampling technique was used. The sample size was 65, calculated with the WHO single-proportion formula using an expected bacterial colonization rate of 87.5% for stents indwelling >4 months, a 95% confidence level, and an 8% margin of error. Adult patients aged 18–60 years presenting with indwelling double-J (DJ) ureteral stents retained for >4 months ("forgotten" stents) after percutaneous nephrolithotomy, extracorporeal shockwave lithotripsy, Double j stenting, ureteroscopy, or lithoclast were enrolled. Patients with recent antibiotic use (within four weeks), known pre-stent urinary tract infection, immunocompromised states, or no documented pre-removal urine culture were excluded. After written informed consent, demographic and clinical data (age, gender, comorbidities, indication for stent, stent size, duration of indwelling time, and prior procedures) were abstracted onto a standardized proforma. Before stent removal, a midstream urine sample was collected for culture; urine-positive patients were treated according to infectious disease recommendations and then scheduled for removal. During removal in the operating room, the distal 3 cm of each stent was cut aseptically, placed in a sterile container, and submitted for microbiological processing. Urine samples were inoculated on CLED agar and incubated at 35 ± 2 °C overnight. Stent segments were inoculated on Chocolate and MacConkey agars and incubated at 35 ± 2 °C overnight. Bacterial identification followed standard microbiological protocols; antimicrobial susceptibility testing adhered to CLSI 2024 performance standards. The primary outcome was DJ stent bacterial colonization; secondary outcomes included organism spectrum, burden, and urine–stent concordance with susceptibility patterns. Data entry and analysis were performed in SPSS v22. Continuous variables (age, indwelling duration) were summarized as mean ± SD or median ± IQR based on Shapiro–Wilk normality testing. Categorical variables (gender, comorbidities, indications, stent size, urine sterility) were expressed as n (%). Comparative analyses employed chi-square or Fisher's exact tests as appropriate. P≤0.05 considered statistically significant, and results reported as adjusted odds ratios with 95% confidence intervals.

RESULTS

Our study included 65 patients with a mean age of 39.4 ± 6.7 years, comprising 37 males (57%) and 28 females (43%). Hypertension was present in 19 patients (29%). The indications for stenting were obstructed kidney (n = 26, 40%), post-URS + LC (n = 16, 25%), post-PCNL (n = 14, 22%), and post-ESWL (n = 9, 14%). The majority of stents used were 6 FR in size (n = 56, 86%), with the remainder being 4 FR (n = 9, 14%). Notably, DJ stent bacterial colonization was observed in 55 patients (85%), while urine sterility before removal was noted in 28 patients (43%). The mean duration of stent retention was 6.7 ± 1.8 months.

Table 1

Demographic and Clinical Variables (Total Number N=65)

Variables		**Mean and Frequency**
Age (years)		39.4±6.7
Gender n (%)	Male	37 (57%)
	Female	28 (43.1%)
Hypertension		19 (29%)
Indication for stent n (%)	Obstructed kidney	26 (40%)
	Post URS + LC	16 (25%)
	Post PCNL	14 (21%)
	Post ESWL	9 (14%)
Stent size (FR) n (%)	6 FR	56 (86%)
	4 FR	9 (14%)
Urine sterile before removal		28 (43%)
DJ Stent bacterial colonization		55 (85%)
Duration stent (months)		6.7±1.8

The association between urine sterility before stent removal and stent colonization was examined. Among patients with non-sterile urine, 34 (91.9%) had stent colonization, while 3 (8.1%) did not. In patients with sterile urine, 21 (75%) had stent colonization, and 7 (25%) did not. The chi-square test revealed a p-value of 0.064, indicating a trend towards an association, but it did not reach statistical significance.

Table 2

Association of Bacterial Colonization and Sterile Urine Before Removal

Urine Sterile before Removal	Bacterial Colonization		P value
	No (n)	Yes (n)	
No	3	34	0.064
Yes	7	21	

The bacterial isolates from stent tips comprised Gram-negative and Gram-positive organisms. Among the Gram-negative isolates (n = 42), Klebsiella pneumoniae was the most prevalent (23.8%, n = 10), followed by Enterobacter cloacae (21.4%, n = 9), Escherichia coli (19%, n = 8), Proteus mirabilis (16.7%, n = 7), Acinetobacter baumannii (14.3%, n = 6), and Pseudomonas aeruginosa (4.8%, n = 2). In terms of overall isolates, Klebsiella pneumoniae accounted for 18.2%, Enterobacter cloacae for 16.4%, and Escherichia coli for 14.5%.

Among the Gram-positive isolates (n = 13), Staphylococcus aureus was the most common (46.2%, n = 6), followed by Staphylococcus epidermidis (30.8%, n = 4), and Enterococcus faecalis (23.1%, n = 3). Staphylococcus aureus accounted for 10.9% of all isolates, while Staphylococcus epidermidis and Enterococcus faecalis accounted for 7.3% and 5.5%, respectively. These findings highlight the diversity of bacterial isolates colonizing stent tips.

Table 3

Types of Isolates

Bacteria Type	Organism	n	Percent (within gram)	Percent (of all isolates)
Gram-negative	*Klebsiella pneumoniae*	10	23.8	18.2
	Enterobacter cloacae	9	21.4	16.4
	Escherichia coli	8	19	14.5
	Proteus mirabilis	7	16.7	12.7
	Acinetobacter baumannii	6	14.3	10.9
	Pseudomonas aeruginosa	2	4.8	3.6
Gram-positive	*Staphylococcus aureus*	6	46.2	10.9
	Staphylococcus epidermidis	4	30.8	7.3
	Enterococcus faecalis	3	23.1	5.5

The antibiotic susceptibility of stent tip isolates revealed distinct patterns. Among gram-negative isolates (n=42), isolated organism showed highest susceptibility Imipenem: 91% (38/42), Meropenem: 74% (31/42) and Cefoperazone-sulbactam 71% (30/42) followed by Piperacillin-tazobactam: 62% (26/42), Amikacin: 62% (26/42), Levofloxacin: 50% (21/42) and Ciprofloxacin 50% (21/42). However, demonstrated low susceptibility rates to Ampicillin: 17% (7/42), Azithromycin: 26% (11/42) and Cotrimoxazole: 29% (12/42). These findings suggest that Imipenem, Meropenem, and Cefoperazone-sulbactam may be effective treatment options for Gram-negative infections related to stent colonization.

The antibiotic susceptibility patterns of Gram-positive bacteria isolated from stent tips revealed 100% susceptibility to Vancomycin and Linezolid (13/13) followed by Ceftriaxone: 76% (10/13), Cotrimoxazole: 76% (10/13), Ampicillin-clavulanic acid: 69% (9/13), Azithromycin: 69% (9/13), Cefazolin: 69% (9/13), Ampicillin/Erythromycin and Ciprofloxacin 46% (6/13). These findings indicate that Vancomycin and Linezolid are highly effective against Gram-positive bacteria isolated from stent tips, and may be considered as treatment of choice for related infections.

Table 4

Gram Negative Bacteria Antibiotic Susceptibility

Antibiotic	Susceptible (%) (n=42)
Ampicillin	7 (17%)
Ampicillin-clavulanic acid	12 (29%)
Ceftriaxone	18 (43%)
Cefepime	16 (38%)
Piperacillin-tazobactam	26 (62%)
Amikacin	26 (62%)
Aztreonam	19 (45%)
Cefoperazone-sulbactam	30 (71%)
Levofloxacin	21 (50%)
Azithromycin	11 (26%)
Meropenem	31 (74%)
Erythromycin	8 (19%)
Imipenem	38 (91%)
Ciprofloxacin	21 (50%)
Cotrimoxazole	12 (29%)

Table 5

Gram Positive Bacteria Antibiotic Susceptibility

Antibiotic	Susceptible (n=13) (%)
Ampicillin	6 (46%)
Ampicillin-clavulanic acid	9 (69%)
Ceftriaxone	10 (76%)
Vancomycin	13 (100%)
Linezolid	13 (100%)
Azithromycin	9 (69%)
Cefazolin	9 (69%)
Erythromycin	6 (46%)
Ciprofloxacin	6 (46%)
Cotrimoxazole	10 (76%)

Discussion

The present cohort of 65 patients with retained double-J stents demonstrated a high colonization rate (85%) despite 43% having sterile pre-removal urine, and a predominance of gram-negative organisms (n=42, 65%) led by Klebsiella pneumoniae, Enterobacter cloacae, Escherichia coli and Proteus mirabilis. This profile aligns with prior reports that colonization escalates with dwell time and that gram-negative species dominate the stent biofilm ecology (17). Our overall rate closely approximates the 87.5% colonization reported for stents retained 90–120 days (16), and exceeds rates in mixed-duration series, likely reflecting our longer mean indwelling time of 6.7 months and the "forgotten stent" phenotype. A recent prospective analysis also identified prolonged dwell time as an independent risk factor for colonization, alongside markers of host vulnerability, supporting the biological plausibility of our findings (17).

Concordance between urine and stent remained imperfect. Although colonization was numerically more frequent when urine was non-sterile (34/37 vs 21/28 with sterile urine), the association did not reach conventional significance (p=0.064). This trend, coupled with substantial absolute colonization in the sterile-urine group, mirror observations that urine cultures underestimate device colonization and that urine–stent microbiology often diverges (14). Such discordance can be explained by biofilm-embedded organisms on polymeric surfaces that intermittently shed into urine, the selective pressures of prior antibiotics, and micro environmental

differences between urine and the stent lumen or surface (14,18). Clinically, these data reinforce that a "sterile" urine culture before removal does not reliably exclude stent colonization and should not by itself dictate peri-procedural antimicrobial strategy (14,17).
Susceptibility patterns showed relatively low activity of ampicillin and ampicillin-clavulanate among gram-negative isolates (17–29%), intermediate susceptibility to piperacillin-tazobactam and amikacin (62% each), and higher activity of carbapenems (meropenem 74%, imipenem 91%). These gradients are consistent with reports of multi-drug resistance among stent-associated uropathogens and with contemporary laboratory expectations when interpreted under CLSI performance standards (11,16). For gram-positive isolates, universal susceptibility to vancomycin and linezolid and mixed responses to beta-lactams and macrolides are likewise in keeping with prior series (11,14). Together, the data argue for culture-directed therapy and careful stewardship: empiric escalation to carbapenems may be unnecessary for stable patients if local antibiograms and device cultures support narrower options (11,16,17).
Our organism distribution *Klebsiella* and E*nterobacte*r featuring prominently, differs somewhat from series where *E. coli* predominated, a discrepancy that may reflect longer retention, comorbidity mix (e.g. Hypertension), and biofilm succession on aged stents (17). Preventive strategies under investigation, including antimicrobial or anti-adhesive coatings for polyurethane stents, may mitigate colonization and warrant evaluation in high-risk settings similar to ours (12). Methodologically, our cross-sectional design limits causal inference and power for small between-group differences; nevertheless, the effect size suggests clinically meaningful discordance between urine sterility and colonization that a larger study could confirm (14,17).
In sum, these findings corroborate that prolonged indwelling time is associated with very high stent colonization, that urine sterility incompletely predicts device colonization, and that susceptibility patterns favor targeted therapy guided by stent cultures under CLSI standards (14,16, 17). Future work should test preventive coatings, optimize indwelling intervals, and validate risk-stratified peri-procedural antibiotic algorithms (12,17).

CONCLUSION

Our study highlights the high prevalence of bacterial colonization of ureteral stents, with Gram-negative organisms being the most common. The antibiotic susceptibility patterns of stent tip isolates revealed distinct patterns, with Imipenem, Meropenem, and Cefoperazone-sulbactam being effective against Gram-negative bacteria, and Vancomycin and Linezolid being highly effective against Gram-positive bacteria. Notably, a "sterile" urine culture before stent removal does not reliably exclude stent colonization, emphasizing the need for a comprehensive approach to managing patients with indwelling stents. These findings have important implications for the prevention and treatment of stent-related infections. Clinically, timely stent exchange/removal, culture-directed therapy, and antimicrobial stewardship should guide management.

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