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Original Article

Changing Trends in Antibiotic Sensitivity of Urinary Tract Infections by *Escherichia coli* at a Tertiary Care Hospital

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Abstract

Background: Urinary tract infection (UTI) is one of the most common causes of bacterial infections worldwide. Rising antibiotic resistance among urinary pathogens to commonly prescribed antibiotics has become a significant therapeutic challenge. **Objective:** Our study aims to investigate the patterns of antibacterial susceptibility in E. coli among patients residing in the densely populated industrial area of Gazipur, Bangladesh. Methodology: This cross-sectional study was conducted in the Department of Microbiology at Tairunnessa Memorial Medical College, Gazipur, Bangladesh from July 2023 to January 2024. The study included 100 adult patients admitted to the Medicine Indoor Department with confirmed UTI, based on clinical symptoms, signs, supportive investigations, and urine culture results (positive or negative). **Results:** Urine samples were taken several times from the 100 patients. Among the 1000 urine samples analyzed, 256 tested positive for pathogenic organisms. Escherichia coli was isolated in 128(50.0%) of the positive samples, followed by Klebsiella species (28.0%,), Pseudomonas species (13.7%), Enterococcus species (5.5%) and Proteus species (2.8%). Escherichia coli exhibited the highest sensitivity to nitrofurantoin (92.5%), meropenem (92.5%), amikacin (84.6%), and gentamicin (71.8%). However, it showed resistance to commonly used antibiotics such as cefixime (78%), cefuroxime (77.5%), ciprofloxacin (62.5%) and ceftriaxone (62.5%). **Conclusions:** Gram-negative bacilli were identified as the primary causative agents of UTI, with Escherichia coli being the most prevalent pathogen. The most effective antibiotics were nitrofurantoin, meropenem, amikacin, and gentamicin. In contrast, frequently prescribed antibiotics like cefixime, cefuroxime, cotrimoxazole, ciprofloxacin, and ceftriaxone demonstrated high resistance rates against E. coli.

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Introduction

Urinary tract infections (UTIs) are common conditions primarily caused by the ascent of normal intestinal bacteria through the urethra into the bladder. UTIs can affect any part of the urinary system, including the urethra, ureters, bladder, and kidneys, triggering an inflammatory response in the urothelium due to invading pathogens[1]. Women face a high lifetime risk of developing cystitis, estimated at 60.0%, whereas men have a lower risk of only 13% cases[2]. Approximately 3.0% of girls and 1.0% of boys

experience at least one UTI episode before the age of 11 years[3]. The main bacterial culprits behind UTIs include Escherichia coli, responsible for 80.0% of cases, along with Klebsiella pneumoniae, Citrobacter species, Enterobacter species, Pseudomonas aeruginosa and various Staphylococcus species[4-5].

While antibiotics play a crucial role in treating UTIs, their overuse and misuse contribute significantly to the development of resistance among uropathogenic bacteria[6-7]. In hospitals, a substantial percentage, ranging from 20.0% to 50.0%, of prescribed antibiotics are unnecessary or inappropriate[8]. Globally, there is a troubling rise in UTIs caused by multidrug-resistant uropathogens, posing severe health risks, particularly in developing nations[9-10]. Recent studies have highlighted that over 75.0% of Escherichia coli strains causing UTIs are resistant to third-generation cephalosporins[11]. It is imperative to closely monitor infection etiology and antibiotic resistance patterns to ensure appropriate antibiotic selection for empirical therapy and to combat the overuse and misuse of antibiotics.

Methodology

Study Settings and Population: This cross-sectional study was conducted at Tairunnessa Memorial Medical College, Gazipur, Bangladesh from July 2023 to January 2024. Data were collected from 100 patients aged 18 to 75 years through purposive sampling technique and samples were taken several times from each patient. A total of 1000 clean catch-midstream urine samples were collected from inpatients suspected of having UTI. Samples were subjected to Gram staining, microscopic identification, colony morphology identification, and biochemical tests following the Clinical Laboratory Standard Institute (CLSI) procedures[12].

Selection Criteria: Patients diagnosed clinically with UTI based on symptoms such as fever, dysuria, and increased frequency of urination were included in the study. Patients receiving antibiotic therapy within one week prior to sample collection were excluded.

Sample Collection Procedure: Urine samples were collected in sterile containers and transported to the laboratory within thirty minutes. Upon arrival, samples were stored at 4°C until further processing and analysis.

Culture Specimen: All specimens were cultured on HiCrome UTI Agar media (HiMedia Laboratory Pvt Ltd, India), blood agar, and MacConkey's agar media. A wire loop with 0.001 mL of urine was used for inoculation, followed by aerobic incubation at 37°C for 24 hours. Urine cultures with colony counts ≥ 10^5 CFU/ml were considered as positive for significant growth. Gram staining was performed on significant single colonies, and further identification was carried out using biochemical tests such as Indole, Citrate Utilization, and Triple Sugar Iron (TSI).

Antimicrobial Sensitivity Testing: Antimicrobial sensitivity testing was conducted using the Kirby-Bauer disc diffusion method. Interpretation of sensitivity (Sensitive or Resistant) was based on the diameters of zones of inhibition of bacterial growth according to disc manufacturer recommendations. The antibiotics tested for sensitivity included Ceftriaxone, Ciprofloxacin, Cefixime, Cefuroxime, Amikacin, Imipenem, Gentamicin, Nitrofurantoin, and Amoxicillin. Demographic data and antibiotic sensitivity profiles were recorded and analyzed for the six-month study period.

Statistical Analysis: Findings were recorded and analysed. Collected data were checked and edited first and processed with the help of the software Statistical Package for Social Sciences (SPSS) version 21 and analysed. Statistical analyses were done by using appropriate statistical tools. Qualitative data were expressed as frequency and percent.

Ethical Clearance: Ethical clearance was given from Head of the department of Microbiology of Tairunnessa Memorial Medical College, Gazipur, Bangladesh.

Results

A total of 1000 urine samples were cultured, 256 samples showed significant growth, whereas majority of the samples showed no growth. This study determines the antibiotic susceptibility of 128 isolates of E. coli from 256 positive urine culture and their sensitivity pattern pertaining to a period of 06 months (July 2023 to January 2024) were analyzed. We noted that UTI was more common in females 65.6% than males 34.4% cases (Table 1).

Table 1: Distribution of Study Patients by Gender

Gender	Frequency	Percent
Male	88	34.4
Female	168	65.6
Total	256	100.0

Among the study population mean age was 33 years (Table 2).

Table 2: Distribution of Study Patients by Age Group

Age	Values
Mean	33.039
Std. Deviation	16.5206
Minimum	0.9
Maximum	85.0

Among the study population the most frequent causative organisms isolated were Escherichia coli 50% followed by, Klebsiella 28% Pseudomonas 13.7%, Enterococcus species 5.5% and Proteus 2.8% (Table 3).

Table 3: Microbiological Pattern of UTI Patients

Traits	Frequency	Percent
Escherichia coli	128	50
Klebsiella	72	28
Pseudomonas	35	13.7
Enterococcus	14	5.5
Proteus	7	2.8

Escherichia coli was found to be most sensitive to nitrofurantoin (92.5%), meropenem (92.5%), amikacin (84.6%) and gentamycin (71.8%) and resistant to most commonly used drugs like cefixime (78.0%), cefuroxime (77.5%), ciprofloxacin (62.5%), ceftriaxone (62.5%). All organisms are mostly sensitive to nitrofurantoin (86.2%), meropenem (93.1%), amikacin (77.2%), and gentamycin (64.9%) and mostly resistant to cefixime (83.3%), cefuroxime (81.4%), and ceftriaxone (66.9%) (Table 4).

Table 4: Antibiotic Sensitivity Pattern of Escherichia coli

Antibiotics	Sensitive	Resistant
Amoxicillin	58.6%	42.4%
Levofloxacin	47.2%	52.8%
Cefixime	22%	78.0%
Cotrimoxazole	40.5%	59.5%
Cefuroxime	22.5%	77.5%
Nitrofurantoin	92.5%	7.5%
Ciprofloxacin	37.5%	62.5%
Ceftriaxone	37.5%	62.5%
Meropenem	92.5%	7.5%
Amikacin	84.6%	15.4%
Gentamycin	71.8%	28.2%

Discussion

Urinary tract infections (UTIs) represent a major clinical challenge in both community and healthcare settings. Epidemiological data indicate that UTIs contribute to approximately seven million outpatient visits and one million emergency department admissions annually in the United States, with 100,000 cases requiring hospitalization, positioning them among the leading causes of bacterial infections in ambulatory care[13]. The economic burden is equally substantial, with yearly costs estimated at $1.6 billion[13].

The study revealed that females (65.6%) were more susceptible to UTI than males (34.4%), which is also like other studies[14,15]. The increased incidence of the urinary tract infection in women is conditioned by favoring anatomic factors, by hormonal changes and by the urodynamic disturbance occurring with age[16].

The predominant number of pathogens isolated in our study were Gram negative bacilli rather than Gram positive pathogens. Bacteriological studies usually reveal the involvement of Gram-negative enteric organisms that commonly cause UTI, such as *E. coli, Klebsiella* species and *Proteus* species[17]. Similarly, in another study, the most predominant pathogens isolated from UTI were Gram negative bacilli[18]. The higher prevalence of Gram-negative enteric organisms in UTI cases may be due to the better chances of these organisms getting access to urinary tract from the intestine where they inhabit as normal flora. In our study, majority of isolated bacteria were also the Gram-negative *Escherichia coli* 50.0%, and Klebsiella 28.0% and *Pseudomonas* 13.7% and Gram-positive *Enterococcus* species 5.5% isolates. Our study, along with previous studies, shows that *E. coli* is the predominant etiology of UTI[19,20,21].

Antimicrobial resistance patterns demonstrate significant geographical and temporal variability[22]. In this study, *Escherichia coli* isolates showed high sensitivity to nitrofurantoin (92.5%), meropenem (92.5%), and amikacin (84.6%), but substantial resistance to first-line agents like cefixime (78.0%) and ciprofloxacin (62.5%). These findings mirror a Bangladesh-based study reporting efficacy of imipenem and amikacin against uropathogens as well as Philippine data highlighting amikacin sensitivity[23-25]. Notably, resistance patterns in high-income countries with stricter antimicrobial stewardship differ, with stable susceptibility profiles despite rising *Escherichia coli* and ESBL prevalence[24].

Aggregate antimicrobial susceptibility analysis revealed high resistance to amoxicillin (52.0%), cotrimoxazole (66.9%), and third-generation cephalosporins (68.9 to 83.3%), consistent with prior Bangladeshi research[25]. Conversely, meropenem (93.1%), nitrofurantoin (86.2%), and amikacin (77.2%) demonstrated robust efficacy, aligning with observations from a Saudi Arabian tertiary care center[26]. These findings underscore the need for region-specific antibiotic stewardship to optimize empirical therapy.

Conclusion

UTI among female is more prevalent and the most predominant pathogen was E-coli. Most effective antimicrobial agents for *E coli* are nitrofurantoin,

meropenem, amikacin and gentamycin. It is resistant to most commonly used drugs like cefixime, cefuroxime, ciprofloxacin, levofloxacin and ceftriaxone. Therefore, the choice of antibiotic therapy should integrate the local sensitivity pattern of the infecting organisms. Periodic evaluations of predominant organisms and their antibiotic susceptibility pattern are essential as it is changing over.

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