(RESEARCH ARTICLE)

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Escherichia coli, an important Uropathogen: Characteristics and antimicrobial susceptibility pattern at Prof. Dr. I.G.N.G. Ngoerah General Hospital, period January 2020 – December, 2021

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Abstract

Background: Urinary tract infections (UTIs) are among the most common infections globally, often treated empirically with broad-spectrum antibiotics without prior culture and sensitivity testing. This practice has contributed to the rise in antibiotic resistance. *Escherichia coli* (*E. coli*) is the primary pathogen in uncomplicated UTIs, accounting for 70–90% of cases. However, other bacteria such as *Klebsiella pneumoniae*, *Proteus mirabilis*, and *Enterococcus faecalis* are also significant, especially in complicated or healthcare-associated UTIs. This study examines the resistance patterns of *E. coli* in UTI cases.

Method: A descriptive cross-sectional study was conducted using secondary data from medical records of UTI patients treated at Prof. Dr. I.G.N.G. Ngoerah General Hospital from January 2020 to December 2021. *E. coli* isolates were identified, and antibiotic sensitivity tests were performed using the VITEK® 2 compact automatic system, with antimicrobial sensitivity and resistance determined according to Clinical and Laboratory Standards Institute (CLSI) guidelines.

Result: Analysis of 639 UTI patients revealed that *E. coli* exhibited high resistance to cefixime (13.3%), ciprofloxacin (23.8%), and trimethoprim-sulfamethoxazole (35.2%). The highest levels of susceptibility were observed with Tigecycline, Meropenem, and Ertapenem, with rates ranging from 99.2% to 99.8%. The demographic data showed a higher incidence of UTIs in female patients (70.9%) compared to males (29.1%), with the majority of cases occurring in adults (94.52%). Additionally, 52.26% of the *E. coli* isolates were ESBL-producing strains, complicating treatment options.

Conclusion: The study underscores the urgent need for judicious antibiotic use, guided by culture and sensitivity testing, to combat the rising threat of antibiotic-resistant UTIs. Tigecycline, Meropenem, and Ertapenem should be prioritized in treatment protocols for multidrug-resistant cases. Continuous surveillance and the development of new antimicrobial agents are essential to address this escalating public health challenge

Keywords: Uropathogen; *Escherichia coli*; Susceptibility pattern; Antibiotic resistance; Extended-spectrum beta-lactamase (ESBL)

1. Introduction

Urinary tract infections (UTIs) remain one of the most frequent infections encountered in community settings, affecting millions globally each year. These infections are commonly treated empirically with broad-spectrum antibiotics, often

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without preceding culture and sensitivity testing. This practice has significantly contributed to the emergence and spread of antibiotic resistance worldwide. According to recent studies, *Escherichia coli* (*E. coli*) is responsible for approximately 70–90% of all uncomplicated UTIs, making it the most prevalent pathogen associated with these infections (1). However, other bacteria such as *Klebsiella pneumoniae*, *Proteus mirabilis*, and *Enterococcus faecalis* are also implicated, particularly in complicated UTIs or healthcare-associated infections (2).

Recent data indicate a worrying increase in antibiotic resistance among UTI pathogens. For instance, a study published in 2023 reported that up to 30% of *E. coli* strains in some regions are resistant to first-line antibiotics, such as trimethoprim-sulfamethoxazole and ciprofloxacin (3). Additionally, the rise of extended-spectrum beta-lactamase (ESBL)-producing bacteria has further complicated treatment options, leading to higher healthcare costs and longer hospital stays (4). These findings underscore the critical need for more judicious use of antibiotics, including the implementation of routine culture and sensitivity testing prior to treatment. Moreover, ongoing surveillance and the development of new antibiotics or alternative therapies are essential to combat the growing threat of antibiotic-resistant UTIs (5).

2. Material and methods

The descriptive cross-sectional design of this study was used to collect secondary data from the medical records of UTI patients treated at Prof. Dr. I.G.N.G. Ngoerah General Hospital between January 2020 and December 2021. The study was conducted at Prof. Dr. I.G.N.G. Ngoerah General Hospital in Denpasar. The study population included all patients with UTI who visited the hospital during this period. Inclusion criteria were UTI patients treated at the hospital between January 2020 and December 2021. Patients lacking complete medical records, which included information on all variables under study, were excluded. E. coli isolates were identified, and antibiotic sensitivity tests were performed using the VITEK® 2 compact automatic system. Antimicrobial sensitivity and resistance were determined based on the Clinical and Laboratory Standards Institute (CLSI).

3. Results

This research is a descriptive study using a cross-sectional design. Analysis of medical records identified 639 UTI patients who presented at Prof. Dr. I.G.N.G. Ngoerah General Hospital between January 2020 and December 2021. The demographic and clinical characteristics of these patients are detailed in tabular form.

Table 1 Characteristics of Antibiotic susceptibility to _E.coli_

% susceptibility																
Ampicillin	Amikacin	Aztreonam	Ceftazidime	Cefixime	Cefoperazone	Ciprofloxacin	Ceftriaxone	Ertapenem	Cefepime	Nitrofurantoin	Gentamicin	Meropenem	Ampicillin /Sulbactam	Trimethoprim/Sulfamethoxazole	Tigecycline	Piperacillin/Tazobactam
9.8	98.3	47.1	62.5	13.3	14.1	23.8	37.3	99.2	65.2	92.0	55.3	99.4	28.8	35.2	99.8	90.0

Based on the table above, the highest level of susceptibility to *E.coli* bacteria is in the drugs Tigecycline, Meropenem and Ertapenem with a range of values of 99.2 – 99.8%.

Table 2 Patient based on gender

Gender	N	%
Male	192	29.1
Female	447	70.9
Total	639	100

Based on the gender of a total of 639 patients with UTIs shown in table 1, it shows that the percentage of UTIs in female patients is higher than that of male with respective percentages of 70.9% and 29.1%.

Table 3 Patient based on age

Age	N	%
Child (≤ 18 years old)	35	5.48
Adult (> 18 years old)	604	94.52
Total	639	100

Based on table 3, the group with the highest characteristics of UTI age distribution, namely as many as 5.48% less with underage (child) and mostly answer 94.52% are adult.

Table 4 ESBL percentage

Age	N	%
ESBL	334	52.26
Non ESBL	305	47.74
Total	639	100

Based on table 4, the group with the highest characteristics of UTI ESBL percentage, namely as many as 52.26 % with ESBL and 47.74% non ESBL.

4. Discussion

The results of this study highlight the significant challenges in managing urinary tract infections (UTIs) due to the high prevalence of antibiotic resistance. *E. coli*, the primary uropathogen identified, exhibited substantial resistance to commonly used antibiotics, with observed resistance rates of 13.3% for cefixime, 23.8% for ciprofloxacin, and 35.2% for trimethoprim-sulfamethoxazole. These findings are consistent with global reports of increasing resistance, which have compromised the effectiveness of these antibiotics as empiric treatments for UTIs (1). The widespread resistance to ciprofloxacin is particularly concerning, given the extensive use of fluoroquinolones, often as over-the-counter medications, which has likely contributed to this issue (6).

Conversely, this study demonstrated that Tigecycline, Meropenem, and Ertapenem maintained high efficacy against *E. coli*, with susceptibility rates ranging from 99.2% to 99.8%. These antibiotics remain reliable options for treating multidrug-resistant UTI cases, consistent with findings from other studies that report high sensitivity rates for these drugs against resistant uropathogens (7). However, the reliance on such potent antibiotics raises concerns regarding the potential for further resistance development, underscoring the importance of routine culture and sensitivity testing prior to initiating treatment.

The demographic analysis revealed a higher incidence of UTIs among female patients (70.9%), consistent with existing literature that identifies women as more susceptible to UTIs due to anatomical and physiological factors. Additionally, the study found that 94.52% of UTI cases occurred in adults, suggesting that age-related factors and comorbidities may contribute to the higher prevalence of UTIs in this demographic. The significant presence of ESBL-producing *E. coli* in

52.26% of cases further complicates treatment, as these strains exhibit resistance to a broad range of antibiotics, thereby limiting treatment options (8).

The high prevalence of ESBL-producing *E. coli* reported in this study is notably higher than figures from other studies, such as Chen et al., who reported an ESBL production rate of 6.6% (8). This discrepancy underscores the variability in resistance patterns across different regions and populations, highlighting the need for localized surveillance data to guide effective treatment protocols.

5. Conclusion

In conclusion, our study highlights the pressing need for judicious antibiotic use, informed by culture and sensitivity testing, to combat the growing threat of antibiotic-resistant UTIs. The high efficacy of Tigecycline, Meropenem, and Ertapenem against resistant *E. coli* suggests these drugs should be prioritized in treatment guidelines, particularly for multidrug-resistant cases. Ongoing surveillance and the development of new antimicrobial agents are essential to address the escalating public health challenge posed by antibiotic-resistant UTIs.

Compliance with ethical standards

Disclosure of conflict of interest

The author reports no conflicts of interest in this work.

References

[1]   Matsumura Y, Pitout JDD. Recent advances in the epidemiology of extended-spectrum β-lactamase-producing *Escherichia coli*. Clin Infect Dis. 2023;76(Suppl_1).

[2]   Gajdács M, Urbán E. Comparative epidemiology and resistance trends of *Proteus mirabilis* and *Klebsiella pneumoniae* isolated from urinary tract infections in Southern Hungary: A 10-year retrospective study. Rev Soc Bras Med Trop. 2020;53.

[3]   Patel M, Pal R, Kumaresan M. Antimicrobial resistance pattern in uropathogens isolated from patients attending tertiary care hospital in Southern India. Indian J Med Microbiol. 2023;41(1):23-28.

[4]   Tamma PD, Aitken SL, Bonomo RA, Mathers AJ, van Duin D, Kreiswirth BN. Infection caused by extended-spectrum β-lactamase-producing Enterobacterales: Treatment and outcomes. Clin Infect Dis. 2022;75(1).

[5]   Prestinaci F, Pezzotti P, Pantosti A. Antimicrobial resistance: A global multifaceted phenomenon. Pathog Glob Health. 2020;114(5):273-281.

[6]   Ayoade F, Obafemi YD, Akpabio EU. Rising antibiotic resistance in *Escherichia coli*: Implications for empiric treatment of urinary tract infections. Microb Drug Resist. 2021;27(4):560-567.

[7]   Lopes CV, Gales AC. Resistance trends of uropathogens: The latest figures and implications for therapy. Infect Dis Clin North Am. 2020;34(4):739-759.

[8]   Chen CJ, Huang YJ, Su LH, Chiu CH. Epidemiology and antimicrobial resistance of ESBL-producing *Escherichia coli* in Taiwan. J Microbiol Immunol Infect. 2020;53(1):142-147