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Original Research Article

Antibiotic Resistance Patterns of Uropathogen in Urinary Tract Infections: A Study from a Tertiary Care Center in the Bihar Region

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Abstract

Background: Urinary tract infection (UTI) is a prevalent illness globally, caused by uropathogen. Effective treatment of UTI requires accurate identification of the underlying cause and appropriate administration of medications. In this age of evolving antibiotic susceptibility trends, it is essential to raise knowledge of regional antibiotic resistance patterns among prescribing physicians.

Aim: The aim of this research was to determine the prevalent uropathogen linked to instances of UTIs as well as their pattern of antibiotic susceptibility.

Materials and Methodology: This was a cross-sectional study that included all inpatients of above 18 years of age and diagnosis with the UTI. The identification of urinary tract infections, midstream urine samples were collected, cultured, and subjected to pertinent biochemical assays at the 'Department of Pharmacology, Anugrah Narayan Magadh Medical College, Gaya, Bihar, India'.

Results: The distribution of uropathogen in 80 cases shows that E. coli was the most common (27.5%), followed by *Enterococcus spp*. (22.5%) and *Klebsiella spp*. (18.75%). Antibiotic resistance patterns revealed varying resistance levels, with *Staphylococcus* and *Enterococcus* showing resistance to Linezolid, Ampicillin/Amoxicillin, and Vancomycin. Gram-negative bacteria like *Klebsiella*, *Proteus*, *E. coli*, and *Pseudomonas* exhibited resistance to Meropenem, Gentamycin, Norfloxacin, and Ceftazidime. E. coli demonstrated the highest resistance overall among Gram-negative pathogens.

Conclusions: Almost all of the test organisms exhibited resistance to multiple antibiotics. The research uncovered a significant amount of antibiotic resistance in uropathogen, which were previously used as the primary treatment for UTI in infants.

Keywords: Antibiotic, Resistance, Susceptibility, Urinary Tract Infection, Uropathogen.

Introduction

Urinary tract infections are among the most prevalent conditions that general practitioners treat [1]. Up to 60% of women are thought to have had a urinary tract infection. Every year, over 150 million people worldwide get a diagnosis of urinary tract infections, leading to medical expenses above $6 billion. Escherichia coli is the most common isolate, responsible for 75–90% of cases of uncomplicated urinary tract infections. Seldom are isolates of Staphylococcus saprophyticus, Klebsiella species, Proteus species, Enterococcus species, and Enterobacter species obtained from outpatients. Antibiotics are often administered empirically until conclusive results from bacteriology are obtained. Therefore, in order to choose the best empirical treatment, area-specific surveillance studies are necessary to identify the microorganisms causing UTIs and their susceptibility to antibiotics [4].

A range of wide spectrum antibiotics are often used to treat urinary tract infections; however, when concerns about the presence of resistant bacteria in the illness arise, an antibiotic with a limited spectrum of action may be appropriate. When resistance is anticipated to be a problem, fluoroquinolones are preferred as first-line therapies for urinary tract infections [5,6]. This is due to the fact that they have low rates of resistance and high rates of bacteriological and clinical cure, in contrast to the majority of uropathogen. There has not been enough research done on the resistance pattern of the bacteria that cause urinary tract infections that are acquired in the community [7]. Antibiotic resistance is a recent major worldwide concern that is virtually invariably the result of the extensive use of antimicrobial medications. Both in the community and nosocomial infections, the causes of UTIs and the uropathogen resistance to antibiotics have changed. [8] On the other hand, the resistance pattern and pathogenesis of community-acquired UTIs in India are little understood. Between 25 and 40 percent of nosocomial infections are urinary tract infections, which place a significant financial and medical strain on medical systems.

Usually starting as a bladder infection, urinary tract infections may ultimately travel to the kidneys and cause renal failure or blood spread, depending on the kind of bacteria involved. UTI is divided into illness groups based on the focal site: bacteriuria, cystitis, and pyelonephritis. Asymptomatic bacteriuria (ABU) is the presence of bacteria in the urine without any accompanying symptoms. Asymptomatic bacteriuria is a mimic of a commensal-like carrier disease that the patient usually ignores. Women and girls are more prone to have UTIs; 40–50% of adult women will get a UTI at some point in their lives. *Escherichia coli* bacteria live in the microbiome of the digestive system. However, certain strains have evolved the capacity to be hazardous. Several extraintestinal diseases, including urinary tract infections, respiratory tract infections, neonatal meningitis, and septicemia, are attributable to *Escherichia coli*, often referred to as Uropathogenic *Escherichia coli*. Numerous intestinal disorders are attributable to pathogenic *Escherichia coli* in the intestines. In contrast to strains that cause diarrhea, Uropathogenic *Escherichia Coli* strains do not infect the gastrointestinal tract. Most people believe that strains that impact the urinary system originate from the fecal flora. About 20% of healthy women have *Escherichia coli* in their vagina [9].

When a bacteria is able to resist an antibiotic's effects, antibiotic resistance occurs. An evolutionary stress may result in antibiotic resistance developing in a population, in addition to being the outcome of random mutations leading to natural selection. In developing countries, the rise of antibiotic resistance in the treatment of urinary tract infections poses a significant threat to public health, where there is a pervasive circulation of counterfeit and fake drugs of questionable quality along with high rates of poverty and poor hygiene habits. Studies aiming at learning more about the bacteria that cause UTIs and their susceptibility patterns may assist doctors in selecting the most appropriate empirical therapy.[10,11]

Methods

This cross-sectional descriptive research was performed at the 'department of Pharmacology at Anugrah Narayan Magadh Medical College, Gaya, Bihar, India for one year. Four age groups comprised the study participants: 18–25 years old, 26–35 years old, 36–45 years old, and 46–60 years old. The research included patients that had not had antibiotic therapy prior to admission.

Microbiological methods and susceptibility testing to antibiotics samples were taken in sterile containers according to the age and physical state of the respondents, and they were submitted to the lab via midstream, pee bag, catheter, and suprapubic methods. Mac For cultivation, 5% blood agar, eosin methylene blue, and conkey agar were used. Traditional techniques were used to identify the microorganisms. The most common gram +ve and gram-negative isolated bacteria were tested for antibiotic susceptibility using disk diffusion techniques, in compliance with the Clinical Laboratory Standard Institute standards. The following antibiotic disks were used: amikacin (30µg), gentamycin HLG (120µg), gentamycin (30µg), amoxiclav (30µg), ampicillin (10µg), erythromycin (15µg), ceftazidime (30µg), imipenem (10µg), co-trimoxazole (1.25/23.75µg), cefotaxime (30µg), norfloxacin (10µg), linezolid (30µg), nitrofurantoin (300µg), vancomycin (30µg), meropenem (10µg), piperacillin + tazobactam (100/10µg), and colistin (10µg). For the susceptibility tents, standard strains of *Pseudomonas aeruginosa* ATCC 27853, *Staphylococcus aureus* ATCC 25923, and *Escherichia coli* ATCC 25922 were used. Based on CLSI criteria, the isolates were classified as resistant or sensitive. For data collecting, analysis, and chart development, Microsoft Excel was used.

2.1. Statistical analysis

The statistical analysis was conducted using SPSS software, specifically version 27. The student's t-test was utilized for comparing the mean values of the two categories. Categorical data were analyzed using the Chi-square test. The P-value below 0.05 was indicated the statistical significance of result.

Results

1. The distribution of uropathogen isolated from a total of 80 cases. The most common bacteria isolated was *E. coli* (22 cases, 27.5%), followed by *Enterococcus spp.* (18 cases, 22.5%) and *Klebsiella spp.* (15 cases, 18.75%). Other bacteria included *Proteus spp.* (12 cases, 15%), *Staphylococcus spp.* (9 cases, 11.25%), and *Pseudomonas spp.* (4 cases, 5%). This distribution highlights the prevalence of *E. coli* as a major uropathogen.

Table 1: Distribution of Isolated Uropathogen (N= 80).

Type of isolated bacteria	No. of bacteria isolated (n=80)	%
Klebsiella spp.	15	18.75%
Pseudomonas spp.	4	5.0%
Enterococcus spp.	18	22.5%
E. coli	22	27.5%
Proteus spp.	12	15.0%
Staphylococcus spp.	9	11.25%

The antibiotic resistance pattern of Gram-positive bacteria, specifically *Staphylococcus spp.* (9 isolates, 11.25%) and *Enterococcus spp.* (18 isolates, 22.5%). Resistance to Linezolid was observed in 1 *Staphylococcus* isolate, while no resistance was found in *Enterococcus*. Resistance to Ampicillin/Amoxicillin was seen in 3(33.33%) *Staphylococcus* and 55(27.78%) *Enterococcus* isolates. Vancomycin resistance was noted in 1(11.11%) *Staphylococcus* and 2(11.11%) *Enterococcus* isolates. Penicillin resistance was higher in *Enterococcus* (8 isolates, 44.44%) compared to *Staphylococcus* (1 isolate, 11.11%). Cefoxitin resistance was found in 3 isolates of both *Staphylococcus* and *Enterococcus*. These results highlight varying levels of resistance across both bacterial species.

Table 2: Antibiotic resistance trend among gram +ve isolates.

Antibiotics	***Staphylococcus spp.*** **(N=9)**	***Enterococcus spp.*****(N=18)**
Linezolid-one	11 (1.11%)	0 (0%)
Ampicillin/amoxicillin	3 (33.33%)	5 (27.78%)
Vancomycin	1 (11.11%)	2 (11.11%)
Penicillin	1 (11.11%)	8 (44.44%)
Cefoxitin	3 (33.33%)	3 (16.67%)

The patterns of antibiotic resistance seen in isolates classified as Gram-negative, such as *Klebsiella species*, *E. coli*, *Pseudomonas species*, and *Proteus species*. Resistance to Meropenem was found in 2(13.33%) isolates of *Klebsiella* and *Proteus*, 3(13.64%) isolates of *E. coli*, and none of *Pseudomonas*. Gentamycin resistance was observed in 4(26.67%) *Klebsiella*, 4(33.33%) *Proteus*, 5(22.73%) *E. coli*, and 1(25%) *Pseudomonas* isolate. Norfloxacin resistance was detected in 4 *Klebsiella*, 1 *Proteus*, 5*E. coli*, and 1*Pseudomonas*. Resistance to Ceftazidime was higher in *E. coli* (7 isolates) compared to *Klebsiella* (3), *Proteus* (3), and *Pseudomonas* (2). Finally, Cephalexin resistance was relatively low, with 2(13.33%) isolates in each of *Klebsiella*, *Proteus*(16.67%), and *E. coli*(9.09%), and none in *Pseudomonas*(0%). This data demonstrates varying levels of resistance across different Gram-negative bacteria, with *E. coli* showing higher resistance overall.

Table 3: Pattern of antibiotic resistance in isolates from gram-negative

Antibiotics	***Klebsiella spp.*** **(N = 15)**	***Proteus spp.*** **(N = 12)**	***E. coli*** **(N = 22)**	***Pseudomonas spp.*** **(N = 4)**
Meropenem	2 (13.33%)	2 (16.67%)	3 (13.64%)	0 (0%)
Gentamycin	4 (26.67%)	4 (33.33%)	5 (22.73%)	1 (25%)
Norfloxacin	4 (26.67%)	1 (8.33%)	5 (22.73%)	1 (25%)
Ceftazidime	3 (20%)	3 (25%)	7 (31.82%)	2 (50%)
Cephalexin	2 (13.33%)	2 (16.67%)	2 (9.09%)	0 (0%)

Discussion

The study reveals that *E. coli* is the most prevalent uropathogen, accounting for 27.5% of the total isolates, followed by *Enterococcus spp.* (22.5%) and *Klebsiella spp.* (18.75%). This finding aligns with the general understanding that *E. coli* is a predominant causative agent in "urinary tract infections". The antibiotic resistance patterns for Gram-positive bacteria show significant resistance, particularly to Penicillin among *Enterococcus spp.* (44.4%) and to Ampicillin/Amoxicillin in both *Staphylococcus spp.* (33.3%) and *Enterococcus spp.* (27.7%). Notably, only one *Staphylococcus* isolate showed resistance to Linezolid, a last-resort antibiotic, highlighting the relative susceptibility of these isolates to this drug. In similar study, the prevalence of vancomycin resistance in *Enterococcus* (11.1%) is alarming, considering its relevance in treating severe Gram-positive infections. In a retrospective investigation, Bahadin et al. found that *klebsiella* was the second most prevalent isolate, with ampicillin resistance of 100 percent [12]. Akram et al. [13] found that

Acinetobacter spp. were very susceptible to fluoroquinolones (100%) and amikacin (100%).

Among Gram-negative bacteria, *E. coli* demonstrated higher resistance across multiple antibiotics, especially to Ceftazidime (31.8%) and Gentamycin (22.7%), which are commonly used to treat UTIs. The widespread resistance observed in *E. coli* is troubling, as it indicates a growing challenge in managing infections caused by this pathogen. Similarly, resistance in *Klebsiella spp.* and *Proteus spp.* was notable, particularly to Meropenem, an antibiotic reserved for multidrug-resistant infections, with 13.3% and 16.7% resistance, respectively. *Pseudomonas spp.* displayed the least resistance across all tested antibiotics, suggesting it may still be treatable with standard antibiotic therapies. In other study, Enterococcus spp. show no resistance to vancomycin and only minor resistance (3.1%) to linezolid, according to Rekha et al. [14]. These findings are in line with those of Marwan O et al. [15], who discovered that Enterococcus spp. exhibited 100% sensitivity to these drugs. Beyene et al. [16] found comparable resistance rates to ampicillin (100 percent), cotrimoxazole (100 percent), ciprofloxacin (50 percent), and ceftriaxone. Reduced levels of resistance to ampicillin, ceftriaxone, and amikacin were discovered in a South Indian study.

Overall, the data reflect increasing antibiotic resistance, particularly in Gram-negative isolates like *E. coli*, which poses a significant public health challenge. These findings underscore the need for ongoing surveillance and prudent use of antibiotics to mitigate the development of further resistance, especially in uropathogen commonly associated with UTIs. In other study ,according to a 2017 research conducted by Marwan O et al. [15], *Pseudomonas spp.* have 0% resistance to colistin. Gram-negative uropathogen resistance to norfloxacin is relatively modest when compared to previous work by Rekha T et al., [14], despite significant resistance to ampicillin/amoxycillin (60%) and nitrofurantoin (60%)—both of which are greater than the study conducted by Sumit G et al.[17]. Dalela et al. discovered that MRSA isolates had similar sensitivity rates to vancomycin and linezolid [18].

Conclusion

The study analyzes the sensitivity of these bacteria to different antibiotics, offering significant insights into the most effective treatment choices, so guiding empirical therapy and mitigating antibiotic abuse, which leads to resistance. These results are essential for enhancing treatment procedures and addressing the increasing challenge of antibiotic resistance in hospital environments.

References

1. Al-Jebouri, Mohemid M. & Mdish, Salih A. (2013). "Antibiotic Resistance Pattern of Bacteria Isolated from Patients of Urinary Tract Infections in Iraq". Open Journal of Urology, 2013, 3, 124-131.
2. Spellberg B, Bartlett JG, Gilbert DN. The future of antibiotics and resistance. N Engl J Med. 2013; 368:299– 302.
3. Lee DS, Lee SJ, Choe HS. Community-Acquired Urinary Tract Infection by Escherichia coli in the Era of Antibiotic Resistance. Biomed Res Int. 2018 Sep 26; 20 18:7656752. https://doi. org/10.1155/2018 /76 56752
4. Hasan AS, Nair D, Kaur J, Baweja G, Deb M, Aggarwal P. Resistance patterns of urinary isolates in a tertiary Indian hospital. J Ayub Med Coll Abbottabad. 2007 JanMar;19(1):39-41.
5. Karen JM, Robert MK, Om PM, Shakuntala SP, Surjit S. Nelson Essentials of Pediatrics, 1st South Asia Edition. Elsevier India; 2016:376.
6. Farajnia S, Alikhani MY, Ghotaslou R, Naghili B, Nakhlband A. Causative agents and antimicrobial susceptibilities of urinary tract infections in the northwest of Iran. Int J Infect Dis. 2009 Mar;13(2):140-4.
7. Gupta K, Hooten TM, Stamm WE (2001) Increasing antimicrobial resistance and the management of uncomplicated community-acquired urinary tract infections. Ann Intern Med 135:41-50
8. Kahan NR, Chinitz DP, Waitman DA, Dushnitzky D, Kahan E, Shapiro M:Empiric treatment of uncomplicated urinary tract infection with fluoroquinolones in older women in Israel: another lost treatment option? Ann Pharmacother2006, 40(12):2223- 7.
9. Vejborg, R. M. et al. (2011). "Comparative Genomics of Escherichia coli Strains Causing Urinary Tract Infections†". Applied And Environmental Microbiology. May 2011, p. 3268–3278, Vol. 77, No. 10, 0099-2240/11/$12.00, doi:10.1128/AEM.02970-10.
10. Chang SL, Shortliffe LD. Pediatric urinary tract infections. Pediatr Clin North Am. 2006;53(3):379-400.
11. Smith RD, Coast J, 2002. Antimicrobial resistance: a global response. Bull World Health Organ 80: 126 – 133.
12. Bahadin J, Teo SS, Mathew S. Aetiology of communityacquired urinary tract infection and antimicrobial susceptibility patterns of uropathogens isolated. Singapore Med J. 2011 Jun;52(6):415-20.
13. Akram M, Shahid M, Khan AU. Etiology and antibiotic resistance patterns of community-acquired urinary tractinfections in J N M C

Hospital Aligarh, India. Ann Clin Microbiol Antimicrob. 2007 Mar 23; 6:4.

14. Rekha T, Gurudas K, Nupur S, Ajeet KK. Antibiotic sensitivity pattern of pathogens in children with urinary tract infection in a tertiary care hospital in Kachchh, Gujarat, India. Int J Contemp Pediatr. 2017;4(6): 21 03-8.
15. Marwan O, Hassan M, Monzer H, Elie BR. Prevalence and antibiotic susceptibility patterns of bacteria causing urinary tract infections in Youssef Hospital Center: first report from Akkar governorate, North Lebanon. Int Arabic J Antimicrobial Agents . 2017;7(1):2-10
16. Khatri B, Basnyat S, Karki A, Poudel A, Shrestha B. Etiology and antimicrobial susceptibility pattern of bacterial pathogens from urinary tract infection. Nepal Med Coll J. 2012 Jun;14(2):129-32.
17. Sumit G, Reshma A, Suneel B, Arti A, Ankur G. Urinary tract infection in paediatrics patients in north India, J Dent Med Sci. 2013;11(3):58-62.
18. Dalela G, Gupta S, Jain DK, Mehta P. Antibiotic resistance pattern in uropathogens at a Tertiary Care Hospital at Jhalawar with special reference to ESβL, AmpC βLactamase and MRSA production. J Clin Diagn Res. 2012;6(4):645–51.