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RESEARCH ARTICLE

Prevalence and Antibiotics Susceptibility Pattern of Escherichia coli Isolated From Urine Samples of Urinary Tract Infection Patients

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Abstract

Background: Urinary tract infection (UTI) is a common bacterial infection affecting the bladder, urethra, and kidneys, caused mainly by organisms like E. coli. Prompt treatment is crucial to prevent complications, given the rising antibiotic resistance. Gram-negative bacteria, especially E. coli, are predominant, posing challenges for treatment. Multidrug resistance (MDR) in E. coli complicates management, leading to increased costs and mortality rates, notably in developing countries like Bangladesh. Continuous monitoring of antibiotic susceptibility is vital to combat MDR strains. However, resistance rates vary globally, necessitating region-specific strategies for effective UTI management and antibiotic use.

Aim of the study: The study aims to assess the prevalence and resistance profiles of E. coli isolates causing UTIs in patients.

Methods: A retrospective study was conducted at the Department of Nephrology, Medical College for Women & Hospital, Dhaka Bangladesh. During 1 year from January 2023 to December 2023, 550 urine samples were collected from UTI patients attending to the hospital.Out of these, 120 patients were confirmed with UTI. Samples were collected in the morning, stored properly, and subjected to microbial culture. Escherichia coli was isolated and identified using standard methods. Sensitivity to various antibiotics was tested, following EUCAST guidelines. Data were analyzed using SPSS, with results presented in tables and graphs.

Result: The study focused on urinary tract infections (UTIs), revealing a high prevalence among individuals aged 51-60 years. Females comprised the majority of cases (85%), with Escherichia coli being the predominant pathogen (75.83%), followed by Klebsiella pneumoniae (8.33%). Other significant contributors included Pseudomonas aeruginosa, Proteus mirabilis, and Staphylococcus saprophyticus. Antibiotic resistance patterns of E. coli were analyzed, showing high sensitivity to meropenem (90%) and nitrofurantoin (80%), among others. However, resistance was notably high against ampicillin (100%) and several cephalosporins and fluoroquinolones (70% each). Intermediate sensitivity was observed for certain antibiotics.

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Conclusion: This study highlights the prevalence of urinary tract infections (UTIs) caused by Escherichia coli (E. coli), especially in the 51-60 age group. E. coli exhibits high resistance to common antibiotics, emphasizing the need for judicious antibiotic use and surveillance to optimize treatment strategies and reduce morbidity and mortality rates associated with UTIs.

Keywords: Prevalence, Antibiotics, Susceptibility Pattern, E. Coli, and UIT.

1. Introduction

Urinary tract infection (UTI) refers to microbial colonization or inflammation in various parts of the urinary system, including the bladder (cystitis), urethra (urethritis), or renal pelvis and kidneys (pyelonephritis). It arises due to the proliferation of microorganisms within the urinary tract, representing one of the most common bacterial infections across all age demographics [1]. UTIs can be instigated by Gram-negative bacteria like E. coli (60-70%), Klebsiella (10%), Proteus (5-10%), and Pseudomonas (2-5%), as well as gram-positive bacteria such as group B Streptococcus and Staphylococcus species [2]. E. coli stands out as the predominant organism responsible for both community and hospital-acquired UTIs [3,4].

While UTIs may manifest with symptoms, they can also remain asymptomatic. Nonetheless, prompt treatment is imperative for both types of infections to prevent potential complications [5]. Gram-negative bacteria are commonly found among organisms isolated from urine samples of UTI patients [6]. Despite varied causative agents, bacterial origins account for 95% of cases, with E. coli being the primary culprit in the majority of instances [5,7,8]. Various factors, including age, gender, immunosuppression, and urological procedures, can influence UTI prevalence [9]. Identifying UTI-causing pathogens and understanding their resistance to commonly prescribed antibiotics is crucial for enhancing the efficacy of empirical treatments [10].

The rise of antibiotic resistance poses a significant health concern, with numerous studies reporting antibiotic-resistant E. coli strains. Multidrug resistance (MDR), characterized by non-susceptibility to at least one antimicrobial agent in three or more antimicrobial categories, is particularly worrisome as it leads to treatment failure, heightened morbidity, and mortality rates [11,12]. UTIs caused by multidrug-resistant (MDR) E. coli substantially escalate treatment costs, morbidity, and mortality, particularly in developing nations like Bangladesh [13,14]. Continuous monitoring of antibiotic susceptibility is vital for managing infections rationally and combating the escalating prevalence of multidrug-resistant E. coli. Drug resistance rates to commonly prescribed antibiotics vary considerably worldwide and may exhibit distinct patterns in different geographic regions. Hence, this study aims to assess the prevalence and resistance profiles of E. coli isolates causing UTIs in patients.

2. Methodology and Materials

The retrospective study was conducted at the Department of Nephrology, Medical College for Women & Hospital, Dhaka Bangladesh. During 1 year from January 2023 to December 2023, 550 urine samples were collected from UTI patients attending to the hospital. From the samples, a total of 120 patients were confirmed as UTI. After providing written informed consent, every patient was asked about symptoms suggestive of UTI (e.g., urgency, dysuria, urinary frequency, loin pain, and nausea). The participants were selected on the basis of inclusion and exclusion criteria.

2.1 Sample Collection

Early morning mid-stream urine samples of about 10ml were collected using clean and sterilized plastic bottles with air-tight screw cap tops. Each urine sample bottle was labeled with a reference code, age, sex, and time of collection.

The samples were placed in a cold box for transportation to the laboratory, where it was stored until analyses were carried out. Ten (10) ml of each urine sample was centrifuged at 2000 revolution per minute (rpm) for 5 minutes, the supernatant was discarded and the sediment was used for microbial culture. These samples were subjected to routine microscopy, culture, and sensitivity according to standard practice.

2.2 Isolation and Identification of Escherichia Coli

Isolation of E. coli was conducted according to the method describe by Prescott et al. [15]. During the process, a sterile wire loop was deep into the sediments of urine sample of the patients and streaked onto the surface of Nutrient agar (Life save Biotech, USA). The procedure was repeated for all the sample and the plates were incubated 370°C for 24 hours.

The presumptive colony of E. coli from each plate was further sub-cultured to obtained pure culture. The pure isolates of E. coli were preserved in peptone water for further use.

The preserved isolates were confirmed as E. coli using conventional microbiological methods which include Gram staining, lactose fermentation, cystine-lactose-electrolyte deficient (CLED) medium growth and motility test as well as biochemical (Indole, methyl orange, vogesproskauer, nitrate reduction and citrate utilization) tests according to the methods described by Holt et al. [16].

2.3 Sensitivity Pattern

Sensitivity pattern of the isolates to Amikacin (30µg), Amoxyclave (30µg), Ampicillin (30µg), Cefepime(30 µg), Cefixime (30µg), Ceftazidime (30µg), Ceftriaxone (30µg), Cefuroxime (30µg), Ciprofloxacin (5µg), Cotrimoxazole (25µg), Gentamycin (10µg), Imipenem (10µg), Levofloxacin (5µg), Meropenem (10µg), Nitrofurantoin (30µg), Piperacillin+Tazobactam (4.5µg), Tetracycline (30µg)were determined.

Isolates were divided into three groups based on the zone of inhibition produced by the antibiotic disc; susceptible, intermediate susceptible and resistant according to the European committee on antimicrobial susceptibility testing (EUCAST) breakpoint for interpretation of MICs and zone diameters [17].

2.4 Data Analysis

All data were presented in a suitable table or graph according to their affinity. A description of each table and graph was given to understand them clearly. All statistical analysis was performed using the statistical package for social science (SPSS) program, and Windows. Continuous parameters were expressed as mean±SD and categorical parameters as frequency and percentage. Comparisons between groups (continuous parameters) were made by Student's t-test.

3. Results

The highest prevalence of UTI was found in the age group of 51-60 years (56.67%), second most 38(31.67%) participants aged under 51-60 years and 12(10.00%) participants aged more than 60 years, respectively (Table 1). Figure 1 shows the gender distribution of the study, where the majority were female (85.00%), and the rest 15.00% were male.

Table 2 provides a comprehensive overview of the distribution of organisms isolated from patients diagnosed with urinary tract infection (UTI).

Escherichia coli dominates the list, comprising 75.83% of the cases, followed by Klebsiella pneumoniae with 8.33%. Pseudomonas aeruginosa, Proteus mirabilis, and Staphylococcus saprophyticus are notable contributors, each representing a smaller yet significant portion of the cases at 5.00%, 5.83%, and 2.50%, respectively.

Enterococci faecalis and Staphylococcus aureus are less frequently encountered, constituting 1.67% and 0.83% of the cases, respectively. Table 3 briefs the antibiotic resistance pattern of E. coli isolates of individuals with urinary tract infections.

E. coli exhibited high sensitivity of isolates meropenem (90%), nitrofurantoin (80%), amikacin and piperacillin+tazobactam (70% each), gentamycin and imipenem (60% each). Only Amikacin, Ciprofloxacin, Cotrimoxazole, Gentamycin, and Imipenem showed intermediate sensitivity to E. coli at 10%. Conversely, high resistance rates were observed against ampicillin (100%), cefepime, cefixime, ceftazidime, ceftriaxone, cefuroxime, and levofloxacin (70% each).

Table 1. *Age-wise distribution of the study population (N=120).*

Age (years)	Frequency (n)	Percentage (%)
Less than 40	2	1.67
41-50	38	31.67
51-60	68	56.67
More than 60	12	10.00
Total	120	100.00

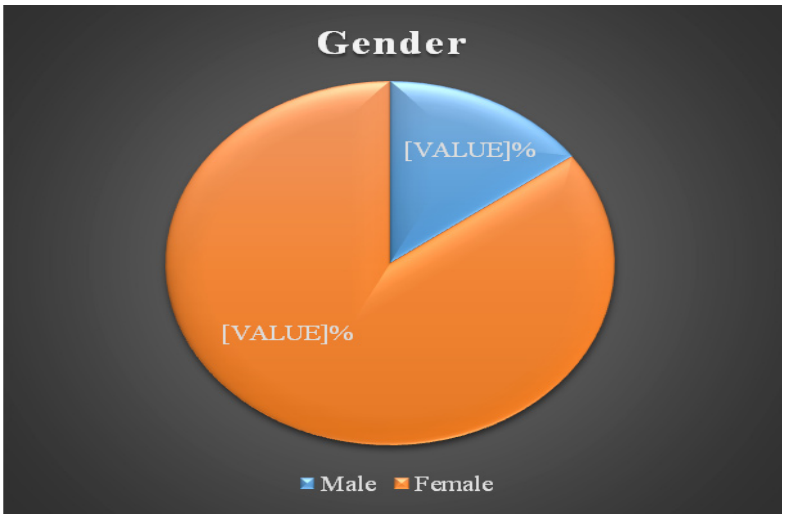

Figure 1. *Age distribution of the study population (N=120).*

Table 2. *Distribution of organisms isolated from patients with urinary tract infection.*

Bacterial pathogens	Frequency (n)	Percentage (%)
Escherichia coli	91	75.83
Klebsiella pneumoniae	10	8.33
Pseudomonas aeruginosa	6	5.00
Proteus mirabilis	7	5.83
Enterococci faecalis	2	1.67
Staphylococcus saprophyticus	3	2.50
Staphylococcus aureus	1	0.83
Total	120	100.00

Table 3. *Antibiotic resistance pattern of E. coli isolates.*

Antibiotics	Concentration (µg)	Sensitive		Intermediate		Resistant	
		n	%	n	%	n	%
Amikacin	30µg	84	70.00	12	10.00	24	20.00
Amoxyclave	30µg	36	30.00	0	0.00	84	70.00
Ampicillin	30µg	0	0.00	0	0.00	120	100.00
Cefepime	30µg	36	30.00	0	0.00	84	70.00
Cefixime	30µg	36	30.00	0	0.00	84	70.00
Ceftazidime	30µg	36	30.00	0	0.00	84	70.00
Ceftriaxone	30µg	36	30.00	0	0.00	84	70.00
Cefuroxime	30µg	12	10.00	0	0.00	108	90.00
Ciprofloxacin	5µg	24	20.00	12	10.00	84	70.00
Cotrimoxazole	25µg	48	40.00	12	10.00	60	50.00
Gentamycin	10µg	72	60.00	12	10.00	36	30.00
Imipenem	10µg	72	60.00	12	10.00	36	30.00
Levofloxacin	5µg	36	30.00	0	0.00	84	70.00
Meropenem	10µg	108	90.00	0	0.00	12	10.00
Nitrofurantoin	30µg	96	80.00	0	0.00	24	20.00
Piperacillin+Tazobactam	4.5µg	84	70.00	0	0.00	36	30.00
Tetracycline	30µg	60	50.00	0	0.00	60	50.00

4. Discussion

Urinary tract infections (UTIs) occur due to microbial invasion and subsequent multiplication within the urinary tract. A study examining UTI prevalence among subjects found a high prevalence among individuals aged 51-60 years, constituting approximately 56.67% of the study population. The study recorded a higher proportion of female participants than male participants, consistent with Shah et al.'s findings [18].

Increased prevalence among females may be attributed to factors such as the proximity of the urinary and genital systems and pregnancy. Analysis of urine samples from UTI patients in this study revealed a notably high prevalence (75.83%) of Escherichia coli (E. coli), consistent with prior research [19,20].

The isolation rate of E. coli was highest among elderly patients (aged 40 to 60 years), aligning with findings by Iqbal [21].The pathogenic potential of E. coli is significantly influenced by its adaptable gene pool, facilitating the acquisition and loss of genetic materials [22, 23].

Over the years, there has been a notable increase in antibiotic-resistant strains of E. coli, particularly those resistant to fluoroquinolones and those producing extended-spectrum β-lactamases. This study also found a high overall resistance of E. coli to antimicrobials. The isolates displayed high sensitivity to meropenem (90%), nitrofurantoin (80%), amikacin and piperacillin+tazobactam (70% each), gentamycin and imipenem (60% each).

Conversely, high resistance rates were observed against ampicillin (100%), cefepime, cefixime, ceftazidime, ceftriaxone, cefuroxime, and levofloxacin (70% each), consistent with previous research [24,25].The elevated resistance rates to ampicillin and amoxicillin in this study corroborate findings by Sabir et al., which reported 100% resistance of E. coli to beta-lactam drugs [26]. Similarly, resistance to tetracycline and erythromycin aligns with studies conducted in Sudan and Slovenia [27,28].

Co-expression of resistance mechanisms within E. coli species may contribute to these high resistance rates. The escalating antimicrobial resistance among E. coli globally is concerning, affecting both developed and developing nations. Factors such as repeated or prolonged antibiotic use can disrupt urethral flora, facilitating uropathogenic colonization and subsequent UTI development, limiting treatment options for clinicians [28,29]. Additionally, this environment promotes horizontal gene transfer among bacteria, disseminating resistance genes against specific antibiotics [30]. In this study, E. coli isolates exhibited sensitivity to meropenem, nitrofurantoin, amikacin, piperacillin+tazobactam, gentamycin, and imipenem. These findings are consistent with various other studies [31-33].

4.1 Limitations of the Study

The study delves into UTI prevalence and E. coli antibiotic susceptibility patterns but acknowledges limitations. Its retrospective design may introduce bias and lacks comprehensive clinical data. Conducted in a single department in Bangladesh, the findings' generalizability could be improved. Focusing solely on E. coli from urine samples overlooks other uropathogens, offering an incomplete resistance picture. Standard antimicrobial testing may need to include emerging resistance mechanisms.

5. Conclusion

In conclusion, this study underscores the significant prevalence of urinary tract infections (UTIs) caused primarily by Escherichia coli (E. coli), especially among individuals aged 51-60 years.

The high resistance rates of E. coli to commonly prescribed antibiotics pose a considerable challenge in the clinical management of UTIs. Notably, the isolates displayed sensitivity to meropenem, nitrofurantoin, amikacin, piperacillin+tazobactam, gentamycin, and imipenem. These findings emphasize the importance of judicious antibiotic use and continuous surveillance of antibiotic resistance patterns to optimize treatment strategies and mitigate the emergence of multidrug-resistant strains, thus ensuring effective management of UTIs and reducing associated morbidity and mortality rates.

6. References

1. Ali M, Garba KA, Abdallah MS. Antibiotic susceptibility profile of bacteria responsible for urinary tract infection (UTI). South Asian journal of biological research (SAJBR). 2018;1(1):12-27.
2. Alemu A, Moges F, Shiferaw Y, Tafess K, Kassu A, Anagaw B, Agegn A. Bacterial profile and drug susceptibility pattern of urinary tract infection in pregnant women at University of Gondar Teaching Hospital, Northwest Ethiopia. BMC research notes. 2012 Dec;5:1-7.
3. Mandell GL. Mandell, Douglas and Bennett's Principles and Practice of Infectious Diseases.

4. Flores-Mireles AL, Walker JN, Caparon M, Hultgren SJ. Urinary tract infections: epidemiology, mechanisms of infection and treatment options. Nature reviews microbiology. 2015 May;13(5):269-84.

5. Daoud Z, Afif C. Escherichia coli isolated from urinary tract infections of Lebanese patients between 2000 and 2009: epidemiology and profiles of resistance. Chemotherapy Research and Practice. 2011;2011.

6. Selvarangan R, Goluszko P, Singhal J, Carnoy C, Moseley S, Hudson B, Nowicki S, Nowicki B. Interaction of Dr adhesin with collagen type IV is a critical step in Escherichia coli renal persistence. Infection and immunity. 2004 Aug;72(8):4827-35.

7. Gales AC, Jones RN, Gordon KA, Sader HS, Wilke WW, Beach ML, Pfaller MA, Doern GV, SENTRY Study Group Latin America T. Activity and spectrum of 22 antimicrobial agents tested against urinary tract infection pathogens in hospitalized patients in Latin America: report from the second year of the SENTRY antimicrobial surveillance program (1998). Journal of Antimicrobial Chemotherapy. 2000 Mar 1;45(3):295-303.

8. Gupta K, Hooton TM, Wobbe CL, Stamm WE. The prevalence of antimicrobial resistance among uropathogens causing acute uncomplicated cystitis in young women. International journal of antimicrobial agents. 1999 May 1;11(3-4):305-8.

9. Al-Jiffri O, El-Sayed ZM, Al-Sharif FM. Urinary tract infection with Esherichia coli and antibacterial activity of some plants extracts.

10. Gupta V, Yadav A, Joshi RM. Antibiotic resistance pattern in uropathogens. Indian journal of medical microbiology. 2002;20(2):96-8.

11. Magiorakos AP, Srinivasan A, Carey RB, Carmeli Y, Falagas ME, Giske CG, Harbarth S, Hindler JF, Kahlmeter G, Olsson-Liljequist B, Paterson DL. Multidrug-resistant, extensively drug-resistant and pandrug-resistant bacteria: an international expert proposal for interim standard definitions for acquired resistance. Clinical microbiology and infection. 2012 Mar 1;18(3):268-81.

12. Howard DH, Scott RD, Packard R, Jones D. The global impact of drug resistance. Clinical Infectious Diseases. 2003 Jan 15;36(Supplement_1):S4-10.

13. Akhtar N, Rahman R, Sultana S. Antimicrobial sensitivity pattern of Escherichia coli causing urinary tract infection in Bangladeshi patients. American Journal of Microbiological Research. 2016;4(4):122-5.

14. Chowdhury S, Parial R. Antibiotic susceptibility patterns of bacteria among urinary tract infection patients in Chittagong, Bangladesh. SMU Medical Journal. 2015 Jan 1:114-26

15. Prescott LM, Harley JP, Klein DA. (2005). Microbiology. 6 th ed. McGrawHill, New York, pp. 833-842.

16. Holt JG, Krieg NR, Sneath PA, Stanley JT and Williams ST. Bergey's manual of systematic bacteriology, 9th edition. Williams & Wilkins Co. Baltimore, Maryland, 1994;p786

17. European Committee on Antimicrobial Susceptibility Testing. European Committee on Antimicrobial Susceptibility Testing Breakpoint tables for interpretation of MICs and zone diameters. EUCAST Clinical Breakpoint Tables. 2015;12.

18. Shah PS, Cannon JP, Sullivan CL, Nemchausky B, Pachucki CT. Controlling antimicrobial use and decreasing microbiological laboratory tests for urinary tract infections in spinal-cord-injury patients with chronic indwelling catheters. American journal of health-system pharmacy. 2005 Jan 1;62(1):74-7.

19. Singh V, Jaryal M, Gupta J, Kumar P. Antibacterial activity of medicinal plants against extended spectrum beta lactamase producing bacteria causing urinary tract infection. Int J Drug Res Tech. 2012;2:263-7.

20. Dimitrov TS, Udo EE, Emara M, Awni F, Passadilla R. Etiology and antibiotic susceptibility patterns of community-acquired urinary tract infections in a Kuwait hospital. Medical principles and Practice. 2004 Oct 7;13(6):334-9.

21. Shah SH. Susceptibility patterns of Escherichia coli: prevalence of multidrug-resistant isolates and extended spectrum beta-lactamase phenotype. JPMA. 2002;52(407).

22. Wiles TJ, Kulesus RR, Mulvey MA. Origins and virulence mechanisms of uropathogenic Escherichia coli. Experimental and molecular pathology. 2008 Aug 1;85(1):11-9.

23. Ulett GC, Totsika M, Schaale K, Carey AJ, Sweet MJ, Schembri MA. Uropathogenic Escherichia coli virulence and innate immune responses during urinary tract infection. Current opinion in microbiology. 2013 Feb 1;16(1):100-7.

24. Pitout JD. Extraintestinal pathogenic Escherichia coli: an update on antimicrobial resistance, laboratory diagnosis and treatment. Expert review of anti-infective therapy. 2012 Oct 1;10(10):1165-76.

25. Khan NA, Saba N, Abdus S, Ali AQ. Incidence and antibiogram patterns of E. coli isolates from various clinical samples from patients at NIH Islamabad. Pak J Biol Sci. 2002;1:111-3.

26. Sabir S, Anjum AA, Ijaz T, Ali MA, Nawaz M. Isolation and antibiotic susceptibility of E. coli from urinary

tract infections in a tertiary care hospital. Pakistan journal of medical sciences. 2014 Mar;30(2):389.

27. Mulu A, Moges F, Tessema B, Kassu A. Pattern and multiple drug resistance of bacterial pathogens isolated from wound infection at University of Gondar Teaching Hospital, Northwest Ethiopia. Ethiopian medical journal. 2006 Apr 1;44(2):125-31.
28. Petkovšek Z, Eleršič K, Gubina M, Zgur-Bertok D, Starčič Erjavec M. Virulence potential of Escherichia coli isolates from skin and soft tissue infections. Journal of clinical microbiology. 2009 Jun;47(6):1811-7.
29. Hillier S, Roberts Z, Dunstan F, Butler C, Howard A, Palmer S. Prior antibiotics and risk of antibiotic-resistant community-acquired urinary tract infection: a case–control study. Journal of antimicrobial chemotherapy. 2007 Jul 1;60(1):92-9.
30. Belay T, Afework K, Andargachew M, Gizachew Y. Predominant isolates of urinary tract pathogens and their antimicrobial susceptibility patterns in Gondar University Teaching Hospital, Northwest Ethiopia. Ethiopian Medical Journal. 2007;45(1):61-7.
31. Akhtar N, Rahman R, Sultana S. Antimicrobial sensitivity pattern of Escherichia coli causing urinary tract infection in Bangladeshi patients. American Journal of Microbiological Research. 2016;4(4):122-5.
32. Lakshmi K, Aishwarya J. R, Sharanya K, Sindhu Cugati, Chitralekha S. Prevalence and antibiotic susceptibility pattern of Escherichia coli isolated from urine samples in patients attending a tertiary care hospital, Chennai. Pathology Updare: Trop J Path Micro 2017;3(4):376-381.doi:10.17511/jopm.2017.i4.03.
33. Sabir S, Anjum AA, Ijaz T, Ali MA, Nawaz M. Isolation and antibiotic susceptibility of E. coli from urinary tract infections in a tertiary care hospital. Pakistan journal of medical sciences. 2014 Mar;30(2):389.