IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

Prevalence Of Bacterial Isolates Causing Community-Acquired Urinary Tract Infection And Its Antibiotic Resistance Pattern In Tertiary Care Hospital.

[1]Dr. Himani Brahmbhatt, [2]Dr. Sejul K. Antala, [3]Dr. Pradnya Mahapure, [4]Dr. Bansari Saradava, [5]Dr. G.U. Kavathia

[1]Third Year Resident Doctor, [2]Assistant Professor, [3]Third Year Resident Doctor, [4]Third Year Resident Doctor, [5]Professor and Head of Department

Department of Microbiology

PDU Medical College, Rajkot, India.

Abstract: Introduction: Urinary tract infection is the most common bacterial infectious disease after respiratory tract infection disease in community practice. Detection of UTI-causing pathogens and resistance of these pathogens to commonly prescribed antibiotics in clinical setups is essential and helpful in improving the efficacy of empirical treatment. **Aims and Objectives:** It aims to identify the most common UTI pathogens and their prevalence by sex and age group to improve treatment and management at this hospital. **Material and Methods:**300 urine samples received at Tertiary Care Hospital, Rajkot from Jan-2024 to June-2024 were tested for bacterial pathogens by culture and Biochemical reaction. **Results:** Out of 300 urine samples, 46 (15%) were positive for urinary tract infection (UTI) isolates. Gender-wise, UTIs were more prevalent in female patients 25(54.34%) compared to male patients 21 (45.65%). The distribution of UTI cases across different age groups and genders revealed that the highest prevalence in females was in the 21-40 years age group (56%), while for males, it was in the >60 years age group (61.90%). E. coli was the most common isolate (67.39%). Antimicrobial susceptibility testing showed Aminoglycosides and carbapenems should be preferred over fluoroquinolones and cephalosporins. **Conclusion:** The present study reported that E. coli isolate was the most common pathogen causing UTI, mainly affecting females. Aminoglycosides and meropenems showed higher sensitivity. This study will help to improve treatment recommendations in a specific geographical region. The study also allows a comparison of the situation in Rajkot with other regions within and outside the state as well as in the country or outside the country.

Keywords: urinary tract infection; dysuria.

1. INTRODUCTION

- The most extensively recognized and occurring nosocomial bacterial infection in human communities throughout the world is urinary tract infection [1–3]. In Africa and Asia, there is a high frequency of urinary tract infections (UTIs) among pregnant women [4]. Bacterial pathogens' invasion in the epithelium that lines the urinary system from the minor calyx to the prostatic urethra causes UTI. The growth of the bacterium in the urothelium could be benign or severe, resulting in acute inflammation, and an indicative case could be defined by a wide range of symptoms, such as fever, tiredness, dysuria, burning micturition, anorexia, and vomiting [5–10]. However, all genders are susceptible to infection, with women being more susceptible because of their conceptual life system, and their physiology seems to be more sensitive. By the age of 32, half of all women could have experienced some sort of UTI sickness experience [11].

- UTI may be community-acquired or nosocomial. Community-acquired infections are caused by E. coli, Klebsiella, Pneumoniae, Proteus mirabilis, Staphylococcus, Saprophyticus, or Enterococcus faecalis. [12] In almost all cases of UTI, empirical antimicrobial treatment initiates before the laboratory results for urine culture are available. In the field of UTIs, there has been a steady increase in the level of resistance to commonly used antibiotics.[13] The emergence of extended-spectrum beta-lactamase has threatened the empirical use of cephalosporins and ciprofloxacin. Microorganisms use various mechanisms to develop any resistance. [14] Detection of UTI-causing pathogens and resistance of these pathogens to commonly prescribed antibiotics in clinical setups is essential and helpful in improving the efficacy of empirical treatment.
- UTIs lead to major economic and public health burdens and affect the quality of life for affected individuals [15,16,17,18]. Escherichia coli is responsible for uncomplicated pyelonephritis and cystitis and is followed by other Enterobacteriaceae species such as Klebsiella pneumoniae and Proteus mirabilis and by Gram-positive bacteria such as Staphylococcus saprophyticus, and Enterococcus faecalis [19,20]. Various agents are used to treat uncomplicated UTIs and pyelonephritis by international guidelines such as trimethoprim-sulfamethoxazole, fosfomycin trometamol, pivmecillinam, nitrofurantoin monohydrate, fluoroquinolones, and beta-lactams [16]. The development of bacterial resistance to presently available antibiotics results from the indiscriminate and widespread use of antibiotics [21,22]. Bacteria producing extended-spectrum beta-lactamases (ESBLs), showing resistance to most antibiotics except for the carbapenem group, are steadily increasing in the population [23,24]
- There is limited data on bacterial resistance in UTIs from the Saurashtra Region of Gujarat State, India. Empirical treatment of UTIs requires choosing antimicrobials based on likely pathogens and local resistance patterns. This highlights the need for periodic monitoring of UTI-causing agents and their resistance in the community. This study addresses the scarcity of such reports from Tertiary Care Hospital in Rajkot, Gujarat. It aims to identify the most common UTI pathogens and their prevalence by sex and age group to improve treatment and management at this hospital.

2. MATERIALS & METHODS

Setting: The present study was conducted on non-catheterized urine samples received at the Bacteriology Laboratory, Department of Microbiology from patients of all ages suspected of UTI at Tertiary Care Hospital, Rajkot, Gujarat, India

Duration: 6 months

Sample size: 300

Exclusion criteria:

- Patients who did not have symptoms at the time of observation.
- All catheterized urine samples.

Data collection procedure: All non-catheterized Urine samples were studied as per the Performa formulated. The Performa includes serial number, registration number, Lab number, age, sex, ward, and clinical features of patients. In the present study, Blood agar, Nutrient agar & MacConkey agar were used.

Ethical consideration & permission: Permission for this study was obtained from the ethical committee.
Sample collection: For collection of urine samples patients were advised to collect a clean catch midstream urine specimen in a sterile, wide-mouthed leakproof container supplied by the laboratory and bring it to the laboratory as early as possible (within 2 hours). Isolation and identification of bacterial pathogens were done by microscopy and culture methods.
Microscopy: collected samples were mixed thoroughly, uncentrifuged, and examined microscopically for wet mount preparation. This was followed by a Gram stain.
Culture: A calibrated sterile Nichrome wire loop with a 1.3 mm diameter, delivering 0.001 ml, was used for the semi-quantitative plating method. A loopful of the well-mixed urine sample was inoculated on Blood, MacConkey, and Nutrient agar plates. These plates were incubated aerobically at 37°C for 24 hours. Post-incubation, the plates were examined for bacterial growth. A significant bacterial count was defined as any

count equal to or exceeding 100,000 CFU/ml, while counts less than 100 CFU/ml were considered negative. Bacterial isolates were identified using conventional biochemical tests.

3. RESULT

Out of the total number of 300 urine samples included in this study, 46 (15%) urine samples were positive for UTI isolates shown in Table 1.

Table 1: Number of positive isolates.

Prevalence	No. of samples	Percentage (%)
No bacterial pathogen	254	84.66
Positive isolates	46	15.33
Total	300	100

In the present study, the prevalence of UTI was higher in female patients (54.34%) than in male patients (45.65%) in 46 positive isolates. The gender-wise prevalence of UTI is shown in Table 2.

Table 2: Gender-wise prevalence of UTI.

Gender	Total no. of samples (n=300)	No. of positive isolates (n=46)	Percentage (%)
male	120	21	45.65
female	180	25	54.34

The study analyzed the distribution of UTI cases across different age groups and genders among 46 positive cases. In the 0-20 years age group, there were 5 cases (10.86%), with females accounting for 3 cases (12%) and males 2 cases (9.52%). The 21-40 years age group had 15 cases (32.60%), predominantly among females with 14 cases (56%), while males had only 1 case (4.76%). The 41-60 years age group recorded 11 cases (23.91%), with females making up 6 cases (24%) and males 5 cases (23.80%). For those over 60 years, there were 15 cases (32.60%), with females having 2 cases (8%) and males 13 cases (61.90%). This data highlights the highest prevalence of UTIs in females within the 21-40 years age group, whereas, for males, the highest prevalence was observed in those over 60 years of age. Table 3.

Table 3: Age groups and gender-wise prevalence of UTI.

years	female		male		total	
Age group	No. of cases(n=25)	Percentage (%)	No. of cases(n=21)	Percentage (%)	No. of cases(n=46)	Percentage (%)
0-20	3	12	2	9.52	5	10.86
21-40	14	56	1	4.76	15	32.60
41-60	6	24	5	23.80	11	23.91
>60	2	8	13	61.90	15	32.60

Among the 46 positive UTI isolates, a significant majority were Gram-negative bacteria, accounting for 97.82% of the cases. Only one isolate, representing 2.17%, was Gram-positive. This data highlights the predominance of Gram-negative bacteria as the causative agent in UTI cases within the studied population.

Table 4: Distribution of gram-positive and gram-negative isolates

Isolate	No. of positive isolates(n=46)	Percentage (%)
Gram-negative	45	97.82
Gram-positive	1	2.17
Total	46	100

Among the 46 positive UTI samples, **E. coli** was the most prevalent isolate, found in 31 samples (67.39%). **Klebsiella spp.** accounted for 7 samples (15.21%), making it the second most common isolate. **Proteus mirabilis** was identified in 4 samples (8.69%), while **Pseudomonas aeruginosa** was present in 2 samples (4.34%). **Proteus vulgaris** and **Staphylococcus aureus** each were isolated from 1 sample (2.17%). This distribution underscores the dominance of Gram-negative bacteria, particularly **E. coli**, in UTI infections in the studied population.

Table 5: Distribution of positive isolates.

Isolates	No. of positive samples	Percentage (%)
E. coli	31	67.39
Klebsiella spp.	7	15.21
Proteus mirabilis	4	8.69
Pseudomonas aeruginosa	2	4.34
Proteus vulgaris	1	2.17
Staphylococcus aureus	1	2.17

Table 6 provides a detailed summary of the antibiotic sensitivity patterns for four bacterial species: *Escherichia coli* (E. coli), *Klebsiella spp.*, *Proteus spp.*, and *Pseudomonas aeruginosa*. The percentages indicate the proportion of bacterial strains that are sensitive to each antibiotic tested.

For *E. coli* (31 samples), the highest sensitivities were observed with meropenem (100%), nitrofurantoin (93%), and imipenem and amikacin (both 90%). Moderate sensitivity was found with antibiotics such as piperacillin-tazobactam (87%) and tigecycline (87%), while lower sensitivity was seen with antibiotics like levofloxacin (38%) and ciprofloxacin (35%).

Klebsiella spp. (7 samples) showed the highest sensitivity to tigecycline (100%), followed by imipenem, meropenem, and aztreonam (all 85%). It also exhibited moderate sensitivity to several antibiotics including piperacillin-tazobactam (71%) and gentamycin (85%), with no significant resistance noted.

Proteus spp. (5 samples) demonstrated perfect sensitivity to piperacillin-tazobactam and meropenem (both 100%), as well as gentamycin (100%). It showed moderate sensitivity to antibiotics like cefuroxime, cefotaxime, ceftazidime, and ceftriaxone (all 75%), but lower sensitivity to levofloxacin and ciprofloxacin (both 50%).

Pseudomonas aeruginosa (2 samples) exhibited complete sensitivity to piperacillin-tazobactam, imipenem, meropenem, and aztreonam (all 100%). However, it showed only partial sensitivity to ceftazidime and cefepime (both 50%), and moderate sensitivity to amikacin and gentamycin (both 50%).

Staphylococcus aureus shows the highest sensitivity of Vancomycin (100%) and Linezolid (100%) followed by Gentamycin (54.2%), Amikacin (54.2%), Clindamycin (48%) and Chloramphenicol (45%).

Overall, the data highlight the effectiveness of certain antibiotics, particularly carbapenems like meropenem and imipenem, in treating infections caused by these bacterial species. The variability in sensitivity underscores the importance of tailored antibiotic therapy based on specific bacterial profiles.

Table 6: Antibiotic sensitivity (%) of positive isolates.

Antibiotics	E. coli (31)	Klebsiella spp. (7)	Proteus spp (6)	Pseudomonas aeruginosa (2)
Ampicillin	25	-	-	-
Ampicillin sulbactam	64	57	50	-
Amoxicillin clavulanic acid	42	57	-	-
Piperacillin tazobactam	87	71	100	100
Cefuroxime	35	71	75	-
Cefotaxime	32	71	75	-
Ceftazidime	45	71	75	50
Ceftriaxone	32	71	75	-
Cefepime	48	57	75	50
Imipenem	90	85	75	100
Meropenem	100	85	100	100
Aztreonam	54	85	75	100
Amikacin	90	71	75	50
Gentamycin	64	85	100	50
Cotrimoxazole	58	-	-	-
Levofloxacin	38	71	50	-
Ciprofloxacin	35	-	50	-
Tetracycline	45	85	-	-
Norfloxacin	42	71	100	-
Nitrofurantoin	93	85	50	-
Fosfomycin	61	71	75	-
Tigecycline	87	100	-	-

4. DISCUSSION

In the present study, the prevalence of UTI was found to be 15%. Comparisons with other similar studies show that the prevalence rates of UTIs vary widely. Different studies report varying rates, reflecting periodic and geographical differences in UTI prevalence. This variation underscores the importance of regional studies to accurately determine local prevalence rates and tailor treatment protocols accordingly.

Table 7: Comparison of overall prevalence of UTI with other studies.

Autor	Year	Positive isolates (%)
Smita Sood, Ravi Gupta et al [25]	2012	17.16
Nazreen Khan et al [26]	2016	36.64
Kalal et al [27]	2016	28
Patel et al [28]	2019	45.69
Mohapatra et al [29]	2022	10
Behera et al [30]	2022	12.6
Present study	2023	15

In the present study, out of 46 positive isolates, 25 were found in female patients, accounting for 54.34% of the total positive isolates. Comparisons with other similar studies consistently show a higher prevalence rate of UTIs in female patients compared to male patients. This trend is reflected across various studies, indicating a common finding of UTIs being more prevalent among females than males. This gender disparity in UTI prevalence underscores the importance of gender-specific considerations in UTI prevention, diagnosis, and treatment strategies.

Table 8: Comparisons of gender-wise prevalence of UTI with other studies.

Author	Year	Isolates in females (%)	Isolates in males (%)
Alka Nerulkar et al [31]	2012	57.74	42.26
Rezina Parveen et al [32]	2015	61.33	38.67
Nazreen Khan et al [33]	2016	68.87	31.33
Pardeshi et al [34]	2018	66	34
Malik et al	2021	77	23
Present study	2023	54.34	45.65

In the present study, the highest prevalence of urinary tract infections (UTIs) in female patients (56%) was found in the age group of 21-40 years. In contrast, the highest prevalence of UTIs in male patients (61.90%) was observed in the elderly age group (above 60 years).

Similar results were observed in other studies, and comparisons of these studies are shown in Table 9. Both studies mentioned in Table 8 are comparable with the present study and found that the most susceptible age group for UTI prevalence in females is 21-40 years, while the most susceptible age group for UTI in male patients is above 60 years.

Table 9: Comparison of age groups and gender-wise UTI prevalence with other studies.

Author	Year	Age group in years	Prevalence (%)
For female			
Smita Sood, Ravi Gupta et al [25]	2012	21-40	38.42
Nazreen Khan et al [33]	2016	21-40	46.49
Present study	2023	21-40	56
For male			
Smita Sood, Ravi Gupta et al [25]	2012	>60	46.92
Nazreen Khan et al [33]	2016	>60	23.07
Present study	2023	>60	61.90

In the present study, 45 (97.82%) were gram-negative isolates, and 1 (2.17%) were gram-positive isolates among 46 positive cases. All studies mentioned in Table 10 reported a higher UTI prevalence rate (>90%) in gram-negative isolates compared to gram-positive isolates.

Table-10: Comparison of distribution of gram-positive and gram-negative isolates with other studies

Author	Year	Gram-negative isolates (%)	Gram-positive isolates (%)
Mohmmed Akram et al [35]	2007	93	7
Atul Kothari, Vishal Sagar et al [36]	2008	95	5
Shalini et al [37]	2011	93.70	6.29
Devanand Prakash et al [38]	2013	90.30	9.68
R Shyamala et al [39]	2013	98.10	1.92
Rezina Parveen et al [32]	2015	94.40	6.61
Bhosle et al [40]	2020	89	11
Present study	2023	97.82	2.17

In the present study, a total of 46 positive samples were analyzed for the prevalence of different bacterial isolates. The most commonly identified isolate was **Escherichia coli (**67.39%), **Klebsiella spp.** was the second most common isolate,(15.21%), **Proteus mirabilis** (8.69%), **Pseudomonas aeruginosa** (4.34%) and **Staphylococcus aureus** (2.17%) of the positive cases. This distribution highlights the predominance of gram-negative bacteria, particularly E. coli, in UTI infections.

Comparison of UTI-causing isolates with other studies UTI-causing;

The present study (2023) reported the highest prevalence of *Escherichia coli* at 67.39%, with *Klebsiella spp* at 15.21%, *Proteus mirabilis* at 8.69%, *Pseudomonas aeruginosa* at 4.34%, and *Staphylococcus aureus* at 2.17%. Comparatively, earlier studies showed varying prevalence rates, with *Escherichia coli* ranging from 34.5% (Alka Nerulkar et al., 2012) to 68% (Atul Kothari and Vishal Sagar et al., 2008). *Klebsiella spp*. was most prevalent in the study by Mohammed Akram et al. (2007) at 22%, while the lowest prevalence was reported by Smita Sood and Ravi Gupta et al. (2012) at 6.64%. *Proteus mirabilis* was notably more prevalent in the study by R Shyamala et al. (2013) at 13.5%. The prevalence of *Pseudomonas aeruginosa* peaked in the study by Devanand Prakash et al. (2013) at 21.9%. The highest prevalence of *Staphylococcus aureus* was reported by Alka Nerulkar et al. (2012) at 21.4%.

Based on studies, it can be recommended that nitrofurantoin be preferred instead of cotrimoxazole and ciprofloxacin. Aminoglycosides and carbapenems should be preferred over fluoroquinolones and cephalosporins.

Comparison of Antibiotic sensitivity (%) of E. coli with other studies;

In the 2023 study, ampicillin sensitivity was 25%, while higher sensitivities were noted for meropenem (100%), imipenem (90%), and nitrofurantoin (93%) but lower sensitivity for Ciprofloxacin (35%) and Ceftriaxone (32%). Comparatively, Patel et al. (2018) showed high sensitivity to imipenem (91.69%) but lower sensitivity to other antibiotics like ciprofloxacin (18.97%) and cotrimoxazole (32.02%). Malik et al. (2021) reported high sensitivity to amikacin (90.6%) and tigecycline (100%) but lower sensitivity to ceftriaxone (32.1%) and ciprofloxacin (26.4%). Mohapatra et al. (2022) found high sensitivity to amikacin (92.8%) and nitrofurantoin (86.7%) but moderate sensitivity to ceftriaxone (59%) and cotrimoxazole (62.7%). Pardesi et al. (2018) showed notable sensitivity to meropenem (96.18%) and gentamycin (90.76%), with moderate responses to cotrimoxazole (53.82%) and ciprofloxacin (29.4%). These variations highlight the dynamic nature of antibiotic resistance and the need for continuous monitoring and updating of treatment protocols.

5. CONCLUSION

This study analyzed 300 urine samples, of which 46 (15%) were positive for urinary tract infection (UTI) isolates. Among the samples, the majority (254, 84.66%) had no bacterial pathogens, while 46 (15.33%) were positive for UTI. Gender-wise, UTIs were more prevalent in female patients (54.34%) compared to male patients (45.65%). The distribution of UTI cases across different age groups and genders revealed that the highest prevalence in females was in the 21-40 years age group (56%), while for males, it was in the >60 years age group (61.90%).

In terms of bacterial isolates, Gram-negative bacteria were predominant, accounting for 97.82% of the cases, while Gram-positive bacteria made up only 2.17%. The most common isolate was *E. coli* (67.39%), followed by *Klebsiella spp.* (15.21%), *Proteus mirabilis* (8.69%), and *Pseudomonas aeruginosa* (4.34%). *Proteus vulgaris* and *Staphylococcus aureus* each accounted for 2.17% of the isolates.

Antibiotic sensitivity testing revealed that *E. coli* showed high sensitivity to meropenem (100%), nitrofurantoin (93%), and imipenem and amikacin (both 90%). *Klebsiella spp.* displayed 100% sensitivity to tigecycline, followed by 85% sensitivity to imipenem, meropenem, and aztreonam. *Proteus spp.* demonstrated perfect sensitivity to piperacillin-tazobactam, meropenem, and gentamycin (all 100%), while *Pseudomonas aeruginosa* showed 100% sensitivity to piperacillin-tazobactam, imipenem, meropenem, and aztreonam.

The findings underscore the importance of carbapenems like meropenem and imipenem in treating infections caused by these bacterial species, highlighting the need for tailored antibiotic therapy based on specific bacterial profiles.

The major limitation of this study is that since direct laboratory data was used, it does not take into account risk factors that can cause drug-resistant and complicated UTIs like diabetes, compromised immunity, recent antibiotic use, incomplete treatment of prior UTIs, urinary tract malformations and old age. This study is also limited by the fact that those outpatients might have had uncomplicated UTIs and physicians treating them might not have requested urine culture and susceptibility reports.

6. WHAT THIS STUDY ADDS TO EXISTING KNOWLEDGE?

This study will help to improve treatment recommendations in a specific geographical region. The study also allows a comparison of the situation in Rajkot with other regions within and outside the state as well as in the country or outside the country.

7. AUTHOR'S CONTRIBUTION

Concept, Design, Preparation & editing of the manuscript, Data Collection, Data Compiling, Literature Review, Sample Testing and Result Analysis.

8. ACKNOWLEDGEMENT

Authors would like to thank Dr. Sejul K. Antala, Assistant Professor, Microbiology Department, P.D.U. Medical College, Rajkot for his guidance on Manuscript editing, Literature Review and Final Approval. of this study and to laboratory staff for their support for the study.

9. FINANCIAL SUPPORT AND SPONSORSHIP

Nil

10. CONFLICTS OF INTEREST

There are no conflicts of interest

11. REFERENCES

[1] I. Zelikovic, R. D. Adelman, and P. A. Nancarrow, "Urinary tract infections in children—an update," Western Journal of Medicine, vol. 157, no. 5, pp. 554–561, 1992.

[2] P. Gastmeier, G. Kampf, N. Wischnewski et al., "Prevalence of nosocomial infections in representative German hospitals," Journal of Hospital Infection, vol. 38, no. 1, pp. 37–49, 1998.

[3] M. Mama, A. Abdissa, and T. Sewunet, "Antimicrobial susceptibility pattern of bacterial isolates from wound infection and their sensitivity to alternative topical agents at Jimma university specialized hospital, south-west Ethiopia," Annals of Clinical Microbiology and Antimicrobials, vol. 13, no. 1, pp. 14–10, 2014

[4] M. Najar, C. Saldanha, and K. Banday, "Approach to urinary tract infections," Indian Journal of Nephrology, vol. 19, no. 4, p. 129, 2009.

[5] C. M. Gonzalez and A. J. Schaeffer, "Treatment of urinary tract infection: what's old, what's new, and what works," World Journal of Urology, vol. 17, no. 6, pp. 372–382, 1999

[6] J. D. Sobel and D. Kaye, "Urinary tract infections," in Mandell, Douglas and Bennett's Principles and Practice of Infectious Diseases, G. L. Mandell, J. E. Bennett, and R. Dolin, Eds., pp. 957–985, Churchill Livingstone, Philadelphia, Pa, USA, 7th edition, 2010.

[7] S. M. Sabra and M. M. Abdel-Fattah, "Epidemiological and microbiological profile of nosocomial infection in Taif hospitals, KSA (2010-2011)," World Journal of Medical Sciences, vol. 7, no. 1, pp. 1–9, 2012.

[8] A. J. Schaeffer, N. Rajan, Q. Cao et al., "Host pathogenesis in urinary tract infections," International Journal of Antimicrobial Agents, vol. 17, no. 4, pp. 245–251, 2001.

[9] E. E. Akortha and O. K. Ibadin, "Incidence and antibiotic susceptibility pattern of Staphylococcus aureus amongst patients with urinary tract infection (UTI) in UBTH Benin City, Nigeria," African Journal of Biotechnology, vol. 7, no. 11, pp. 1637– 1640, 2008

[10] K. C. Arul, K. G. Prakasam, D. Kumar, and M. Vijayan, "A cross sectional study on distribution of urinary tract infection and their antibiotic utilization pattern in Kerala," International Journal of Research in Pharmaceutical and Biomedical Sciences, vol. 3, no. 3, pp. 1125–1130, 2012.

[11] Brumbaugh AR, Smith SN, Mobley HL. Immunization with the yersiniabactin receptor, FyuA, protects against pyelonephritis in a murine model of urinary tract infection. Infect Immun. 2013;81(9):3309–16.
[12] B. Foxman, "Epidemiology of urinary tract infections: incidence, morbidity, and economic costs," Ee American Journal of Medicine, vol. 113, no. 1, pp. 5–13, 2002.
[13] C. M. Gonzalez and A. J. Schaeffer, "Treatment of urinary tract infection: what's old, what's new, and what works," World Journal of Urology, vol. 17, no. 6, pp. 372–382, 1999.
[14] F.-X. Liang, M. C. Bosland, H. Huang et al., "Cellular basis of urothelial squamous metaplasia," Journal of Cell Biology, vol. 171, no. 5, pp. 835–844, 2005.
[15] G. A. Ouno, S. C. Korir, J. C. Cheruiyot et al., "Isolation, identification and characterization of urinary tract infectious bacteria and the effect of different antibiotics," Journal of Natural Sciences Research, vol. 3, 2013.
[16] T. Weichhart, M. Haidinger, W. H. Horl, and M. D. S ¨ aemann, ¨ "Current concepts of molecular defence mechanisms operative during urinary tract infection," European Journal of Clinical Investigation, vol. 38, pp. 29–38, 2008.
[17]G. Williams and J. C. Craig, "Long-term antibiotics for preventing recurrent urinary tract infection in children," Cochrane Database of Systematic Reviews, vol. 4, 2019.
[18] Enterobacteriaceae 1: Coliform - Proteus. In: Kanugo R, editor. Ananthnarayan and panikar's textbook of microbiology. Universities press; 2017. p. 279–90.
[19] Kahlmeter G. An international survey of the antimicrobial susceptibility of pathogens from uncomplicated urinary tract infections: the ECOmiddle dotSENS Project. J Antimicrob Chemother. 2003;51(1):69–76.
[20] Sumera S, Aftab A, Ijaz T. Isolation and Antibiotic susceptibility of E.coli from urinary tract infections in a tertiary care hospital. Pak J Med Sci. 2014;30(2):389–92.
[21] El-Sahrigy, S.A.; Shouman, M.G.; Ibrahim, H.M.; Rahman, A.M.A.; Habib, S.A.; Khattab, A.A.; Gomaa, H.E.; Helmy, N.A. Prevalence and antimicrobial susceptibility of hospital acquired infections in two pediatric intensive care units in Egypt. Open access Macedonian journal of medical sciences 2019, 7, 1744, https://doi.org/
[22] 3889/oamjms.2019.485. 10. Hvidberg, H.; Struve, C.; Krogfelt, K.A.; Christensen, N.; Rasmussen, S.N.; Frimodt-Møller, N. Development of a long-term ascending urinary tract infection mouse model for antibiotic treatment studies. Antimicrobial agents and chemotherapy 2000, 44, 156-163, http://pascalfrancis.inist.fr/vibad/index.php?action=getRecordDetail&idt=1259055.
[23] Öztürk, R.; Murt, A. Epidemiology of urological infections: A global burden. World journal of urology 2020, 10.1007/s00345-019-03071-4, 1-11, https://doi.org/10.1007/s00345-019-03071-4.
[24] Kumar, A.; Jhadwal, N.; Lal, M. Antibacterial activity of some medicinal plants used against UTI causing pathogens. 2012, https://www.sid.ir/en/Journal/ViewPaper.aspx?ID=498102.
[25] Sood S, Gupta R. Antibiotic Resistance Pattern of Community Acquired Uropathogens at a Tertiary Care Hospital in Jaipur, Rajasthan. Indian J Commun Med. 2012;37(1)39-44. DOI: 10.4103/0970 0218.94023 [Crossref][PubMed][Google Scholar]
[26] Nazreen Khan, Mohd Shahid khan. Prevalence of Antimicrobial Resistance in Bacterial Isolates causing Urinary Tract Infection in Patients attending IIMS & R Hospital, Lucknow. Int J Life Sci & Scientific Res. 2016;2(1)1-8. [Crossref][PubMed] [Google Scholar]
[27]Kalal BS, Nagaraj S. Urinary tract infections: a retrospective, descriptive study of causative organisms and antimicrobial pattern of samples received for culture, from a tertiary care setting. GERMS 2016;6(4):132-138 10.11599/germs.2016.1100(BANGALORE) doi:
[28] Patel HB, Soni ST, Bhagyalaxmi A, Patel NM. Causative agents of urinary tract infections and their antimicrobial susceptibility patterns at a referral center in Western India: An audit to help clinicians prevent antibiotic misuse. J Family Med Prim Care 2019;8:154-9
[29] Mohapatra S, Panigrahy R, Tak V, J V S, K C S, Chaudhuri S, Pundir S, Kocher D, Gautam H, Sood S, Das BK, Kapil A, Hari P, Kumar A, Kumari R, Kalaivani M, R A, Salve HR, Malhotra S, Kant S. Prevalence and resistance pattern of uropathogens from community settings of different regions: an experience from India. Access Microbiol. 2022 Feb 9;4(2):000321. doi: 10.1099/acmi.0.000321. 35355869; PMCID: PMC8941965. PMID:
[30] Behera B, Debbarma M, Rout B, et al. Prevalence of ESBL Producing Bacteria in Community-Acquired UTI from Eastern Part of India. J Pure Appl Microbiol. 2022;16(3):1682-1688. doi: 10.22207/JPAM.16.3.07
[31] Nerulkar A, Solanky P, Naik SS. Bacterial path ogens in urinary tract ifection and antibiotic susce ptibility pattern. J Pharmaceut Biomed Sci. 2012; 21(12)1 3.[Crossref][PubMed][Google Scholar]

[32] Parveen R, Md Yushuf A, Sharmin I, Md Islam S, Rahim I. Antibiotic Sensitivity of Bacteria Causing Urinary Tract Infection Bang. J Infect Dis. 2015;2(1)13-18. DOI: 10.3329/bjid.v2i1.31324 [Crossref][PubMed][Google Scholar]
[33] Nazreen Khan, Mohd Shahid khan. Prevalence of Antimicrobial Resistance in Bacterial Isolates causing Urinary Tract Infection in Patients attending IIMS & R Hospital, Lucknow. Int J Life Sci & Scientific Res. 2016;2(1)1-8. [Crossref][PubMed] [Google Scholar]
[34] Pardeshi P. Prevalence of urinary tract infections and current scenario of antibiotic susceptibility pattern of bacteria causing UTI. Indian J Microbiol Res. 2018;5(3):334-338
[35] Akram M, Shahid M, Khan AU. Annals of Clinical Microbiology and Antimicrobials, Etiology and antibiotic resistance patterns of community acquired urinary tract infections in JN MC hospital Aligarth, India. Ann Clin Microbiol Antimicrob. 2007;6(4)1-7. [Crossref][PubMed][Google Scholar]
[36] Kothari A, Sagar V. Antibiotic resistance in pathogens causing community acquired urinary tract infection in India: a multicentre study. J infect Developing Countries. 2008;2(5)354-358. [Crossref][PubMed][Google Scholar]
[37] Shalini, Joshi MC, Rashid MK, Joshi HK. Study of Antibiotic Sensitivity Pattern in Urinary Tract Infection at a Tertiary Hospital. Nat J Integ Res Med. 2011;2(3)43-46. [Crossref][PubMed][Google Scholar
[38] Prakash D, Saxena RS. Distribution and antimicrobial susceptibility pattern of bacterial pathogens causing urinary tract infection in urban community of Meerut City, India. ISRN Microbiology. 2013. DOI: 10.1155/2013/749629 [Crossref] [PubMed][Google Scholar]
[39] Shyamala R, Ravinder N, Shazia Parveen, Janardhan Rao. Escherichia coli as the commonest uropethogen in a tertiary care hospital. J Microbiol Biotechnol Res. 2013;3(6)49-51. [PubMed][Google Scholar]
[40] Bhonsle, Kaina & Vyas, Harish & Hemwani, Kirti & Vyas, Alka. (2020). STUDY OF PREVALENCE OF URINARY TRACT INFECTIONS IN PATIENTS OF UJJAIN, MADHYA PRADESH (INDIA). INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCH. 69-71. 10.36106/ijsr/1833083