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Original article

Assessment of Antibiotic Resistance in *Escherichia coli*

Mohammed Amhimmid*, Esra Mohammed, Aml Alateleb, Nora Albahry, Ateka Mohammed, Fatima Almouri, Aisha Althaeb, Amani Amlek, Taha Elkhedrawe

Faculty of Medical Technology-Surman, Sabratha University, Sabratha, Libya.
***Correspondence email**. mohammed.amhimmid@sabu.edu.ly*

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Escherichia coli, Urinary Tract Infections, and Antimicrobial Resistance.

A B S T R A C T

Escherichia coli is the most common cause of urinary tract infections (UTIs) and has shown increasing resistance to widely used antibiotics. Resistance assessment is crucial for guiding clinical therapies and public health measures. This cross-sectional study was conducted on 30 *E. coli* isolates obtained from urine samples of patients attending clinics. Antimicrobial susceptibility testing was performed against 10 commonly prescribed antibiotics using the disk diffusion test. High resistance was detected to azithromycin and fusidic acid (70% each) and to amoxicillin (66.6%). Cefotaxime (30%) and amikacin (50%) showed significant resistance. Ciprofloxacin (16.6%), levofloxacin and ceftriaxone (13.3% each), and meropenem (3.3%) showed lower levels of resistance. The most sensitive antibiotics were levofloxacin (86.7%), ceftriaxone (86.7%), and meropenem (96.7%). *E. coli* isolates exhibited considerable resistance to several commonly used antibiotics, particularly azithromycin, fusidic acid, and amoxicillin. However, meropenem and third-generation cephalosporins retained strong activity. These findings underscore the importance of ongoing antimicrobial resistance surveillance and rational antibiotic prescribing to maintain treatment efficacy.

Introduction

Escherichia coli (*E. coli*), a member of the Enterobacteriaceae family, is a well-known commensal bacterium but also includes several pathogenic strains capable of causing disease [1,2]. Through the virulence factors, certain strains can adapt to diverse environments and cause a wide range of infections. Among these, urinary tract infections (UTIs) are the most common, with *E. coli* responsible for more than 80% of cases worldwide [3,4]. Antibiotics such as β-lactams, trimethoprim, and nitrofurantoin remain the standard treatment for uncomplicated UTIs, while fluoroquinolones are widely prescribed for both uncomplicated and complicated infections [5,6]. However, *E. coli* has demonstrated a remarkable capacity to develop resistance across multiple antibiotic classes, posing a major challenge to effective treatment [5,7]. This problem has been compounded by the misuse of antibiotics and the decline in the discovery of new antimicrobial agents, accelerating the emergence and spread of resistance [1,4].

Global surveillance studies have documented increasing rates of antimicrobial resistance (AMR) in *E. coli*, including multidrug-resistant (MDR) strains [8]. Developed countries have implemented AMR surveillance systems that provide essential data to guide treatment protocols and public health strategies. In contrast, data from low- and middle-income countries remain limited, despite evidence suggesting a growing burden of resistance [9,10]. Despite a high rate of UTIs and the widespread use of oral antibiotic therapy, little is known about the *E. coli* resistance in Libya. Therefore, local surveillance is crucial to enhance antimicrobial management, prevent treatment failure, and inform treatment guidelines. The present study aims to evaluate the antibiotic resistance profile of *E. coli* isolates from patients, providing possible data to support local AMR assessment and therapeutic choices.

Methods

The study was conducted on patients from a clinic in western Libya between October 2024 and January 2025. Urine culture samples were obtained from patients who reported UTI symptoms, as well as a positive urine identification culture for *E. coli* (10*5 CFU/mL). A total of 30 samples were tested for 10 antibiotic susceptibility tests. The tested antibiotics: Amikacin 30mg, Amoxicillin 30mg, Azithromycin 15mg, Cefotaxime 30mg, Ceftriaxone 5mg, Cinoxacin, Ciprofloxacin 30mg, Fusidic acid 10 mg, Levofloxacin, and Meropenem 10mg.

Data presentation and statistical analysis

Graph Pad Prism 9.4.1 software, 2022 U.S.A. was used analyse the data.

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Ethical considerations

Ethical approval for this study was obtained from the main management of the clinic under investigation at Sabratha University, Libya.

Results

Among the 30 *E. coli* isolates obtained from patients, high resistance was observed to azithromycin and fusidic acid, with 21/30 isolates (70%) resistant to each. Resistance to amoxicillin was detected in 20/30 isolates (66.6%), while 15/30 (50%) were resistant to amikacin, and cefotaxime resistance was detected in 9/30 isolates (30%). Lower resistance rates were recorded for ceftriaxone and levofloxacin (4/30; 13.3% each), ciprofloxacin (5/30; 16.6%), and cinoxacin (7/30; 23.3%). Meropenem exhibited the lowest resistance, with only 1/30 isolates (3.3%) affected. In terms of sensitivity, meropenem showed the highest effectiveness (29/30; 96.7%), followed by ceftriaxone and levofloxacin (26/30; 86.7% each), and ciprofloxacin (25/30; 83.4%). Cinoxacin also demonstrated relatively high sensitivity (23/30; 76.7%). Cefotaxime was effective in 21/30 isolates (70%). Amikacin displayed a balanced profile, with 15/30 (50%) sensitive isolates. In contrast, low sensitivity was observed for azithromycin (9/30; 30%), fusidic acid (9/30; 30%), and amoxicillin (10/30; 33.4%), indicating limited therapeutic potential of these agents against the isolates (Table 1, Fig. 1).

Table 1. Resistance and Sensitivity of E. coli Isolates. Total number (n) = 30

Antibiotic	Number of isolates	Resistant (%)	Number of isolates	Sensitive (%)
Amikacin	15	50 %	15	50%
Amoxicillin	20	66.6 %	10	33.4%
Azithromycin	21	70 %	9	30 %
Cefotaxime	9	30 %	21	70%
Ceftriaxone	4	13.3%	26	86.7%
Cinoxacin	7	23.%	23	76.7%
Ciprofloxacin	5	16%	25	83.4
Fusidic acid	21	70%	9	30 %
Levofloxacin	4	13.3%	26	86.7%
Meropenem	1	3.1%	29	96.7%

Discussion

The present study assessed the antimicrobial resistance profile of *E. coli* isolates obtained from patients. In the present study, 50% of the *E. coli* isolates were resistant to amikacin, which contrasts with findings from several other studies where amikacin retained higher levels of activity against *E. coli*. For instance, one report demonstrated that more than 90% of *E. coli* strains (n = 188) were susceptible to amikacin in vitro [11]. Similarly, another study reported no resistance to amikacin among a total of 215 isolates [12]. This difference may be explained by several factors, including differences in dosing practices and variation of resistance genes within bacterial isolations. High levels of resistance were observed to azithromycin and fusidic acid (70% each), as well as to amoxicillin (66.6%). There is very little information on azithromycin resistance in *E. coli* [13]. Fusidic acid is active against *E. coli* but does not have significant activity against Gram-negative bacteria [14]. For example, among the above 200 *E. coli* isolates, almost 37% were resistant to amoxicillin [12]. Thirty percent of the *E. coli* isolates in this investigation were resistant to cefotaxime, while a lower resistance rate was observed for ceftriaxone, within13.3%. The susceptibility levels to cefotaxime and ceftriaxone reported in this study are in line with previous findings, where similar resistance and susceptibility rates were documented [11]. In contrast, another report demonstrated resistance rates exceeding 62% for ceftriaxone among 215 isolates [12]. Since cefotaxime and ceftriaxone are third-generation cephalosporins commonly used in the treatment of serious infections [15], the detection of resistance to these antibiotics could be clinically significant. Ciprofloxacin resistance was detected in 16% of the *E. coli* isolates, while resistance to levofloxacin and meropenem was observed in 13.3% and 3.1% of isolates, respectively. Other studies have reported higher susceptibility rates, with ciprofloxacin and levofloxacin showing over 30% susceptibility and meropenem nearly 99% susceptibility [11]. Consistently, meropenem demonstrated the highest effectiveness against *E. coli* in the present study. However, another study documented a resistance rate exceeding 65% for ciprofloxacin and levofloxacin among more than 200 isolates, while resistance to meropenem remained below 1% [12]. Although meropenem appears to retain strong activity, continuous surveillance is essential to preserve its efficacy and to detect emerging resistance at an early stage.

Limitations

This study was conducted over a limited period of four months, which may not fully reflect the long-term examination of antibiotic resistance rates. In addition, several practical challenges were faced. The high cost

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of culture media and antibiotics limited the scope of examination, while limited laboratory equipment posed difficulties in performing certain experiments. Furthermore, access to bacterial isolates was restricted, reducing the number of samples available for analysis. These limitations may have influenced the comprehensiveness of the findings and highlight the need for larger, longer-term, and better-resourced studies in the future.

Conclusion

This study highlights the high resistance of *E. coli* isolates to commonly used antibiotics such as azithromycin, fusidic acid, and amoxicillin, while showing strong sensitivity to meropenem, levofloxacin, and ceftriaxone. These findings highlight the need for continuous antimicrobial resistance surveillance and rational antibiotic use to guide effective treatment strategies and limit the spread of multidrug-resistant *E. coli*. Whole-genome sequencing of these isolates is recommended, as it may reveal a wide range of resistance genes and provide a deeper understanding of the mechanisms of antimicrobial resistance.

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Conflicts of Interest

The authors declare no conflicts of interest.

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