



Clinical Isolation and Antibiotic Resistance Assessment of *Escherichia coli* from Urinary Tract Infections in Khanaqin of Iraq

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Abstract

Background: Urinary tract infections can be considered as one of the most common infectious diseases, with *Escherichia coli* being the leading causative organism for these infections. **Objective:** The objective of this study was to determine the antibiotic resistance profile of *Escherichia coli* isolated from patients admitted to hospitals in Khanaqin city of Iraq. **Methodology:** This cross-sectional study involved 100 urine culture specimens that were collected from patients during November 2025 to April 2026 in medical laboratories of Khanaqin, Iraq. The urine cultures and their sensitivity patterns were analyzed according to the standards set by CLSI. Data analysis was done using descriptive and inferential statistics such as the chi-square test through Stata version 20, at 5.0% significance level. **Results:** The average age of the subjects who were infected with *Escherichia coli* was 48.3 years; age ranged between 1 and 70 years. The most prevalent age for males and females, respectively, was over 40 years and 41-60 years. Furthermore, cephalexin (CN) had the highest resistance, while cefazolin (CZ) had the highest sensitivity towards antibiotics. **Conclusion:** In conclusion, there is a high level of resistance in *Escherichia coli* isolates. It is imperative that antibiotic resistance be detected at an early stage, and appropriate infection control strategies applied. [Bangladesh Journal of Infectious Diseases, June 2026; 13(1):341-347]

Keywords: Pattern of antimicrobial resistance; *Escherichia coli*; urinary tract infection

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Introduction

Infections of the urinary tract are common and significant types of infection which affect persons of all ages. Failure in proper management leads to complications such as urinary abnormalities, high blood pressure, uremia, and miscarriages in expectant mothers. In the US, UTIs are some of the most common types of infection, second only to infections of the upper respiratory tract. An annual visit by more than 8 million patients to physicians in the United States is noted, with a significant portion of urinary tract infections being asymptomatic². A significant number of research studies done on

different communities indicate that the most common causes of UTIs are Gram-negative bacteria, with over 80.0% of the causative agents being *Escherichia coli*³. The organism is considered the commonest cause of UTIs in men and women of all age ranges⁴. Once UTIs have been diagnosed and the causative agents identified, it is often recommended that an antibiotic sensitivity test be done before starting any treatment⁵.

Management of UTIs calls for the use of an antibiotic that is efficient and at the same time cost-effective. The most difficult problem in the treatment of UTIs due to *Escherichia coli* lies in the

resistance of the bacteria to various antibiotics that are frequently used. At the same time, the development of AMR is always followed by high antibiotic use^{6,7}. The development and dissemination of antibiotic-resistant bacterial strains are typically attributed to bacterial genetic traits, proliferating populations, global mobility, and overuse of antibiotics⁸. With an increase in antibiotic resistance within different types of bacteria and its importance as a health issue, it is crucial to describe the antibiotic resistance pattern in the prevalent pathogenic bacteria. Therefore, this experiment was done to detect the antibiotic resistance/susceptibility pattern in *Escherichia coli* bacteria causing urinary tract infection in the city of Khanaqin in Iraq.

Methodology

Study Design and Settings: This cross-sectional study was conducted in the Department of Microbiology in the Faculty of Basic Sciences of Razi University, Kermanshah, Iran, to investigate the antibiotic susceptibility patterns of *Escherichia coli* isolated from patients with symptomatic urinary tract infections (UTIs). The study was carried out in Khanaqin, Iraq. The study was conducted over five months, from November 2025 to April 2026.

Sample Collection Site: Clinical specimens were collected from patients attending selected teaching hospitals in Khanaqin, Iraq. Microbiological analyses, bacterial identification, and antibiotic susceptibility testing were performed in the microbiology laboratory according to standard microbiological procedures.

Sample Collection: A total of 100 non-duplicate *Escherichia coli* isolates were prospectively collected from urine samples obtained from patients diagnosed with symptomatic urinary tract infections. Inclusion criteria consisted of urine cultures yielding bacterial growth of $\geq 10^5$ CFU/mL together with clinical manifestations consistent with the Centers for Disease Control and Prevention (CDC) definition of urinary tract infection. Immediately after collection, urine samples were inoculated onto Blood Agar and MacConkey Agar (Merck, Germany) and incubated aerobically at 37°C for 18 to 24 hours.

Identification of Isolates: Preliminary identification of *E. coli* isolates was based on colony morphology, including large, flat colonies with irregular margins, gas production, and the appearance of a characteristic metallic sheen on Eosin Methylene Blue (EMB) agar. Final identification was confirmed using standard

biochemical tests, including catalase test positive, oxidase test negative, motility test in sim medium positive, and indole production test positive. Triple Sugar Iron (TSI) agar reaction was Acid/Acid (A/A) with gas production and no H₂S production. Confirmed isolates were preserved in Tryptic Soy Broth (TSB) supplemented with 20.0% glycerol and stored at -70°C until further analysis.

Antibiotic Susceptibility Testing: Antimicrobial susceptibility testing was performed using the Kirby–Bauer disk diffusion method on Mueller–Hinton Agar (MHA) (Merck, Germany) according to the Clinical and Laboratory Standards Institute (CLSI, 2024) guidelines. Three commonly prescribed antibiotics (MAST Diagnostics, UK) were evaluated: Cephalexin (30 µg), Gentamicin (10 µg) and Cefazolin (10 µg). Bacterial suspensions were adjusted to a turbidity equivalent to 0.5 McFarland standard (approximately 1.5×10^8 CFU/mL) and uniformly spread on MHA plates. Antibiotic discs were applied to the agar surface, and plates were incubated at 35°C for 18 to 24 hours. The diameters of inhibition zones were measured using a calibrated ruler or caliper and interpreted according to CLSI breakpoints. Isolates were classified as susceptible (S), intermediate (I), or resistant (R).

Quality Control: *Escherichia coli* ATCC 25922 was used as a quality control strain throughout the study.

Statistical Analysis: Data were entered and analyzed using the Statistical Package for the Social Sciences (SPSS) version 20 (IBM Corporation, USA). Descriptive statistics, including frequencies, percentages, and means, were used to summarize demographic characteristics and antibiotic resistance patterns. The Chi-square test was applied to compare resistance frequencies among different groups, such as gender and hospital wards. Fisher's Exact Test was used whenever the expected cell count was less than five. Statistical significance was considered at a p-value < 0.05.

Ethical Consideration: All procedures of the present study were carried out in accordance with the principles for human investigations (i.e., Helsinki Declaration 2013) and also with the ethical guidelines of the Institutional Research Ethics Committee. Formal ethics approval was granted by the local ethics committee. Participants in the study were informed about the procedure and purpose of the study and the confidentiality of information provided. All participants consented willingly to be a part of the study during the data collection periods. All data were collected anonymously and were analyzed using the coding system.

Results

A total of 100 non-repeated isolates of *Escherichia coli* were studied in this research. Of these, 60(60.0%) isolates were isolated from female samples and 40(40.0%) isolates from male samples. Although there was a higher proportion of female patients compared to males, statistical analysis using the chi-square goodness-of-fit test indicated that this difference was statistically significant ($p = 0.028$). This finding suggests that *Escherichia coli* infection occurred more frequently in females within the study population (Table 1).

Table 1: Gender Distribution of Patients with *Escherichia coli* Infection

Gender	Frequency	Percent	P value*
Male	40	40.0	0.028
Female	60	60.0	
Total	100	100.0	

* The chi-square test was employed to calculate p-values, with $p < 0.05$ being considered statistically significant.

The distribution of isolates in different hospital departments was as follows: outpatient department (60 isolates, 60.0%), intensive care unit (ICU) (22 isolates, 22.0%), internal medicine department (10 isolates, 10.0%), and burn department (8 isolates, 8.0%). Statistical analysis showed that there was no significant association between the gender of the patients and the hospital ward from which the isolate was isolated (p -value = 0.18). The chi-square goodness-of-fit test revealed that the distribution of isolates was not uniform across wards ($p < 0.001$), demonstrating a statistically significant difference in the frequency of *Escherichia coli* infections between hospital wards (Table 2).

Table 2. Distribution of Clinical *Escherichia coli* isolates by hospital wards

Ward	Frequency	Percent	P value*
Outpatient	60	60.0	
ICU	22	22.0	0.00
Internal medicine	10	10.0	
Burn	8	8.0	
Total	100	100.0	

*p-values were calculated with a p-value less than 0.05, indicating statistical significance.

Antibiotic Resistance Patterns: The antimicrobial susceptibility of *Escherichia coli* isolates was determined against several antibiotics. Antibiotic susceptibility test results indicated that the greatest resistance was to cefalexin (91, 91.0%) and gentamicin (65, 65.0%). Also, the greatest

sensitivity was associated with cefazolin (43, 43.0%). The results showed the prevalence of sensitive, intermediate, and resistant strains. The data provided a detailed overview of the antimicrobial susceptibility of the *Escherichia coli* isolates to a range of antibiotics. It is clear from the results above that there is great variability in resistance patterns of the bacteria with respect to the antibiotics studied. Cefalexin displayed the highest percentage of resistance at 91.0%. This implies that the medication cannot be considered a treatment for this strain of bacteria since it shows minimal effectiveness. Gentamicin and Cefazolin were also quite resistant, with percentages of 65.0% and 57.0%, respectively. It is therefore evident that the two drugs can no longer be considered for use when treating infections caused by this species in hospitals. From the above results, it is evident that there is widespread resistance to various commonly used antibiotics in the treatment of *Escherichia coli* (Table 3).

Table 2. Distribution of Clinical *Escherichia coli* isolates by hospital wards

Antibiotics	Cefalexin	Gentamicin	Cefazolin
Sensitive	5(5.0%)	15(15.0%)	43(43.0%)
Intermediate	4(4.0%)	20(20.0%)	0(0.0%)
Resistance	91(91.0%)	65(65.0%)	57(57.0%)
Total	100(100.0%)	100(100.0%)	100(100.0%)

Discussion

UTIs are some of the most common infectious diseases in the world, with a prevalence rate of 10.0% to 15.0% cases¹³. The causative organism of UTI is *Escherichia coli*, which accounts for 80 to 90.0% of community-acquired cases and 30 to 50.0% of UTIs in hospitals^{14,15}. However, the development of AMR in *Escherichia coli* urinary isolates has increasingly become a public health issue, making the treatment of UTIs difficult as well as leading to increased stay at hospitals¹⁶. While the prevalence of AMR is not similar everywhere, there have been approximations that AMR will lead to the deaths of more than 10,000 Australians between 2015 and 2050¹⁷. Worldwide, mortality associated with AMR may exceed 10 million by 2050¹⁸.

Antimicrobial resistance (AMR) is a critical worldwide public health concern, threatening the efficacy of life-saving antibiotics and complicating the treatment of common infections¹⁹. The World Health Organization (WHO) and other global bodies have identified AMR as a leading cause of death and disability worldwide, with estimates of millions of

deaths directly attributable to drug-resistant infections²⁰. This crisis is particularly acute in hospital settings, where a high concentration of sick patients, intensive antibiotic use, and the presence of multi-drug resistant (MDR) pathogens create a perfect storm for the emergence and spread of what are known as healthcare-associated infections (HAIs)^{21,22}.

Among the most significant perpetrators of HAIs and community-acquired infections is *Escherichia coli*. While typically a harmless commensal of the human gut flora, certain strains of *E. coli* are opportunistic pathogens that can cause a wide range of extraintestinal illnesses, including urinary tract infections (UTIs), surgical site infections (SSIs), pneumonia, meningitis, and sepsis²³. UTIs, in particular, are the most common bacterial infection globally, with uropathogenic *Escherichia coli* (UPEC) responsible for the vast majority of cases. The clinical importance of *Escherichia coli* is underscored by its adaptability and its remarkable ability to acquire and disseminate antibiotic resistance determinants²⁴. Antibiotic resistance in bacteria is not an isolated phenomenon but involves a series of intricate processes related to genetics and biochemistry. Such mechanisms include degradation of the antibiotic by enzymes (β -lactamase for instance), alteration of the antibiotic target, reduced permeability of the bacterial membrane, and antibiotic efflux via efflux pumps²⁵. One of the main reasons for the existence of drug resistance is the phenomenon of horizontal gene transfer of resistance genes between bacterial cells. This occurs with the help of mobile elements, like plasmids, transposons, and integrons. Plasmids can be considered extrachromosomal DNA that have the capacity to carry multiple resistance genes and spread between bacterial cells²⁶. This feature makes the quick transmission of these resistant bacteria among patients in hospitals and other areas more likely to occur, making the process of infection control and treatment very difficult. The study presents a crucial point of view on the current problem of AMR at a global level, based on a local analysis of 100 *Escherichia coli* samples taken from patients with UTIs in Khanaqin, Iraq. The results show the high frequency of this disease and its occurrence in certain populations and conditions.

Following previous scholarly work, the investigation discovered that *Escherichia coli* is one of the predominant culprits responsible for UTIs in hospitalized patients²⁷⁻²⁹. As predicted, females had the greatest incidence of *Escherichia coli* infection. From demographic data, it can be deduced that middle-aged to elderly males were significantly

susceptible to the infection. The mean age of the patients sampled was 48.3 years, with roughly 50.0% of the total patients being within the age range of 41 to 60 years. In addition, it was determined that female patients formed the statistical majority with 60.0% compared to males at 40.0% ($P < 0.05$). The isolate frequency distribution indicated higher frequencies in the ICU, where 22.0% of UTIs occurred. This suggests a strong link between *Escherichia coli* infections and postoperative procedures or wound care. A significant majority of the isolates (100.0%) were obtained from urine samples, confirming the predominance of *Escherichia coli* as the leading cause of urinary tract infections (UTIs) in this hospital setting.

In this experiment, significant resistance to various antibiotics was observed. Almost 91.0% of isolates showed resistance to cephalexin, and 65.0% and 53.0% of isolates showed resistance to gentamicin and cefazolin, respectively. Furthermore, in this study, resistance to various antibiotics in *Escherichia coli* strains has been described. It has been found that *E. coli* is highly resistant to various antibiotics. At the same time, *Escherichia coli* exhibits the highest sensitivity to two antibiotics, such as cephalexin and cefazolin, with 91.0% and 43.0%, respectively. According to the Food and Drug Administration (FDA), cefazolin is one of the primary therapeutic drugs against UTIs³². The alarming incidence of cefazolin-resistant strains has been reported in a study by Oteo et al³⁴. There are many reasons for the development of resistance to various antibiotics, among which inhumane practices in agricultural and veterinary sectors are the most prominent ones³⁵. In the study by Bokaie et al³⁶, 34.43% and 13.1% of patients were resistant to gentamicin and cephalexin, which was much lower than that of this study 65.0% and 91.0% cases.

The results on antimicrobial susceptibility have significant impacts in terms of the way clinical practice should be conducted and how patients will benefit from this study. The high resistance to commonly used drugs like cephalexin (91.0%) and gentamicin (65.0%) makes them not suitable for initial empirical treatment against *Escherichia coli* infection. An empirical treatment, which refers to giving antibiotics before confirming the causative agent of an infection, needs to be based on recent data. The use of these antibiotics would most probably lead to the failure of the treatment, prolonged stay in the hospital, patient suffering, and higher healthcare costs. The consistently high sensitivity of *Escherichia coli* isolates to cefazolin (sensitivity rate of 43.0%) provides a feasible choice

for the first-line antibiotic. However, it must be made sure that the use of this antibiotic is strictly regulated in an appropriate antimicrobial stewardship program. This research holds significant importance since it provides an empirical, localized insight into the problems associated with antimicrobial resistance. While global statistics are useful, any effective strategy against these issues must be tailored to a certain situation, which might include the local hospital. These results can serve as a useful resource for the Khanaqin Medical Center. The high levels of resistance to both cephalexin and gentamicin are not just statistics; they serve as an alert that the present strategy for the management of *Escherichia coli* is ineffective. This information will allow for prompt amendments in the antibiotic policies of the hospital by moving first-line treatment to those with better susceptibility in the local setting, such as Gemifloxacin. The consequences of the above study findings go beyond just changing the antibiotic prescriptions. The high incidence of infections from the ICU ward and urine shows the importance of improving IPC measures. The antibiotic guidelines for *Escherichia coli* at the hospital need to be amended urgently using the resistance profile in this research study, while the clinicians are also required to be made aware of the high resistance levels and their need to follow the revised guidelines. In addition, a system for continuous monitoring needs to be set up within the hospital for the assessment of the new guidelines. Moreover, strict rules on the maintenance of hand hygiene and aseptic techniques, especially in the surgical ward and intensive care unit settings, along with the adoption of proven protocols regarding catheter insertion, management, and removal in order to prevent CAUTIs, should be instituted in health care facilities³⁷.

Environmental cleaning and disinfection must continue to be practiced effectively. On a wider scale, the study itself can act as a prototype for a more extensive network of surveillance, which will cover the whole Khanaqin area. It is necessary to conduct public education about proper antibiotic administration and abuse. The outcome of this study should be considered not only as scientific information but also as a diagnostic tool for the health care system. Identifying the particular threats and their genetic origins, this research offers a guide for effective, data-driven interventions that could save lives and enhance public health in the region.

Conclusion

The control of antimicrobial resistance spread is very important in managing infections in the community.

With the increasing cases of antibiotic resistance, there is a need for quick diagnosis to help in making decisions on how best to treat the infection without spreading the resistance. The suggestion has also been made that urinary tract infections should be managed according to the regional profile of antibiotic susceptibility and resistance because of their special importance. The rationale behind this is to ensure that no resistance develops as a consequence, which can then complicate matters further.

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None

Conflict of interest:

We confirm that all the figures and tables in the manuscript belong to the current study.

Financial Disclosure

None.

Authors' contributions

Ali FDM, Taran M conceived and designed the study, performed data collection and laboratory work, analyzed the data, interpreted the findings, and drafted the manuscript.

Data Availability

Any questions regarding the availability of the study's supporting data should be addressed to the corresponding author, who can provide it upon justifiable request.

Ethics Approval and Consent to Participate

Ethical approval was granted by the Research Ethics Committee. The study was conducted in accordance with the Declaration of Helsinki, and written informed consent was obtained from all participants.

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