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UROPATHOGENS AND THEIR ANTIMICROBIAL SUSCEPTIBILITY PATTERN AT A TERTIARY CARE CENTRE OF JHARKHAND.

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Abstract-
Introduction- Urinary tract infections (UTIs) are among the most common bacterial infections, with an increasing prevalence of antimicrobial resistance (AMR). The rise in AMR among uropathogens is a growing concern, necessitating region-specific studies to guide appropriate treatment. This study aims to identify the predominant uropathogens and analyze their antimicrobial susceptibility patterns at a tertiary care center in Jharkhand.
Material and methods- A cross-sectional study was conducted on urine samples collected from 154 patients suspected of UTIs. Out of these, 122 cases were confirmed to have bacterial infection and standard microbiological methods were used for pathogen isolation and identification. Antimicrobial susceptibility testing was performed using the Kirby-Bauer disk diffusion method as per Clinical and Laboratory Standards Institute (CLSI) guidelines. A p-value of <0.05 was considered statistically significant.
Result- The present study reported 122 UTI positive cases with female dominance with maximum patients in the age group of 21–40years. History of DM and UTI showed a significant difference in positivity rates. Analysis of symptoms associated with UTI showed significant correlations. Escherichia coli were the most frequently isolated Gram-negative bacteria with Gram-positive bacteria being equally distributed. The antibiotic susceptibility pattern showed that among Gram-positive isolates, vancomycin, nitrofurantoin and gentamicin exhibited the highest sensitivity and among Gram-negative isolates, nitrofurantoin, meropenem, and piperacillin-tazobactam were the most effective antibiotics.
Conclusion- This study highlights the alarming rise in antimicrobial resistance among uropathogens in Jharkhand. Regular monitoring of susceptibility patterns is crucial for effective treatment and infection control strategies.

Keywords- Uropathogens, Gram negative, Gram positive, Bacteria, UTI, Antibiotic, susceptibility etc.

Introduction-

Urinary tract infections (UTIs) are one of the most frequently encountered bacterial infections in clinical settings, affecting individuals of all ages and genders.[1] These infections contribute significantly to the global disease burden, leading to numerous outpatient visits, hospital admissions, and antimicrobial prescriptions.[2] The urinary tract, which comprises the kidneys, bladder, ureters, and urethra, is susceptible to bacterial invasion, resulting in conditions ranging from mild cystitis to severe pyelonephritis and urosepsis. The increasing prevalence of antimicrobial resistance among uropathogens has added to the complexity of UTI management, highlighting the need for continuous monitoring of susceptibility patterns to guide empirical therapy.[3] The increasing incidence of UTIs, coupled with the growing challenge of antimicrobial resistance, underscores the importance of ongoing surveillance of uropathogens and their susceptibility patterns.[4] The overuse of antibiotics, self-medication, incomplete treatment courses, and lack of awareness significantly contribute to the emergence of drug-resistant bacterial strains.[5] In India, additional factors such as overcrowding, poor sanitation, and inadequate infection control measures in healthcare settings further facilitate the transmission of resistant pathogens.[6]

Understanding the local epidemiology of uropathogens and their resistance patterns is essential for optimizing treatment protocols. While national and global data on antimicrobial resistance exist, regional variations necessitate location-specific studies.[7] The scarcity of data from Jharkhand presents a challenge in making informed decisions regarding UTI management. Jharkhand, located in eastern India, has a diverse demographic and healthcare system, where tertiary care centers play a crucial role in delivering specialized medical services. The distribution of uropathogens and their antimicrobial susceptibility patterns in this region may be influenced by various factors, including differences in prescribing habits, socio-economic conditions, and healthcare infrastructure.[8] Understanding the microbiological profile and resistance trends at a tertiary care center in Jharkhand is vital for formulating evidence-based treatment guidelines, preventing therapeutic failures, and controlling the spread of multidrug-resistant strains. A region-specific study will aid clinicians in selecting appropriate empirical therapies, thereby reducing treatment failures and limiting the emergence of further resistance.[9]

This study aims to evaluate the prevalence of uropathogens and their antimicrobial susceptibility patterns among patients with suspected UTIs at a tertiary care center in Jharkhand. By identifying the predominant pathogens and their resistance trends, this research will provide critical insights into current UTI management strategies in the region.[10] Furthermore, findings from this study can contribute to updating institutional antibiotic policies and implementing antimicrobial stewardship programs.[11] By identifying the predominant uropathogens and their resistance profiles, healthcare providers can design targeted interventions to improve patient outcomes and alleviate the economic burden associated with recurrent and complicated UTIs. This research will also serve as a valuable reference for future studies, enhancing the understanding of antimicrobial resistance patterns in the region.[12]

Material and Methods

The current study followed a cross-sectional design and was conducted on outpatient department or hospitalized UTI patients at Laxmi Chandravansi Medical College & Hospital, Bisrampur, Jharkand for 6 months, from June to December 2024. The primary objective was to determine the prevalence of uropathogens and evaluate their antimicrobial resistance patterns in patients diagnosed with UTIs. Ethical clearance was obtained from the Institutional Ethics Committee prior to initiating the study. A total of 154 patients of any age and sex, exhibiting clinical symptoms suggestive of UTIs, such as painful urination, increased urgency, frequent urination, fever, and flank discomfort, were included in the study. Informed consent was taken from all the participants. Urine samples were obtained using the midstream clean-catch method in sterile containers from both hospitalized and outpatient participants. Strict adherence to urine collection and transportation protocols was maintained to minimize the risk of contamination. Each urine sample underwent microscopic examination and bacterial culture using standard microbiological procedures. The specimens were inoculated onto

Variable		**n(%)**
Sex	Male	62(40.3%)
	Female	92(59.7%)
Age	0-20years	30(19.4%)
	21-40years	58(37.7%)
	41-60years	42(27.3%)
	>60years	24(15.6%)
History of UTI	Yes	65(42.2%)
	No	89(57.8%)
History of DM	Yes	48(31.2%)
	No	106(68.8%)
Laboratory investigations	Positive cases	122(79.2%)
	Negative cases	32(20.8%)

Table 1- Distribution of participants based on different variables.

Cystine Lactose Electrolyte Deficient (CLED) agar and MacConkey agar and incubated at 37°C for 24 to 48 hours. The presence of significant bacteriuria was established by a colony count of $\geq 10^5$ CFU/mL in midstream urine samples. Bacterial isolates were identified based on morphological characteristics, Gram staining, and a series of biochemical tests, including catalase, oxidase, indole, methyl red, Voges-Proskauer, citrate utilization, urease, and triple sugar iron tests. For further confirmation, automated identification systems such as the VITEK-2 system were employed.

The antimicrobial susceptibility of the isolated uropathogens was assessed using the Kirby-Bauer disk diffusion method on Mueller-Hinton agar, following the Clinical and Laboratory Standards Institute (CLSI) guidelines. The antibiotics tested included vancomycin, erythromycin, amikacin, ampicillin, gentamicin, nitrofurantoin, norfloxacin, ceftriaxone, ciprofloxacin, amoxicillin-clavulanate, meropenem, piperacillin- tazobactam and ceftazidime. Interpretation of results categorized isolates as sensitive, intermediate, or resistant in accordance with CLSI breakpoints. To ensure accuracy and

consistency in antimicrobial susceptibility testing, reference strains such as Escherichia coli ATCC 25922 and Pseudomonas aeruginosa ATCC 27853 were used for quality control measures. Data collected from the study were analyzed using SPSS software. Descriptive statistics were utilized to determine the prevalence of different uropathogens, while chi-square tests were applied to examine the correlation between resistance patterns and patient demographics. A p-value of <0.05 was considered statistically significant.

Results

A total of 154 urine samples were analyzed during the study period. Among the participants, as shown in table 1, 62(40.3%) were male, while 92(59.7%) were female. The age distribution revealed that 30(19.4%) patients were aged 0–20years, 58(37.7%) were between 21–40years, 42(27.3%) were between 41–60years, and 24(15.6%) were above 60 years. Out of the total participants, 65(42.2%) had a history of urinary tract infection (UTI), whereas 89(57.8%) did not report any prior UTI episodes. Additionally, 48(31.2%) patients had a history of diabetes mellitus (DM), while 106(68.8%) did not have DM. Laboratory investigations identified 122(79.2%) cases as positive for uropathogens, while 32(20.8%) cases showed no microbial growth.

Table 2 depicts association of different variables with bacterial positivity. Among males, 50(80.6%) tested positive, while 12(19.4%) tested negative. Similarly, among females, 72(78.2%) were positive, and 20(21.8%) were negative. The age distribution among positive cases showed that 23(76.7%) were in the 0–20years group, 48(82.7%) in the 21–40years group, 33(78.6%) in the 41–60years group, and 18(75.0%) in the >60years group. Patients with a history of DM had a significantly higher positivity rate, with 50(92.6%) testing positive compared to 72(72.0%) among non-diabetics (p=0.0052). Similarly, individuals with a history of UTI had significantly higher prevalence of positive cases

(65;92.8%) compared to those without prior UTI history (57;67.8%) (p=0.0003). Age and sex wise distribution did not show a significant difference in positivity rates.

Table 2- Association of different variables with bacterial positivity.

Variable		Positive cases	Negative cases	p- value
Sex	Male	50(80.6%)	12(19.4%)	0.8787
	Female	72(78.2%)	20(21.8%)	
Age	0-20years	23(76.7%)	7(23.3%)	0.8422
	21-40years	48(82.7%)	10(17.3%)	
	41-60years	33(78.6%)	9(21.4%)	
	>60years	18(75.0%)	6(25.0%)	
History of DM	Yes	50(92.6%)	4(7.4%)	**0.0052**
	No	72(72.0%)	28(28.0%)	
History of UTI	Yes	65(92.8%)	5(7.2%)	**0.0003**
	No	57(67.8%)	27(32.2%)	

Table 3 shows that an analysis of symptoms associated with UTI showed significant correlations. Foul-smelling and cloudy urine was strongly associated with positive cases (90.9%,p<0.001). Similarly, hematuria (93.7%,p<0.001) and dysuria (92.4%,p<0.001) were significantly associated with UTI positivity. Frequent urination was also found to be a significant predictor (88.6%,p=0.0018), as was pain in the lower abdomen (85.9%,p=0.0118). Other symptoms such as fever (p=0.2386), fatigue (p=0.1644), vomiting (p=0.9353), and convulsions (p=0.2767) did not show statistically significant associations with positive cases.

Table 3- Association of symptoms of UTI with bacterial positivity.

Symptoms of UTI		Positive cases	Negative cases	p- value
Foul smell and cloudy urine	Present	80(90.9%)	8(9.1%)	**<0.001**
	Absent	42(63.6%)	24(36.4%)	
Fatigue	Present	65(84.4%)	12(15.6%)	0.1644
	Absent	57(74.0%)	20(26.0%)	
Hematuria	Present	75(93.7%)	5(6.3%)	**<0.001**
	Absent	47(63.5%)	27(36.5%)	
Dysuria	Present	85(92.4%)	7(7.6%)	**<0.001**
	Absent	37(59.7%)	25(40.3%)	
Fever	Present	70(83.3%)	14(16.7%)	0.2386
	Absent	52(74.3%)	18(25.7%)	
Frequent urination	Present	78(88.6%)	10(11.4%)	**0.0018**
	Absent	44(66.7%)	22(33.3%)	
Vomiting	Present	50(78.1%)	14(21.9%)	0.9353
	Absent	72(80.0%)	18(20.0%)	
Convulsion	Present	12(66.7%)	6(33.3%)	0.2767
	Absent	110(80.9%)	26(19.1%)	
Pain in lower abdomen	Present	85(85.9%)	14(14.1%)	**0.0118**
	Absent	37(67.3%)	18(32.7%)	

In the present study as seen in figure 1, microbiological analysis revealed that Gram-negative bacteria were the predominant pathogens, accounting for 110(90.2%) of positive cases and the rest 12(9.8%) positive cases of reported Gram-positive bacteria.

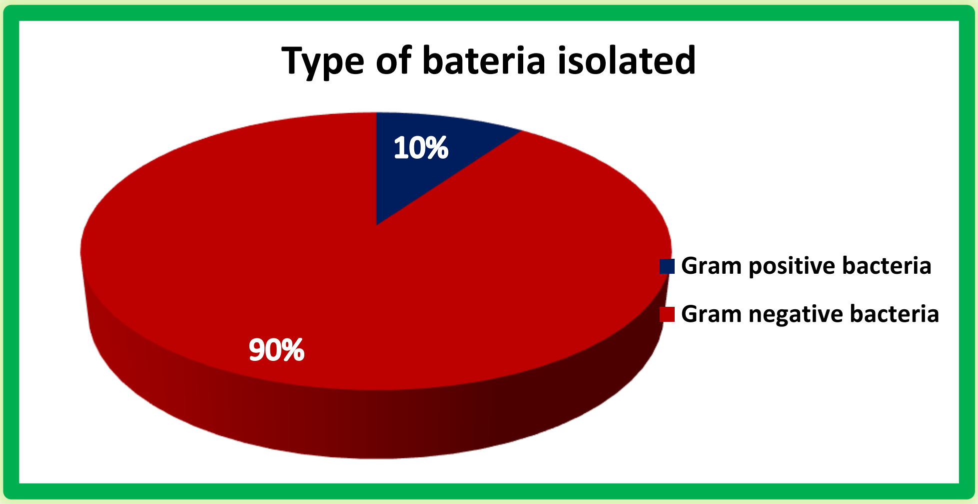

Figure 1- Distribution of positive cases based on the type of bacteria isolated.

Among Gram-negative bacteria, Escherichia coli was the most frequently isolated organism (70;57.4%), followed by Klebsiella pneumoniae (22;18.0%), Proteus spp. (10;8.2%), and Pseudomonas spp. (8;6.6%). As clear from figure 2, Gram-positive bacteria i.e. Enterococcus spp. and Staphylococcus spp. were equally distributed, each contributing 6(4.9%) cases.

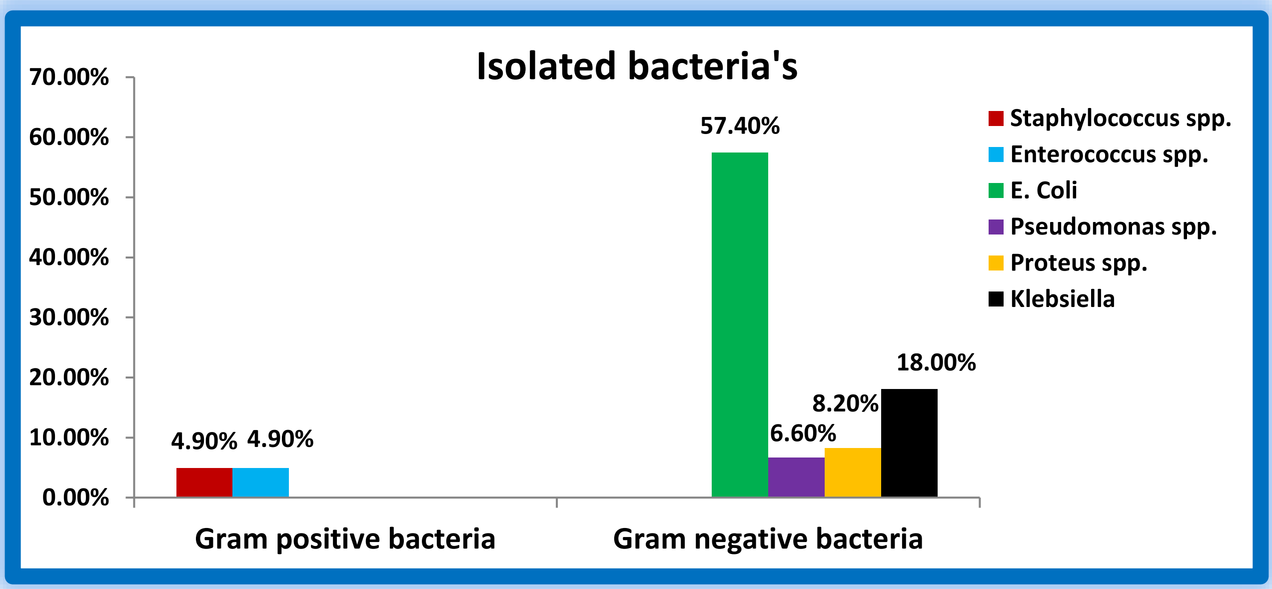

Figure 2- Distribution of positive cases based on the isolated bacteria's.

The antibiotic susceptibility pattern of individual bacteria showed varying levels of resistance as depicted in table 4. Among Gram-negative bacteria, Escherichia coli exhibited high resistance to ampicillin (85.7%) and cephalosporins like ceftriaxone (57.1%) and ceftazidime (57.1%). However, it showed good sensitivity to nitrofurantoin (85.7%), gentamicin (71.4%), amikacin (71.4%), meropenem (78.6%), and piperacillin-tazobactam (71.4%). Klebsiella pneumoniae showed significant resistance to ampicillin (80%) and moderate resistance to cephalosporins such as ceftriaxone (50%) and ceftazidime (65%). It retained high susceptibility to nitrofurantoin (90%), amikacin (75%), gentamicin (70%), meropenem (80%), and piperacillin-tazobactam (70%). Proteus spp. displayed resistance to ampicillin (62.5%) and cephalosporins (56.3% for ceftriaxone and 68.8% for ceftazidime). It was highly sensitive to amikacin (75%), gentamicin (68.8%), meropenem (81.3%), and piperacillin-tazobactam (75%). Pseudomonas spp. showed notable resistance to ampicillin (87.5%) and cephalosporins (50% for ceftriaxone and 87.5% for ceftazidime). However, it had high susceptibility to amikacin (87.5%), gentamicin (81.3%), meropenem (87.5%), and piperacillin-tazobactam (93.8%). Among Gram-positive bacteria, Enterococcus spp. and Staphylococcus spp.

exhibited high sensitivity to vancomycin (90–95%) and nitrofurantoin (90%). Gentamicin showed moderate effectiveness (50–80%), while resistance was observed against ampicillin (40–70%) and erythromycin (35–60%). The antibiotic susceptibility pattern showed that among Gram-positive isolates, vancomycin exhibited the highest sensitivity (90–95%), followed by nitrofurantoin (90%) and gentamicin (50–80%). Amikacin and piperacillin-tazobactam were also effective, while erythromycin and ampicillin showed lower susceptibility rates. Among Gram-negative isolates, nitrofurantoin (85.7-90%), meropenem (78.6–87.5%), and piperacillin-tazobactam (71.4–93.8%) were the most effective antibiotics. Gentamicin and amikacin demonstrated good efficacy against most Gram-negative uropathogens. However, resistance was observed against ampicillin and cephalosporins, particularly ceftriaxone and ceftazidime.

Table 4- Antibiotic sensitivity pattern of gram-positive and negative bacterias.

Antibiotic	**Gram positive**		**Gram negative**				**Total**
	Enterococcus	**Staphylococcus**	**E. coli**	**K.pneumonia**	**Proteus**	**Pseudomonas**	
Vancomycin	18(90%)	19(95%)	NT	NT	NT	NT	37(22.8%)
Erythromycin	7(35%)	12(60%)	NT	NT	NT	NT	19(11.7%)
Amikacin	5(25%)	15(75%)	50(71.4%)	15(75%)	12(75%)	14(87.5%)	111(68.5%)
Ampicillin	8(40%)	14(70%)	10(14.3%)	4(20%)	6(37.5%)	2(12.5%)	44(27.2%)
Gentamicin	10(50%)	16(80%)	50(71.4%)	14(70%)	11(68.8%)	13(81.3%)	114(70.4%)
Nitrofurantoin	18(90%)	18(90%)	60(85.7%)	18(90%)	10(62.5)	4(25%)	128(79%)
Norfloxacin	8(40%)	10(50%)	42(60%)	12(60%)	8(50%)	9(56.3%)	89(54.9%)
Ceftriaxone	5(25%)	8(40%)	30(42.9%)	10(50%)	9(56.3%)	8(50%)	70(43.2%)
Ciprofloxacin	7(35%)	9(45%)	40(57.1%)	14(70%)	10(62.5%)	12(75%)	92(56.8%)
Amoxicillin-clavulanate	6 (30%)	12 (60%)	25(35.7%)	9 (45%)	8 (50%)	7 (43.8%)	67 (41.4%)
Meropenem	4 (20%)	10 (50%)	55 (78.6%)	16 (80%)	13 (81.3%)	14 (87.5%)	112 (69.1%)
Piperacillin-tazobactam	6 (30%)	12 (60%)	50 (71.4%)	14 (70%)	12 (75%)	15 (93.8%)	109 (67.3%)
Ceftazidime	2 (10%)	8 (40%)	40 (57.1%)	13 (65%)	11 (68.8%)	14 (87.5%)	88 (54.3%)

Discussion-

Urinary tract infections (UTIs) remain a significant public health concern, particularly due to the increasing antimicrobial resistance among uropathogens. The present study at a tertiary care center in

Jharkhand highlights the prevalence of various uropathogens and their antibiotic susceptibility patterns, providing crucial insights into effective treatment strategies. The predominance of Gram-negative bacteria (90.2%) in this study is consistent with prior research, which identifies Escherichia coli as the most frequently isolated uropathogen.[13,8] The high prevalence of E. coli (57.4%) aligns with global and national studies, confirming its role as the leading cause of UTIs.[14] The presence of Klebsiella pneumoniae (18.0%), Proteus spp. (8.2%), and Pseudomonas spp. (6.6%) further corroborates findings from previous reports that emphasize their opportunistic nature in urinary tract infections.[15] Gram-positive bacteria were relatively less frequent (9.8%), with Enterococcus spp. and Staphylococcus spp. contributing equally (4.9% each). This finfings is in agreement with the study by Hooton TM. et al.[16] The study revealed a significant association between UTI positivity and patients with diabetes mellitus ($p=0.0052$) and a history of recurrent UTI ($p=0.0003$). This finding aligns with prior studies that identify diabetes as a risk factor for UTIs due to immune dysfunction and poor glycemic control, which facilitate bacterial colonization.[17] Another study by Nicolle LE. Et al.[18] is also in harmony with our outcome. Similarly, a history of UTIs has been linked to antimicrobial resistance, which may lead to recurrent infections and complications.[19] Symptom analysis demonstrated a strong correlation between UTI positivity and classic UTI symptoms such as foul-smelling/cloudy urine ($p<0.001$), hematuria ($p<0.001$), dysuria ($p<0.001$), frequent urination ($p=0.0018$), and pain in the lower abdomen ($p=0.0118$). Study by Tan CW, et al, is in concordance with the present result.[20] These findings highlight the importance of clinical symptomatology in early UTI diagnosis, reinforcing the necessity of laboratory confirmation for proper management.
The antimicrobial susceptibility pattern observed in this study underscores a worrying trend of antibiotic resistance. Among Gram-negative isolates, resistance to ampicillin and cephalosporins (ceftriaxone and ceftazidime) was notably high, particularly in E. coli (85.7% resistance to ampicillin and 57.1% to cephalosporins). Study by Arslan H, et al.[21] also reported comparable resistance pattern of these antibiotics in UTI cases for gram negative bacterias. In present study, similar resistance was noted in K. pneumoniae, Proteus spp., and Pseudomonas spp., emphasizing the limitations of these antibiotics in empirical therapy. These findings are consistent with the study by Johnson JR, et al.[22] However, in our study nitrofurantoin, meropenem, piperacillin-tazobactam, gentamicin, and amikacin exhibited high efficacy against Gram-negative uropathogens, making them viable treatment options. Study by Marchaim D, et al.[23] also reported high efficacy of these antibiotics against Gram-negative bacteria. Among Gram-positive isolates, in current study Enterococcus spp. and Staphylococcus spp. showed high susceptibility to vancomycin (90–95%) and nitrofurantoin (90%). This result is comparable to the study by Wang J, et al.[24] Resistance to erythromycin (35–60%) and ampicillin (40–70%) reported by our study, highlights the challenges in treating Gram-positive UTIs, reinforcing the need for targeted therapy. Study by also documented similar resistance pattern of these antibiotics against Gram-positive bacteria. A comparison with previous study by Ulett GC, et al.[25] revealed similar resistance pattern. A study conducted by Gupta et al.[26] reported E. coli as the predominant uropathogen, consistent with our findings, but noted higher resistance to fluoroquinolones compared to our study. In contrast, a study by Kahlmeter et al.[27] highlighted an increasing prevalence of multidrug-resistant K. pneumoniae, which was not as pronounced in our study population. Similarly, Patel et al.[28] observed high resistance patterns in Pseudomonas spp., particularly to cephalosporins, a trend also noted in our findings. Antimicrobial stewardship programs have been recommended by several studies to curb the rising trend of multidrug resistance. Regular surveillance of antimicrobial resistance patterns is essential for guiding effective treatment policies and preventing the spread of resistant strains. Future research should focus on molecular mechanisms of resistance, emerging uropathogens, and the role of host factors in treatment outcomes.

Conclusion-

In conclusion, the study highlights the predominance of *E. coli* among uropathogens and the alarming resistance to commonly prescribed antibiotics. The high efficacy of nitrofurantoin and carbapenems suggests their potential role in empirical therapy. This study will contribute to a more comprehensive understanding of the microbial landscape in Jharkhand, supporting the development of effective and sustainable strategies for UTI prevention and treatment. Given the observed associations with diabetes and recurrent UTIs, through consistent surveillance, targeted therapy, adherence to antimicrobial stewardship principles, evidence-based interventions and stringent infection control measures, it is possible to curb the growing threat of drug-resistant uropathogens and improve public health.

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