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CHARACTERIZATION OF URINARY PATHOGENS AND THEIR ANTIBIOTIC SENSITIVITY IN CATS WITH LOWER URINARY TRACT DISEASE

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ABSTRACT

Feline Lower Urinary Tract Disease (FLUTD) is a common clinical syndrome in cats characterized by disorders affecting the bladder and urethra, leading to signs such as dysuria, haematuria, pollakiuria, and periuria. This study aimed to identify bacterial pathogens and their antibiotic sensitivity pattern in urine samples of FLUTD-affected cats. Twenty clinically diagnosed cases were included. Urine samples collected by transurethral catheterization or ultrasound-guided cystocentesis were subjected to routine urinalysis and cultured on brain heart infusion agar. Antibiotic susceptibility was determined following Clinical and Laboratory Standards Institute (CLSI) guidelines. Urinalysis revealed predominantly yellow (70%) and clear to slightly cloudy urine, with isosthenuria in 70% of cases. Proteinuria (100%), haematuria (90%), and bilirubinuria (70%) were frequent, with pH ranging from 5.0–7.5. Microscopy showed erythrocytes (85%), leukocytes (80%), crystals (20%; struvite and calcium oxalate), and bacterial forms including cocci (40%), bacilli (50%), and mixed types (10%). Bacterial growth was observed in sixteen out of twenty samples, with *Pseudomonas aeruginosa* as the most common isolate, followed by *Escherichia coli* and *Klebsiella* spp. Carbapenems and amikacin showed highest efficacy, whereas β-lactams and cephalosporins exhibited widespread resistance. The study highlights multidrug resistant uropathogens in FLUTD and emphasizes culture based antibiotic selection for effective therapy.

Keywords: Feline lower urinary tract disease, Urinalysis, Urine culture, Antibiotic sensitivity

Feline lower urinary tract disease (FLUTD) is a common, multifactorial clinical syndrome in cats that affects the bladder and urethra and presents with clinical signs *viz* dysuria, haematuria, pollakiuria and periuria (Taylor *et al*., 2025). The condition encompasses a spectrum of diagnoses *viz* feline idiopathic cystitis, urolithiasis, bacterial urinary tract infection and urethral obstruction (Gunn-Moore, 2003).

Routine urinalysis in FLUTD commonly demonstrates gross or microscopic haematuria, proteinuria and pyuria when inflammation or infection is present (Dorsch *et al*., 2019). Urine specific gravity and pH are variable and may reflect renal concentrating ability, diet or bacterial urease activity, while crystalluria (struvite and calcium oxalate) is reported in a minority of cases (Yadav *et al*., 2020). These urinalysis parameters remain essential in the first line diagnostics to guide further testing.

Although bacterial urinary tract infection (UTI) is an important cause of FLUTD in some populations, the prevalence of true bacterial UTI among cats with lower urinary tract disease is generally lower in young, otherwise healthy cats and higher in older or systemically ill animals (Martinez-Ruzafa *et al*., 2012). A quantitative urine culture is recommended when infection is suspected or when empirical therapy is contemplated. Antimicrobial susceptibility testing has revealed rising rates of resistance among common uropathogens (e.g: *Escherichia coli, Klebsiella, Pseudomonas, Enterococcus*), and recent surveillance and retrospective studies emphasize an increasing incidence of multidrug resistance, underlining the need for culture guided antibiotic selection and periodic antibiogram surveillance (Hernandez *et al*., 2014).

MATERIALS AND METHODS

The present study was conducted on client owned cats clinically diagnosed with FLUTD presented to the Teaching Veterinary Clinical Complex, Mannuthy and University Veterinary Hospital, Kokkalai during the study period February 2025 to March 2025. Only cats showing clinical signs of dysuria, haematuria, pollakiuria, or periuria were included. Signalment data including age, sex, and breed were recorded. Among the 20 cats selected, 18 were male and two were female and most were young adults, comprising 75 per cent Persian, 15 per cent Domestic Short Hair, 5 per cent Himalayan, and 5 per cent crossbred cats.

The cats were thoroughly examined and urine samples were collected for routine urinalysis and urine culture and sensitivity tests. Routine haematology and serum biochemistry were done to assess general health status of the animals, while the present study focused primarily on urinalysis, urine culture and antimicrobial susceptibility patterns.

RESULTS AND DISCUSSION

Physical, Chemical and Microscopical examination of Urine

Physical examination of urine samples from cats affected with FLUTD revealed that 70 per cent were yellow in color, while 30 per cent exhibited darker shades such as amber, red, or orange (figure 1) these findings were in accordance with Brabson *et al*. (2015) where they have reported urine colour categories from yellow to burgundy. Urine clarity varied, with 45 per cent of the samples appearing clear and 55 per cent showing different degrees of opacity. Isosthenuria was detected in 70 per cent of cases, suggesting reduced renal concentrating ability, whereas 30 per cent of samples were hypersthenuric but these findings were in contradictory with the findings of Culp *et al*. (2016) where they have noticed, hyperesthenuria in majority of the cats affected with FLUTD.

Chemical analysis indicated that urine pH ranged from 5.0 to 7.5, with the majority (65 per cent) between 6.0 and 6.5 which was similar to the findings of Tefft *et al*. (2021). Proteinuria (100 per cent) and haematuria (30 per cent) were predominant findings, reflecting inflammation and mucosal irritation of the lower urinary tract (Defauw *et al*., 2011). Bilirubinuria (70 per cent), leucocyturia (65 per cent), and nitrite positivity (50 per cent) were also recorded, indicating active bacterial infection.

Microscopic examination revealed erythrocytes in 85 per cent and leukocytes in 80 per cent of samples. Crystals were present in 20 per cent of cases, predominantly struvite and calcium oxalate these findings were in accordance with the findings of Okafor *et al*. (2019) (figure 2 and 3). Bacterial forms were detected in 40 per cent of samples as cocci, 50 per cent as bacilli, and 10 per cent showed mixed bacterial morphologies.

These observations are consistent with previous studies describing variable urine characteristics in cats with FLUTD, including haematuria, pyuria and crystalluria associated with lower urinary tract inflammation and infection (Dorsch *et al*., 2019; Weese *et al*., 2019).

Bacterial Culture and Identification

Within the 20 urine samples cultured, 16 (80 per cent) showed positive bacterial growth on brain heart infusion agar. *Pseudomonas aeruginosa* was the most frequently isolated organism, followed by *Escherichia coli* and *Klebsiella* species. Other bacterial isolates included *Enterococcus faecium*, coagulase negative *Staphylococcus*, *Enterobacter* species, and *Proteus mirabilis* (table 1). Another study conducted by Lister *et al*. (2007) repprted that the majority of bacterial isolates were of *Escherichia coli*, followed by *Enterococcus faecalis*.

Antimicrobial susceptibility testing was carried out using 24 antibiotic discs representing various drug classes to evaluate the sensitivity and resistance profiles of the bacterial isolates as enlisted in table 2.

Antibiotic Sensitivity Pattern

Gram negative isolates, including *Escherichia coli*, *Klebsiella, Enterobacter*, *Pseudomonas* and *Proteus* species, exhibited high susceptibility to amikacin and carbapenems (imipenem, meropenem), which concurs with the findings of Sattasathuchana *et al*. (2024). Resistance to cephalosporins was widespread, particularly among *Klebsiella*, *Enterobacter*, and *Pseudomonas* species, as also reported by Scarpellini *et al*. (2025). *Escherichia coli* showed moderate resistance to certain cephalosporins, *Pseudomonas* displayed intrinsic β-lactam resistance, whereas *Klebsiella* and *Proteus* isolates remained universally susceptible to carbapenems and amikacin.

Among Gram positive organisms, *Enterococcus faecium* demonstrated extensive resistance to β-lactams, with limited susceptibility to aminoglycosides and carbapenems, indicating the potential utility of alternative agents such as vancomycin or linezolid. These observations align with those of Koontz *et al*. (2023). Coagulase negative *Staphylococcus* (CNS) isolates were sensitive to amikacin and carbapenems but resistant to several cephalosporins, in agreement with Rumi *et al*. (2021). Overall, carbapenems and amikacin emerged as the most effective agents, while cephalosporin resistance was common. The emergence of multidrug resistant (MDR) *Pseudomonas* and *Enterococcus* strains underscores the necessity of regular antibiogram surveillance, with empirical therapy for severe Gram negative infections prioritizing carbapenems or aminoglycosides over cephalosporins.

Gentamicin demonstrated moderate antimicrobial efficacy against *Escherichia coli*, *Pseudomonas aeruginosa*, *Klebsiella* spp. and *Proteus mirabilis*, consistent with the findings of Teichmann-Knorrn *et al*. (2018), although resistance was still noted in some isolates. Piperacillin exhibited limited activity, with higher resistance rates observed in *Klebsiella* and *Pseudomonas* species, corroborating the findings of Nduagu *et al*. (2024). Amoxicillin and its combinations displayed poor efficacy, marked by extensive resistance across most tested isolates, emphasizing their diminished clinical utility. Aminoglycosides and fluoroquinolones demonstrated comparatively higher susceptibility rates and better activity against Gram negative pathogens (Lopez-Cordova *et al*., 2025). Cephalosporins showed moderate susceptibility overall, yet resistance remained particularly pronounced in *Klebsiella* and *Enterobacter* species as shown in table 3.

Collectively, these results reveal a concerning prevalence of resistance to commonly prescribed β-lactam antibiotics and highlight aminoglycosides and fluoroquinolones as more reliable therapeutic alternatives. As emphasized by Hritcu *et al*. (2020), Caneschi *et al*. (2023), Temmerman *et al*. (2024), and Wang *et al*. (2025), variability in antimicrobial resistance (AMR) patterns may be attributed to genetic diversity among pathogens, previous antibiotic exposure, infection source, as well as environmental and geographical influences. The present findings further reinforce the need for prudent antibiotic use, robust antimicrobial

Fig. 1. Variations in urine colour among FLUTD affected cats

Fig. 2. Oxalate crystals

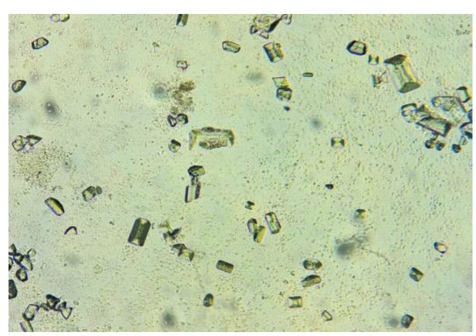

Fig. 3. Struvite crystals

Table 1. List of bacterial isolates obtained from urine culture of affected cats

Sl. No.	Organism isolated	Number of cases
1	*Pseudomonas aeruginosa*	6 (37.5%)
2	*Escherichia coli*	4 (25%)
3	*Klebsiella* spp	2 (12.5%)
4	*Enterococcus faecium*	1 (6.25%)
5	Coagulase negative *Staphylococcus*	1 (6.25%)
6	*Enterobacter species*	1 (6.25%)
7	*Proteus mirabilis*	1 (6.25%)
Total		**16 (100%)**

Table 2. List of antibiotic discs used for antimicrobial susceptibility testing in bacterial isolates

Antibiotic Class	Antibiotic Name
Aminoglycosides	Amikacin, Gentamicin
Carbapenems	Imipenem, Meropenem
Cephalosporins	Ceftriaxone, Cefepime, Ceftriaxone tazobactam, Cefotaxime, Cefixime, Cephalexin
Fluoroquinolones	Ciprofloxacin, Norfloxacin, Ofloxacin, Enrofloxacin
β-lactam/β-lactamase inhibitors	Amoxicillin clavulanate, Amoxicillin sulbactam, Piperacillin
Penicillins	Ampicillin
Tetracyclines	Doxycycline
Sulfonamides	Cotrimoxazole
Lincosamides	Clindamycin
Nitrofurans	Nitrofurantoin
Polymyxins	Colistin
Amphenicols	Chloramphenicol

stewardship programs, and continuous surveillance to mitigate the escalating threat of multidrug resistance.

SUMMARY

The present study investigated the bacterial isolates and antibiotic sensitivity patterns in urine samples from cats affected with feline lower urinary tract disease. Urinalysis commonly revealed yellow to dark urine with variable clarity, isosthenuria, proteinuria and haematuria, indicating inflammation and impaired renal concentrating ability. Bacterial culture yielded growth in 80 per cent of samples, with *Pseudomonas aeruginosa*, *Escherichia coli*, and *Klebsiella* species as predominant isolates. Carbapenems and amikacin were found to be the most effective antimicrobials, whereas widespread resistance was observed against β-lactams and cephalosporins. Gentamicin

Table 3. Antibiogram pattern of bacteria isolated from the urine of affected cats

Sl No.	Antibiotc	*Escherichia coli*		*Psuedomonas aeruginosa*		*Klebsiella* spp		*Enterococcus faecium*		CNS		*Enterobacter* spp		***Proteus mirabilis***	
		S	R	S	R	S	R	S	R	S	R	S	R	S	R
1	Amikacin	4	0	5	1	1	1	0	1	1	0	1	0	1	0
2	Meropenem	3	1	6	0	2	0	0	1	1	0	1	0	1	0
3	Imipenem	4	0	5	1	2	0	0	1	1	0	1	0	1	0
4	Ceftriaxone	4	0	4	2	1	1	0	1	0	1	1	0	1	0
5	Cefipime	4	0	6	0	1	1	0	1	1	0	1	0	1	0
6	Ceftriaxone tazobactum	1	3	4	2	2	0	0	1	1	0	1	0	1	0
7	Cefotaxime	4	0	0	6	1	1	0	1	1	0	1	0	1	0
8	Cefixime	1	3	0	6	1	1	0	1	0	1	1	0	1	0
9	Cephalexin	3	1	0	6	0	2	0	1	0	1	0	1	1	0
10	Ciprofloxacn	1	3	5	1	2	0	0	1	0	1	1	0	1	0
11	Norfloxacin	4	0	3	3	2	0	0	1	0	1	1	0	1	0
12	Ofloxacin	4	0	4	2	2	0	0	1	1	0	1	0	1	0
13	Gentamicin	4	0	5	1	1	1	0	1	1	0	1	0	1	0
14	Piperacillin	4	0	5	1	0	2	0	1	0	1	1	0	1	0
15	Ampicillin	0	4	0	6	0	2	0	1	0	1	0	1	1	0
16	Amoxicillin clavulanate	1	3	0	6	1	1	1	0	0	1	0	1	1	0
17	Amoxicillin sulbactum	0	4	0	6	0	2	1	0	1	0	0	1	0	1
18	Clindamycin	0	4	0	6	0	2	0	1	1	0	0	1	0	1
19	Cotrimaxazole	1	3	1	5	2	0	0	1	1	0	1	0	1	0
20	Doxycycline	3	1	1	5	1	1	1	0	1	0	0	1	0	1
21	Enrofloxacin	4	0	6	0	0	2	0	1	0	1	0	1	0	1
22	Nitrofurantoin	4	0	0	6	1	1	1	0	1	0	0	1	0	1
23	Colistin	1	3	6	0	1	1	1	0	0	1	1	0	0	1
24	Chloramphenicol	1	3	0	6	1	0	0	1	0	1	1	0	0	1

and fluoroquinolones demonstrated moderate efficacy, while amoxicillin and its combinations were largely ineffective. The high prevalence of multidrug resistant organisms, particularly *Pseudomonas* and *Enterococcus*, underscores the importance of culture based antibiotic selection. The findings highlight the need for regular antibiogram surveillance and prudent antimicrobial use for effective management of feline urinary tract infections.

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