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Antimicrobial Resistance Phenotypes and Clinical Predictors of Multidrug-Resistant Uropathogens among Patients with Urinary Tract Infection: A Cross-Sectional Study

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ABSTRACT:

Background & objectives: Multidrug-resistant (MDR) uropathogens complicate empirical treatment of urinary tract infection (UTI), particularly in settings with frequent healthcare exposure. This study evaluated antimicrobial resistance phenotypes and clinical factors associated with MDR among adults with culture-confirmed UTI.

Methods: A hospital-based analytical cross-sectional study included 425 adults with culture-confirmed bacterial UTI at a tertiary-care teaching hospital in Moradabad, India, from January to August 2026. Uropathogen distribution, antimicrobial resistance patterns and relevant clinical exposures were recorded. Factors associated with MDR were assessed using univariable and multivariable logistic regression.

Results: MDR was identified in 252 (59.3%) isolates. Escherichia coli was the predominant uropathogen (64.9%), followed by Klebsiella pneumoniae (15.1%). Among E. coli, resistance to ciprofloxacin and ceftriaxone was 51.8% and 51.4%, respectively, whereas resistance to nitrofurantoin and fosfomycin was 14.9% and 6.9%. Recurrent UTI (aOR 1.77, 95% CI 1.07-2.93), hospitalisation within 90 days (aOR 2.94, 1.62-5.34) and

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urinary catheterisation (aOR 3.19, 1.44-7.06) were independently associated with MDR. Sensitivity analysis using non-susceptibility increased MDR prevalence to 67.5% but retained the same three independent clinical associations overall.

Interpretation & Conclusions: MDR was common in culture-confirmed UTI. Recent hospitalisation, recurrent UTI and urinary catheterisation may help identify patients at greater risk while awaiting susceptibility results.

INTRODUCTION

Urinary tract infection (UTI) is among the most common bacterial infections encountered in community and hospital practice. Global estimates for 2019 indicated more than 400 million UTI episodes, underscoring its substantial and persistent burden [1]. Treatment has become increasingly difficult as antimicrobial resistance (AMR) reduces the reliability of several agents commonly used for empirical therapy. In 2021, bacterial AMR was associated with an estimated 4.71 million deaths worldwide, including 1.14 million deaths directly attributable to resistance [2]. Within UTIs specifically, Escherichia coli and Klebsiella pneumoniae account for a large share of the AMR burden, with fluoroquinolone and third-generation cephalosporin resistance contributing importantly to adverse outcomes [3].

The problem is particularly relevant in India, where resistance patterns vary across regions and healthcare settings. A recent multicentre Indian study of community-acquired urinary E. coli reported low susceptibility to fluoroquinolones and oral cephalosporins, while fosfomycin and nitrofurantoin retained substantially greater activity [4]. Earlier multicentre community data from India also documented a considerable burden of extended-spectrum beta-lactamase (ESBL)-producing uropathogens [5]. These findings reinforce the need for local surveillance rather than assuming that resistance patterns from one setting apply uniformly to another.

Multidrug resistance further narrows therapeutic options. Internationally used terminology defines MDR as non-susceptibility to at least one agent in three or more relevant antimicrobial categories [6]. The likelihood of MDR is not uniform across patients; previous hospital exposure, recurrent infection, antimicrobial use and urinary devices have repeatedly been associated with resistant urinary pathogens. In the prospective multicentre UTILY study, recent hospital admission was independently associated with MDR UTI [7]. Evidence from northern India has also linked urinary catheter use with multidrug-resistant infection [8].

Although antibiograms describe local resistance, fewer studies examine microbiological phenotypes together with patient-level clinical factors in adjusted analyses. The present study therefore aimed to describe the distribution and antimicrobial resistance patterns of bacterial uropathogens among adults with culture-confirmed UTI and to identify clinical factors independently associated with MDR. A sensitivity analysis using a non-susceptibility-based MDR definition was also performed to assess the robustness of the principal findings.

MATERIALS AND METHODS

Study design and setting: This hospital-based analytical cross-sectional study was conducted at a tertiary-care teaching hospital in Moradabad, Uttar Pradesh, India, from January to August 2026. Adult patients evaluated for UTI in outpatient departments, inpatient wards, and intensive care units were screened for eligibility.

Study population: Patients aged 18 years or older with culture-confirmed bacterial UTI and sufficient clinical and microbiological information were included. Contaminated specimens, clinically insignificant growth, and cultures yielding only non-bacterial organisms were excluded. For patients with more than one positive urine culture during the same infectious episode, only the first clinically relevant isolate was considered.

Data collection: Demographic and clinical data were recorded using a structured data collection form. Variables included age, sex, residence, care setting, diabetes mellitus, hypertension, chronic kidney disease, immunocompromised status, recurrent UTI, hospitalisations and antibiotic exposure during the preceding 90 days, urinary catheterisation, urinary instrumentation, structural urinary tract abnormalities, and urinary calculus.

Urine collection and microbiological processing: Midstream clean-catch urine specimens were obtained from non-catheterised patients. In catheterised patients, urine was collected aseptically from the catheter sampling port after disinfection. Samples

were transported promptly to the microbiology laboratory and processed using routine semiquantitative culture methods. Significant growth was interpreted according to specimen type, colony count, purity of growth, and clinical presentation. Clinically significant bacterial isolates were identified to species level using routine laboratory procedures.

Antimicrobial susceptibility testing: Antimicrobial susceptibility testing was performed using the standard method followed in the clinical microbiology laboratory. Results were interpreted according to the Clinical and Laboratory Standards Institute criteria applicable during the study period and classified as susceptible, intermediate, or resistant. Antimicrobials that were not tested or were not applicable to a particular species were excluded from the corresponding resistance calculations.

Definition of multidrug resistance: An isolate was classified as MDR when resistance to at least one antimicrobial agent was present in three or more applicable antimicrobial categories. Only categories relevant to the individual organism were considered. A sensitivity analysis was also performed in which both intermediate and resistant results were classified as non-susceptible. ESBL phenotype, carbapenem resistance, methicillin resistance in Staphylococcus aureus, and vancomycin resistance among enterococci were assessed according to the applicable laboratory susceptibility criteria.

Outcome measures: The primary outcome was the presence of an MDR uropathogen among patients with culture-confirmed bacterial UTI. Secondary outcomes included uropathogen distribution, organism-specific resistance patterns, ESBL phenotype, carbapenem resistance, fluoroquinolone resistance, resistance to third-generation cephalosporins, methicillin resistance among S. aureus, and vancomycin resistance among enterococci. Clinical factors evaluated for their association with MDR included demographic characteristics, comorbidities, recurrent UTI, recent healthcare and antibiotic exposure, urinary catheterisation, urinary instrumentation, structural urinary tract abnormalities, urinary calculus, and infecting pathogen group.

Statistical analysis: Data were analysed using R statistical software. Continuous variables were summarised as median with interquartile range (IQR), while categorical variables were presented as frequencies and percentages. Differences between MDR and non-MDR groups were assessed using the Mann–Whitney U test for continuous variables and Pearson's χ^2 test or Fisher's exact test for categorical variables, as appropriate. Factors associated with MDR were evaluated using univariable and multivariable binary logistic regression and reported as crude and adjusted odds ratios with 95% confidence intervals. Clinically relevant demographic, comorbidity, healthcare-exposure, urinary-tract, and pathogen-related variables were included in the adjusted model. Model discrimination was assessed using the area under the receiver operating characteristic curve, and calibration was evaluated using the Hosmer–Lemeshow goodness-of-fit test. All tests were two-sided, and a p value <0.05 was considered statistically significant.

RESULTS

Study population and multidrug resistance

The median age of the 425 participants was 51 years (IQR 38-63), and 254 (59.8%) were female. Most participants were managed in the outpatient setting (299 [70.4%]), and 336 (79.1%) infections were community-acquired. Using the primary resistance-based definition, 252 (59.3%) isolates were classified as MDR (Table 1). MDR was more frequent among patients with recurrent UTI than among those without recurrent UTI (69/99 [69.7%] vs 183/326 [56.1%]; p=0.016). MDR was also more frequent among patients with hospitalisation within the preceding 90 days (62/81 [76.5%]; p<0.001), urinary catheterisation (34/44 [77.3%]; p=0.010), and healthcare-associated UTI (64/89 [71.9%]; p=0.0064).

Table 1: Demographic and clinical characteristics according to multidrug-resistance status

Characteristic	Overall (n=425)	Non-MDR (n=173)	MDR (n=252)	p value
Age, years	51 (38–63)	52 (38–63)	51 (37.75–61)	-
Sex, female	254 (59.8%)	103 (59.5%)	151 (59.9%)	-
Sex, male	171 (40.2%)	70 (40.5%)	101 (40.1%)	-
Residence, urban	254 (59.8%)	100 (57.8%)	154 (61.1%)	-
Residence, rural	171 (40.2%)	73 (42.2%)	98 (38.9%)	-
Care setting, OPD	299 (70.4%)	127 (73.4%)	172 (68.3%)	-

Care setting, IPD	106 (24.9%)	42 (24.3%)	64 (25.4%)	-
Care setting, ICU	20 (4.7%)	4 (2.3%)	16 (6.3%)	-
Diabetes mellitus, yes	103 (24.2%)	34 (19.7%)	69 (27.4%)	0.068
Hypertension, yes	113 (26.6%)	51 (29.5%)	62 (24.6%)	0.260
Chronic kidney disease, yes	40 (9.4%)	12 (6.9%)	28 (11.1%)	0.150
Immunocompromised, yes	17 (4.0%)	6 (3.5%)	11 (4.4%)	0.640
Previous UTI within 12 months, yes	158 (37.2%)	59 (34.1%)	99 (39.3%)	0.280
Recurrent UTI, yes	99 (23.3%)	30 (17.3%)	69 (27.4%)	**0.016**
Hospitalisation within 90 days, yes	81 (19.1%)	19 (11.0%)	62 (24.6%)	<0.001
Antibiotic exposure within 90 days, yes	127 (29.9%)	45 (26.0%)	82 (32.5%)	0.150
Urinary catheterisation, yes	44 (10.4%)	10 (5.8%)	34 (13.5%)	**0.010**
Urinary instrumentation within 90 days, yes	40 (9.4%)	14 (8.1%)	26 (10.3%)	0.440
Structural urinary tract abnormality, yes	45 (10.6%)	17 (9.8%)	28 (11.1%)	0.670
Urinary calculus, yes	48 (11.3%)	18 (10.4%)	30 (11.9%)	0.630
Complicated UTI, yes	161 (37.9%)	56 (32.4%)	105 (41.7%)	0.052
Healthcare-associated UTI, yes	89 (20.9%)	25 (14.5%)	64 (25.4%)	**0.006**

Data are n (%) unless otherwise indicated. Age is presented as median (IQR). Percentages in the Non-MDR and MDR columns were calculated using the respective column totals. Age was compared using the Mann–Whitney U test. Categorical variables were compared using Pearson's χ^2 test or Fisher's exact test, as appropriate. For variables with more than two categories, including care setting, the reported p value represents the overall comparison across categories. MDR=multidrug resistant; UTI=urinary tract infection; OPD=outpatient department; IPD=inpatient department; ICU=intensive care unit.

Uropathogen distribution and resistance phenotypes

Escherichia coli was the predominant uropathogen (276/425 [64.9%]), followed by Klebsiella pneumoniae (64/425 [15.1%]) and Pseudomonas aeruginosa (32/425 [7.5%]) (Table 2; Figure 1). Among E. coli, 135/276 (48.9%) isolates were ESBL positive and 32/276 (11.6%) were carbapenem resistant. For K. pneumoniae, ESBL positivity was 31/64 (48.4%) and carbapenem resistance was 11/64 (17.2%).

Table 2: Distribution of uropathogens and major resistance phenotypes

Organism	Overall, n (%)	MDR, n/N (%)	ESBL positive, n/N (%)	Carbapenem resistant, n/N (%)	MRSA, n/N (%)	VRE, n/N (%)
Escherichia coli	276 (64.9%)	170 (61.6%)	135 (48.9%)	32 (11.6%)	—	—
Klebsiella pneumoniae	64 (15.1%)	35 (54.7%)	31 (48.4%)	11 (17.2%)	—	—
Pseudomonas aeruginosa	32 (7.5%)	21 (65.6%)	—	21 (65.6%)	—	—

Enterococcus faecalis	18 (4.2%)	6 (33.3%)	—	—	—	3 (16.7%)
Proteus mirabilis	12 (2.8%)	5 (41.7%)	3 (25.0%)	0 (0.0%)	—	—
Enterococcus faecium	11 (2.6%)	7 (63.6%)	—	—	—	8 (72.7%)
Acinetobacter baumannii	8 (1.9%)	6 (75.0%)	—	5 (62.5%)	—	—
Staphylococcus aureus	4 (0.9%)	2 (50.0%)	—	—	3 (75.0%)	—

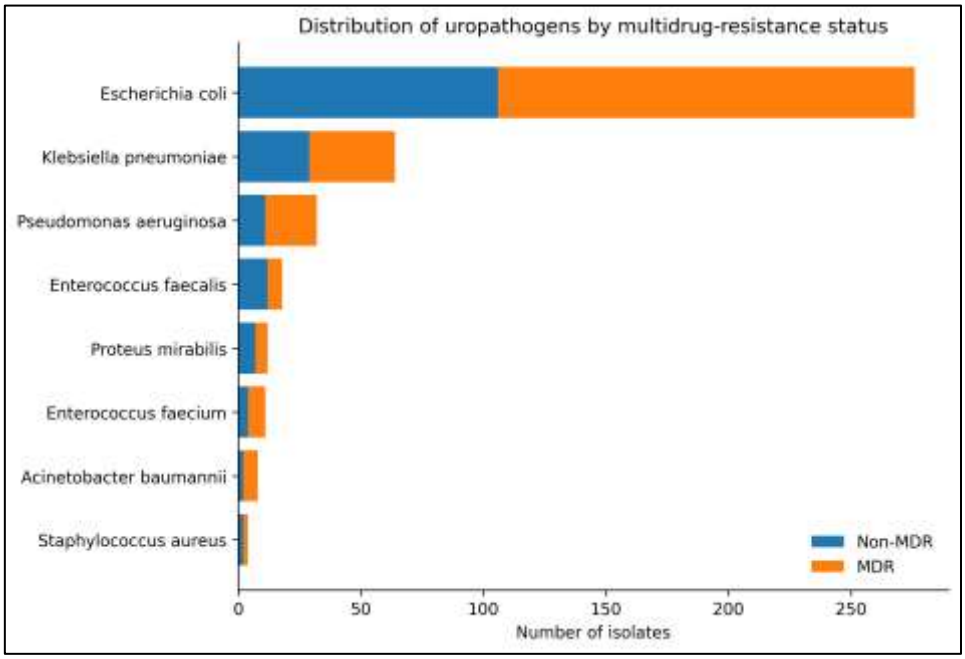

Figure 1: Distribution of uropathogens by multidrug-resistance status. Bars show the absolute number of non-MDR and MDR isolates for each organism. MDR was defined in the primary analysis as resistance (R) in three or more applicable antimicrobial categories. MDR=multidrug resistant.

Antimicrobial Resistance Profiles

Among E coli, resistance was highest for third-generation cephalosporins and fluoroquinolones: ceftriaxone resistance was 142/276 (51.4%), ciprofloxacin resistance was 143/276 (51.8%), whereas nitrofurantoin and fosfomycin resistance were 41/276 (14.9%) and 19/276 (6.9%), respectively (Table 3). K pneumoniae showed substantial resistance to ceftriaxone and nitrofurantoin, while P aeruginosa had high resistance to ciprofloxacin and meropenem. Estimates for A baumannii were imprecise because only eight isolates were present.

Table 3: Antimicrobial resistance among major Gram-negative uropathogens

Antimicrobial	**E coli (n=276)**	**K pneumoniae (n=64)**	**P aeruginosa (n=32)**	**A baumannii (n=8)**
Ampicillin	141/276 (51.1%)	—	—	—

Amoxicillin–clavulanate	123/276 (44.6%)	33/64 (51.6%)	—	—
Cefuroxime	120/276 (43.5%)	27/64 (42.2%)	—	—
Ceftriaxone	142/276 (51.4%)	36/64 (56.2%)	—	—
Ceftazidime	144/276 (52.2%)	36/64 (56.2%)	18/32 (56.2%)	3/8 (37.5%)
Cefepime	124/276 (44.9%)	30/64 (46.9%)	18/32 (56.2%)	1/8 (12.5%)
Ciprofloxacin	143/276 (51.8%)	20/64 (31.2%)	20/32 (62.5%)	5/8 (62.5%)
Levofloxacin	139/276 (50.4%)	21/64 (32.8%)	19/32 (59.4%)	6/8 (75.0%)
Trimethoprim–sulfamethoxazole	137/276 (49.6%)	19/64 (29.7%)	—	—
Nitrofurantoin	41/276 (14.9%)	33/64 (51.6%)	—	—
Fosfomycin	19/276 (6.9%)	7/64 (10.9%)	—	—
Gentamicin	71/276 (25.7%)	21/64 (32.8%)	15/32 (46.9%)	2/8 (25.0%)
Amikacin	61/276 (22.1%)	21/64 (32.8%)	15/32 (46.9%)	2/8 (25.0%)
Piperacillin–tazobactam	62/276 (22.5%)	11/64 (17.2%)	14/32 (43.8%)	6/8 (75.0%)
Ertapenem	31/276 (11.2%)	9/64 (14.1%)	—	—
Imipenem	28/276 (10.1%)	9/64 (14.1%)	19/32 (59.4%)	4/8 (50.0%)
Meropenem	27/276 (9.8%)	9/64 (14.1%)	21/32 (65.6%)	4/8 (50.0%)

Among enterococci, vancomycin resistance was 3/18 (16.7%) in E faecalis and 8/11 (72.7%) in E faecium (Table 4). Three of four S aureus isolates were cefoxitin resistant, but this proportion is based on a very small denominator and should not be interpreted as a stable estimate.

Table 4: Antimicrobial resistance among Gram-positive uropathogens

Antimicrobial	**E faecalis (n=18)**	**E faecium (n=11)**	**S aureus (n=4)**
Ampicillin	5/18 (27.8%)	4/11 (36.4%)	—
Ciprofloxacin	15/18 (83.3%)	6/11 (54.5%)	1/4 (25.0%)
Levofloxacin	14/18 (77.8%)	6/11 (54.5%)	0/4 (0.0%)
Trimethoprim–sulfamethoxazole	—	—	1/4 (25.0%)
Nitrofurantoin	8/18 (44.4%)	5/11 (45.5%)	2/4 (50.0%)
Gentamicin	10/18 (55.6%)	6/11 (54.5%)	2/4 (50.0%)
Cefoxitin	—	—	3/4 (75.0%)

Vancomycin	3/18 (16.7%)	8/11 (72.7%)	0/4 (0.0%)
Linezolid	1/18 (5.6%)	2/11 (18.2%)	1/4 (25.0%)
Teicoplanin	5/18 (27.8%)	4/11 (36.4%)	0/4 (0.0%)

Data are resistant isolates/tested isolates (%). Only R was counted as resistant. A dash indicates not applicable/not tested. The S aureus denominator is only four; phenotype percentages therefore have substantial sampling uncertainty.

Clinical predictors of multidrug-resistant uropathogens

In the pathogen-adjusted multivariable model, recurrent UTI was associated with higher odds of MDR (aOR 1.77, 95% CI 1.07-2.93; p=0.026). Previous hospitalisation within 90 days was independently associated with MDR (aOR 2.94, 95% CI 1.62-5.34; p<0.001), as was urinary catheterisation (aOR 3.19, 95% CI 1.44-7.06; p=0.0043) (Table 5; Figure 2). Recent antibiotic exposure, urinary instrumentation, structural urinary tract abnormality and urinary calculus were not independently associated with MDR.

The overall model likelihood-ratio test was significant (χ^2=40.57, df=16, p=0.00064). Discrimination was modest (area under the ROC curve 0.675); the Brier score was 0.220. The Hosmer–Lemeshow test did not indicate lack of calibration (χ^2=4.27, df=8, p=0.83). No material multicollinearity was detected in the clinical covariates in the corresponding design matrix.

Table 5: Logistic regression analysis of factors associated with multidrug-resistant uropathogens

Variable	Crude OR (95% CI)	p value	Adjusted OR (95% CI)	p value
Age, per 10-year increase	0.97 (0.87–1.08)	0.6	0.91 (0.80–1.03)	0.14
Male sex	0.98 (0.66–1.46)	0.94	0.99 (0.65–1.51)	0.97
Diabetes mellitus	1.54 (0.97–2.46)	0.069	1.49 (0.88–2.50)	0.13
Chronic kidney disease	1.68 (0.83–3.40)	0.15	1.64 (0.76–3.53)	0.21
Immunocompromised	1.27 (0.46–3.50)	0.64	1.92 (0.67–5.48)	0.22
Recurrent UTI	1.80 (1.11–2.91)	0.017	1.77 (1.07–2.93)	0.026
Previous hospitalisation within 90 days	2.64 (1.52–4.61)	0.00061	2.94 (1.62–5.34)	0.00038
Antibiotic exposure within 90 days	1.37 (0.89–2.11)	0.15	1.20 (0.76–1.89)	0.44
Urinary catheterisation	2.54 (1.22–5.29)	0.013	3.19 (1.44–7.06)	0.0043
Urinary instrumentation within 90 days	1.31 (0.66–2.58)	0.44	0.99 (0.47–2.07)	0.97
Structural urinary tract abnormality	1.15 (0.61–2.17)	0.67	1.26 (0.63–2.50)	0.51
Urinary calculus	1.16 (0.63–2.16)	0.63	1.03 (0.53–2.02)	0.93
K pneumoniae vs E coli	0.75 (0.43–1.30)	0.31	0.74 (0.41–1.34)	0.32
P aeruginosa vs E coli	1.19 (0.55–2.57)	0.66	1.01 (0.44–2.31)	0.97

Enterococcus spp vs E coli	0.51 (0.23–1.10)	0.084	0.45 (0.19–1.02)	0.057
Other pathogens vs E coli	0.74 (0.32–1.70)	0.48	0.71 (0.29–1.72)	0.45

The dependent variable was MDR (yes vs no). The adjusted model included all listed clinical variables and pathogen group simultaneously. E coli was the reference pathogen group. Age is expressed per 10-year increase; all other clinical variables are yes vs no unless stated. Composite acquisition and UTI-complexity variables were not included with component exposures. OR=odds ratio; CI=confidence interval; UTI=urinary tract infection; MDR=multidrug resistant.

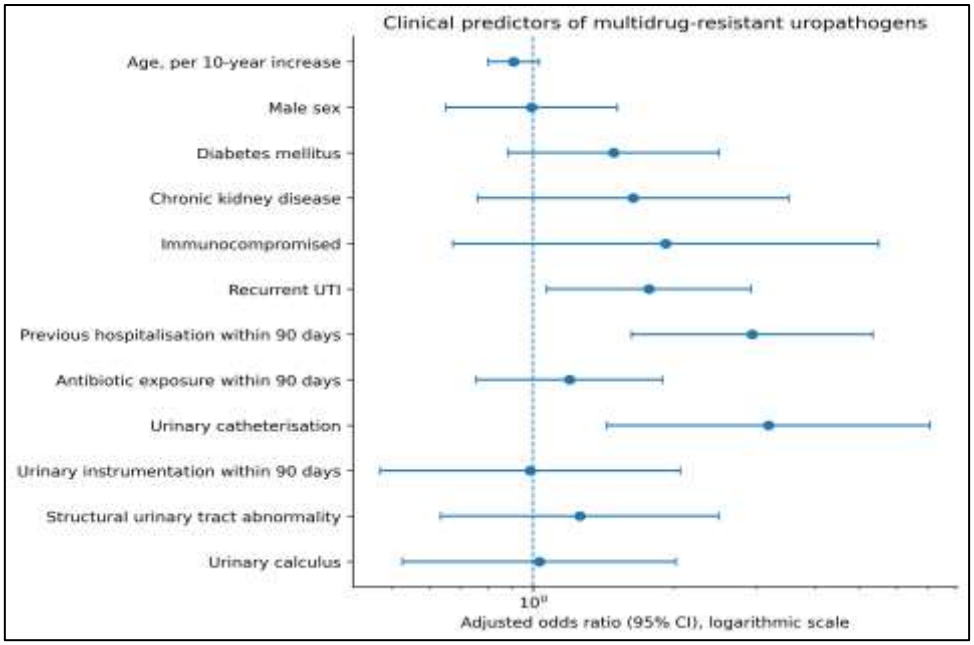

Figure 2: Adjusted associations between prespecified clinical factors and multidrug-resistant uropathogens

Sensitivity analysis of the MDR definition

When intermediate results were counted together with resistant results as non-susceptible, 287/425 (67.5%) isolates met the >=3-category MDR rule, compared with 252/425 (59.3%) under the resistance-only definition. Recurrent UTI (aOR 1.94, 95% CI 1.12-3.34; p=0.018), previous hospitalisation (aOR 2.31, 95% CI 1.24-4.33; p=0.0087), and urinary catheterisation (aOR 3.72, 95% CI 1.51-9.20; p=0.0044) remained associated with MDR. The sensitivity model had an area under the ROC curve of 0.681.

DISCUSSION

The present study found a substantial burden of multidrug resistance among adults with culture-confirmed UTI, with 59.3 per cent of isolates meeting the primary resistance-based MDR definition. Escherichia coli remained the dominant uropathogen, accounting for 64.9 per cent of isolates, followed by Klebsiella pneumoniae. Recurrent UTI, hospitalisation within the preceding 90 days and urinary catheterisation were independently associated with MDR. These associations remained evident in the sensitivity analysis, although the estimated MDR prevalence increased to 67.5 per cent when intermediate results were also classified as non-susceptible.

The predominance of E. coli is consistent with Indian multicentre data. Mohapatra et al. reported E. coli in 68 per cent and K. pneumoniae in 17.6 per cent of community-acquired urinary isolates across four regions of India [5]. A more recent multicentre study also demonstrated marked regional variation in susceptibility among community-acquired urinary E. coli isolates [4]. In the present study, E. coli resistance exceeded 50 per cent for ciprofloxacin and ceftriaxone, whereas resistance to nitrofurantoin and fosfomycin was 14.9 and 6.9 per cent, respectively. The same broad pattern has been observed in Indian multicentre data,

where nitrofurantoin and fosfomycin retained considerably greater activity than fluoroquinolones and oral cephalosporins [4,5]. These findings support the use of local antibiograms when empirical therapy is selected rather than relying on resistance estimates from other institutions or regions.

ESBL positivity was observed in 48.9 per cent of E. coli and 48.4 per cent of K. pneumoniae isolates. Mohapatra et al. similarly reported a high prevalence of ESBL-producing uropathogens in community settings in India [5]. Carbapenem resistance was lower in E. coli and K. pneumoniae than in P. aeruginosa and A. baumannii in the present cohort, although estimates for the less common organisms should be interpreted cautiously because of the small denominators. The overall resistance profile is clinically important because fluoroquinolone- and third-generation cephalosporin-resistant E. coli contribute substantially to the global AMR burden associated with UTI [3]. Recent hospitalisation showed a clear independent association with MDR in the adjusted model. This finding agrees with the prospective multicentre UTILY study, in which hospital admission during the previous 90 days was independently associated with isolation of an MDR pathogen [7]. Urinary catheterisation was also independently associated with MDR in the present study. Evidence from northern India has linked urinary catheter use with multidrug-resistant infection [8], and prospective data from hospitalised patients with UTI have similarly identified a permanent bladder catheter as an independent risk factor for MDR infection [10]. Catheters may facilitate biofilm formation and repeated healthcare exposure, both of which can increase contact with resistant organisms.

Recurrent UTI was independently associated with MDR even after adjustment for other clinical factors. Repeated episodes may reflect persistent colonisation, underlying urinary tract abnormalities or repeated antimicrobial and healthcare exposure. By contrast, recent antibiotic exposure did not retain an independent association in the adjusted model. This should not be interpreted as evidence that antimicrobial exposure is unimportant; information on drug class, duration, adherence and treatment received outside the hospital may not be fully captured in routinely collected clinical histories. The multivariable model showed modest discrimination (AUC 0.675), indicating that the measured clinical variables are useful for risk stratification but are not sufficient for patient-level prediction on their own. Culture and susceptibility testing, previous microbiology results and institution-specific resistance data therefore remain central to treatment decisions. The sensitivity analysis also illustrates the importance of clearly stating the MDR definition: applying a non-susceptibility-based definition, consistent with internationally used terminology [6], increased the measured prevalence but did not materially change the principal clinical associations.

This study has limitations. Its single-centre, cross-sectional design limits causal inference and generalisability to settings with different patient populations and resistance patterns. Several less common organisms were represented by small numbers, making their phenotype estimates imprecise. Clinical exposure histories may have been incomplete, and phenotypic testing does not identify the underlying genetic mechanisms of resistance. Nevertheless, the analysis combined organism-specific resistance data with patient-level clinical information, avoided duplicate isolates from the same infectious episode, and examined the main findings under an alternative MDR definition.

CONCLUSION

Multidrug-resistant uropathogens were common in this cohort, with E. coli remaining the predominant isolate. Recurrent UTI, recent hospitalisation and urinary catheterisation were independently associated with MDR. The resistance pattern, particularly to fluoroquinolones and third-generation cephalosporins, supports continued local surveillance and careful empirical antibiotic selection while culture and susceptibility results are awaited.

Declarations

- **Informed consent:** Informed consent was obtained from all participants, where applicable.
- **Conflict of interest:** The authors declare no conflict of interest.
- **Funding:** No external funding was received for this study.
- **Data availability:** The data supporting the findings of this study are available from the corresponding author on reasonable request.
- **Author contributions:** All authors contributed to the study conception and design, data collection, analysis and interpretation, manuscript drafting and critical revision. All authors read and approved the final manuscript.
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