ORIGINAL RESEARCH

DOI: 10.4274/globecc.galenos.2025.30306
Glob Emerg Crit Care 2025;4(3):170-175

Evaluation of Urine Culture Results and Antibiotic Resistance Patterns in the Emergency Department Between 2020 and 2023

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Abstract

Objective: Urinary tract infections (UTIs) are one of the most common infectious diseases encountered in emergency departments (EDs), and increasing antimicrobial resistance has become a significant challenge in managing these infections. This study evaluated the antibiotic resistance patterns of pathogens isolated from urine cultures obtained from patients presenting to the ED between 2020 and 2023 and investigated the changes in resistance rates over time.

Materials and Methods: This was a retrospective, single-center study. Urine culture and antibiogram results of patients aged 18 years who presented with a preliminary diagnosis of UTI between January 1, 2020, and December 31, 2023, were reviewed. Data were collected from electronic patient records, and pathogens isolated in cultures were analyzed according to antibiotic susceptibility.

Results: A total of 978 patients who had urine cultures requested were included in the study. Growth was detected in 258 (26.4%) patients. The median age of patients with positive cultures was 55.5 years (interquartile range: 35-74.25), and 69.8% were female. The most frequently isolated pathogen was *Escherichia coli* (61.6%), followed by *Klebsiella pneumoniae* (19%). Ampicillin (38%), ceftriaxone (32.9%), ciprofloxacin (28.3%), and trimethoprim-sulfamethoxazole (TMP/SMX) (24.4%) had the highest resistance rates. Resistance to antibiotics such as meropenem, amikacin, and gentamicin was also lower. An increase in resistance rates was observed for amoxicillin-clavulanate, ampicillin, and TMP/SMX between 2020 and 2023.

Conclusion: Our study shows that the UTI pathogens most commonly isolated from patients presenting to the ED exhibit increasing resistance rates to widely used antibiotics. These findings highlight the need for empirical antibiotic therapy to be guided by local resistance patterns and regularly updated. Continuous monitoring of local antibiogram data is crucial for reducing antibiotic resistance and improving patient outcomes.

Keywords: Urinary tract infections, emergency department, antibiotic resistance, *Escherichia coli*, *Klebsiella pneumoniae*, urine cultures

Introduction

Urinary tract infections (UTIs) are one of the most commonly encountered infectious diseases in emergency departments (EDs), accounting for 25% of all infectious diseases, making them the second most prevalent cause [1,2]. UTIs are classified based on their clinical characteristics into uncomplicated and complicated infections. Complicated UTIs involve factors that increase the risk of treatment failure and recurrence, such as underlying anatomical or functional abnormalities, immunosuppression, comorbidities, and resistant microorganisms. Therefore, urine cultures play a critical role in complicated UTIs; culture results guide the selection of appropriate antibiotics, helping to prevent treatment failures and the development of severe complications, such as urosepsis [3,4]. Delays in obtaining culture results in the ED often lead clinicians to rely on previous culture results or empirical treatment, which can sometimes result in the unnecessary use of broad-spectrum antibiotics. Although empirical antibiotic therapy can expedite the treatment process, especially when culture results are not promptly available, the effectiveness of antibiotics administered in this manner is influenced by

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Received: 15.10.2024 **Accepted:** 03.01.2025 **Epub:** 17.02.2025 **Publication Date:** 30.12.2025

Cite this article as: Özen Olcay H, Emektar E, Ertaş İ, Tokgöz ZH, Çevik Y. Evaluation of urine culture results and antibiotic resistance patterns in the emergency department between 2020 and 2023. Glob Emerg Crit Care. 2025;4(3):170-175

regional antibiotic resistance patterns. Increasing antibiotic resistance leads to treatment failure and hospital admissions and places significant economic burden on the healthcare system. Therefore, determining the most appropriate antibiotics for treating UTIs and basing treatment decisions on up-to-date antibiogram data are essential for improving patient outcomes and preventing antibiotic resistance [3,5]. The aim of this study was to examine the urine culture and antibiogram results obtained from patients presenting to the ED and to investigate the changes in antibiotic susceptibility of the isolated pathogens between 2020 and 2023. By providing updated data to the literature, this study aims to contribute to the optimization of antimicrobial treatment strategies.

Materials and Methods

Study Design

This retrospective study was conducted in an ED with an annual average of 385,000 patient visits. The local ethics committee approved the study at University of Health Sciences Türkiye Ankara Atatürk Sanatoryum Training and Research Hospital, Scientific studies Ethics Committee (approval number: 2024-BÇEK/125, date: 31.07.2024). Data were collected from electronic health records and patient files.

Data Collection

Data were collected from electronic medical records and patient files. A retrospective chart review was performed by two emergency physicians, each with at least 3 years of experience. This review included both the clinical and demographic details of the patients. In cases in which there were differences in the evaluations made by the two physicians, the lead investigator reviewed the cases and provided the final decision.

Study Population

The study included patients aged 18 and over who had urine cultures with a preliminary diagnosis of UTI between January 1, 2020, and December 31, 2023, in the Emergency Department of University of Health Sciences Türkiye Ankara Atatürk Sanatoryum Training and Research Hospital. Only patients with complete data and positive pathogen growth in their urine cultures were included, whereas those with suspected contamination based on culture results were excluded.

The demographic data, chronic diseases, and urine culture results of the included patients were recorded. The microorganisms isolated from the urine cultures were classified, and the antibiogram results were analyzed in two groups based on susceptibility and resistance. Additionally, the antibiotic resistance profiles of frequently isolated pathogens were evaluated by year, and changing resistance patterns were analyzed.

Statistical Analysis

All data collected and recorded in the study form were analyzed using IBM SPSS 20.0 statistical software (Chicago, IL, USA). The normality of the distribution of categorical and continuous numerical variables was assessed using the Shapiro-Wilk test. Descriptive statistics for categorical and continuous numerical variables are presented as median [(interquartile range (IQR): 25-75] and frequencies and percentages for categorical variables. Categorical variables were evaluated using the chi-square test, whereas continuous variables were assessed using the Mann-Whitney U test. A critical alpha value of 5% was considered for all statistical analyses, and the hypotheses were tested in a two-tailed manner.

Results

Urine cultures were requested for 978 patients in the ED between 2020 and 2023. Bacterial growth was detected in 258 patients (26.4%) (Figure 1). The median age of patients with positive urine cultures was found to be 55.5 years (IQR: 35-74.25). Among the patients with growth, 69.8% were female, 18.2% had a diagnosis of diabetes mellitus, and 2.3% were pregnant. Polymicrobial growth was observed in 6 patients. The most commonly encountered microorganism in urine cultures was *Escherichia coli (E. coli)* at 61.6%, followed by *Klebsiella pneumoniae (K. pneumoniae)* at 19%. The pathogens identified

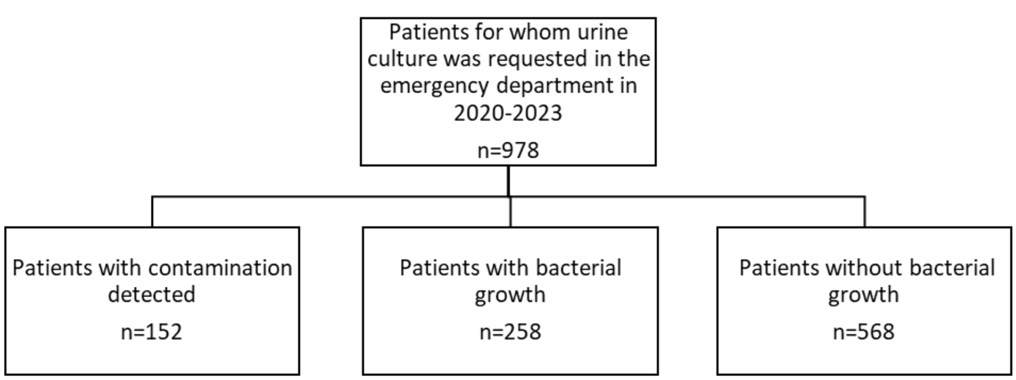

Figure 1. Flowchart of the patients

in the urine cultures are presented in Table 1. When examining all positive samples, the antibiotic resistance rates were found to be 38% for ampicillin, 32.9% for ceftriaxone, 28.3% for ciprofloxacin, and 24.4% for trimethoprim-sulfamethoxazole (TMP/SMX). The antibiotics with lower resistance rates were meropenem (10.5%), amikacin (7%), and gentamicin (7%) (Figure 2, Table 2). Among the 158 patients with *E. coli* growth, 51 (32.1%) were found to be susceptible to all tested agents. The antibiotic to which the isolated *E. coli* strains exhibited the highest resistance was ampicillin (38.4%), whereas the antibiotics with the lowest resistance rates were ofloxacin and ertapenem, both with a resistance rate of 0.6%. An increase in resistance rates over the years was observed for amoxicillin/clavulanate, ampicillin, and trimethoprim/sulfamethoxazole. The changes in the antibiotic resistance of *E. coli* strains over time are presented in Table 3. The antibiotic to which the isolated *K. pneumoniae* strains exhibited the highest resistance was ampicillin (55.1%), whereas the antibiotics with the lowest resistance rates were gentamicin (16.3%) and ertapenem (10.2%). An increase in resistance to gentamicin was observed over time. The changes in the antibiotic resistance of *K. pneumoniae* strains over time are presented in Table 4.

Table 1. Pathogens identified in urine cultures

Isolated microorganism	n (%)
Escherichia coli	159 (61.6)
Klebsiella pneumoniae	49 (19)
Enterococcus fecalis (Group D)	11 (4.3)
Enterobacter cloacae	10 (3.9)
Pseudomonas aeruginosa	9 (3.5)
Streptococcus agalactiae (Group B)	9 (3.5)
Staphylococcus aureus	5 (1.9)
Candida albicans	5 (1.9)
Proteus mirabilis	3 (1.2)
Klebsiella oxytoca	2 (0.8)
Acinetobacter baumannii	1 (0.4)
Citrobacter freundii	1 (0.4)
Streptococcus dysgalactiae (Group C/Group G)	1 (0.4)

A single patient may have multiple isolated pathogens

Discussion

This study aimed to provide a contemporary perspective on the management of UTIs in the ED by examining the changes in urine culture results and antibiotic resistance patterns over time among patients who presented to the ED between 2020 and 2023. In our study, growth was detected in approximately one-quarter (26.4%) of patients who underwent urine culture in the ED. The most frequently encountered pathogen among the isolated microorganisms was *E. coli*, consistent with previous studies. This finding supports the notion that *E. coli* is the dominant pathogen in community-acquired UTIs [1,6,7]. The second most commonly isolated pathogen was *K. pneumoniae*, which is consistent with findings reported in other studies in the literature [1,7,8]. In our country, patients often present to EDs for initial evaluation of

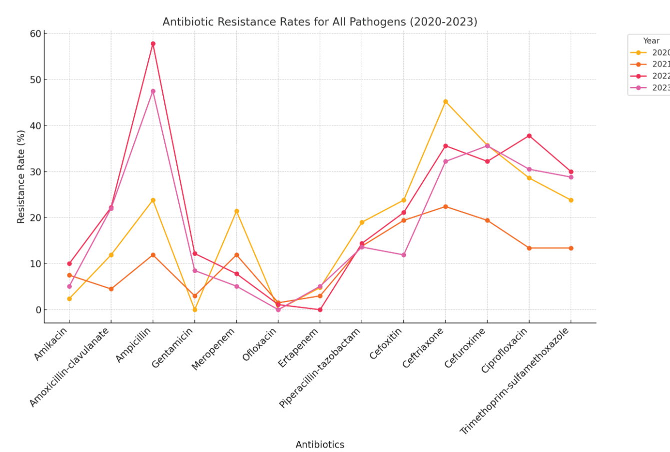

Figure 2. Antibiotic resistance rates for all pathogens between 2020 and 2023

Table 2. Antibiotic resistance rates for all pathogens between 2020 and 2023

Antibiotics, n (%)	2020	2021	2022	2023	Total
Amikacin	1 (2.4)	5 (7.5)	9 (10)	3 (5.1)	18 (7)
Amoxicillin-clavulanate	5 (11.9)	3 (4.5)	20 (22.2)	13 (22)	41 (15.9)
Ampicillin	10 (23.8)	8 (11.9)	52 (57.8)	28 (47.5)	98 (38)
Gentamicin	0 (0)	2 (3)	11 (12.2)	5 (8.5)	18 (7)
Meropenem	9 (21.4)	8 (11.9)	7 (7.8)	3 (5.1)	27 (10.5)
Ofloxacin	0 (0)	1 (1.5)	1 (1.1)	0 (0)	2 (0.8)
Ertapenem	2 (4.8)	2 (3)	0 (0)	3 (5.1)	7 (2.7)
Piperacillin-tazobactam	8 (19)	9 (13.8)	13 (14.4)	8 (13.6)	38 (14.7)
Cefoxitin	10 (23.8)	13 (19.4)	19 (21.1)	7 (11.9)	49 (19)
Ceftriaxone	19 (45.2)	15 (22.4)	32 (35.6)	19 (32.2)	85 (32.9)
Cefuroxime	15 (35.7)	13 (19.4)	29 (32.2)	21 (35.6)	78 (30.2)
Ciprofloxacin	12 (28.6)	9 (13.4)	34 (37.8)	18 (30.5)	73 (28.3)
Trimethoprim-sulfamethoxazole	10 (23.8)	9 (13.4)	27 (30)	17 (28.8)	63 (24.4)

Table 3. Antibiotic resistance rates for *E. coli* between 2020 and 2023 (n=159)						
Antibiotics, n (%)	**2020**	**2021**	**2022**	**2023**	**Total**	**p**
Amikacin	0 (0)	0 (0)	3 (5.3)	0 (0)	3 (1.9)	0.140
Amoxicillin-clavulanate	1 (4)	2 (5.6)	12 (21.1)	10 (24.4)	25 (15.7)	0.030
Ampicillin	3 (12)	4 (11.1)	33 (57.9)	21 (51.2)	61 (38.4)	0.001
Gentamicin	0 (0)	0 (0)	5 (8.8)	2 (4.9)	7 (4.4)	0.144
Meropenem	3 (12)	4 (11.1)	2 (3.5)	0 (0)	9 (5.7)	0.077
Ofloxacin	0 (0)	0 (0)	1 (1.8)	0 (0)	1 (0.6)	0.615
Ertapenem	0 (0)	1 (2.8)	0 (0)	0 (0)	1 (0.6)	0.329
Piperacillin-tazobactam	5 (20)	5 (13.9)	6 (10.5)	5 (12.2)	21 (13.2)	0.702
Cefoxitin	6 (24)	9 (25)	9 (15.8)	3 (7.3)	27 (17)	0.152
Ceftriaxone	10 (40)	10 (27.8)	19 (33.3)	15 (36.6)	54 (34)	0.764
Cefuroxime	8 (32)	10 (27.8)	15 (26.3)	17 (41.5)	50 (31.4)	0.418
Ciprofloxacin	6 (24)	6 (16.7)	21 (36.8)	13 (31.7)	46 (28.9)	0.186
Trimethoprim-sulfamethoxazole	4 (16)	2 (5.6)	14 (24.6)	12 (29.3)	32 (20.1)	0.049

E. coli: Escherichia coli

Table 4. Antibiotic resistance rates for *Klebsiella pneumoniae* between 2020 and 2023 (n=49)						
Antibiotics, n (%)	**2020**	**2021**	**2022**	**2023**	**Total**	**p**
Amikacin	1 (12.5)	5 (33.3)	7 (33.3)	3 (60)	16 (32.7)	0.364
Amoxicillin-clavulanate	2 (25)	1 (6.7)	8 (38.1)	3 (60)	14 (28.6)	0.074
Ampicillin	4 (50)	3 (20)	15 (71.4)	5 (100)	27 (55.1)	0.003
Gentamicin	0 (0)	0 (0)	5 (23.8)	3 (60)	8 (16.3)	0.006
Meropenem	5 (62.5)	2 (13.3)	5 (23.8)	3 (60)	15 (30.6)	0.038
Ertapenem	1 (12.5)	1 (6.7)	0 (0)	3 (60)	5 (10.2)	0.001
Piperacillin-tazobactam	2 (25)	3 (20)	7 (33.3)	3 (60)	15 (30.6)	0.389
Cefoxitin	3 (37.5)	3 (20)	8 (38.1)	3 (60)	17 (34.7)	0.395
Ceftriaxone	6 (75)	5 (33.3)	11 (52.4)	4 (80)	26 (53.1)	0.148
Cefuroxime	5 (62.5)	3 (20)	11 (52.4)	4 (80)	23 (46.9)	0.055
Ciprofloxacin	4 (50)	3 (20)	9 (42.9)	2 (40)	18 (36.7)	0.428
Trimethoprim-sulfamethoxazole	4 (50)	5 (33.3)	10 (47.6)	3 (60)	22 (44.9)	0.701

their complaints and face social barriers to accessing outpatient clinics. This situation frequently leads to the implementation of empirical antibiotic therapy without urine culture, which can result in antibiotic resistance or treatment failure. Urine culture is therefore requested in the ED for accurate diagnosis and treatment management. In a study conducted in the ED, the rate of urine culture requests for complicated UTIs was reported to be 70.2%, resulting in a treatment change rate of 4.6% [8]. Studies in EDs have reported growth rates in urine cultures of 33.5%, 11.6%, 28.1%, 35%, and 51.2%, respectively [9-13]. This rate was found to be 26.4%. Although the rates of culture requests and positive results may vary across clinics, the positivity rates of cultures were significantly high. These differences can be explained by various factors, such as patient profile, physicians' approaches to laboratory utilization, the functioning of the laboratory, and the hospital's operational system.

The most common pathogen responsible for UTIs is typically *E. coli* International studies have reported that the proportion of *E. coli* in urine cultures ranges from 50% to 85% [2,5,8,14]. In our country, this rate varies between 35% and 80% [1,3,6,7,10,11]. In our study, the frequency of *E. coli* was found to be 61.6%. The second most frequently observed microorganism was *K. pneumoniae* (19%), which is consistent with other data in the literature [7,12,14,15]. In our study, particularly high resistance rates were observed against commonly used antibiotics such as ampicillin, ceftriaxone, ciprofloxacin, and TMP/SMX. Resistance to ampicillin was found to be as high as 38%, which may be a result of the widespread production of beta-lactamases in *E. coli* and *K. pneumoniae* strains [16]. In a study conducted in Türkiye in 2012, the antibiotic with the lowest resistance observed against *E. coli* strains was meropenem (0%), whereas the highest resistance was found with ampicillin-sulbactam (36.8%) [1]. Another study reported that the most resistant antibiotic for isolated *E. coli* strains was ampicillin (64.7%), with the most sensitive being imipenem/meropenem at a resistance rate of 2.5% [7]. A 2006 study found resistance rates of 64%, 48%, 47.1%, and 40.4% against ampicillin, ciprofloxacin, levofloxacin, and TMP/SMX, respectively [12]. In our study, the most resistant antibiotic for isolated *E. coli* strains was ampicillin (38.4%), whereas the most sensitive antibiotics were ofloxacin and ertapenem, both of which had a resistance rate of 0.6%. Resistance to ciprofloxacin was found to be 28.9%, TMP/SMX resistance was 20.1%, and meropenem resistance was 5.7%. Additionally, between 2020 and 2023, an increase in resistance rates to amoxicillin/clavulanic acid, ampicillin, and TMP/SMX was observed among *E. coli* strains. However, when examining studies from previous years, particularly between 2006 and 2012, it is notable that resistance rates for ampicillin, ciprofloxacin, and TMP/SMX were approximately twice as high. This trend may be attributed to the success of rational antibiotic use practices implemented over the years. In our study, the antibiotic resistance rates of the isolated *K. pneumoniae* strains were consistent with previous research [7,17]. High resistance rates were particularly recorded against commonly used antibiotics such as ampicillin, ceftriaxone, TMP/SMX, and ciprofloxacin. A previous study reported resistance rates of 64.7% for amoxicillin-clavulanate, 58.5% for ciprofloxacin, and 57.2% for ceftriaxone in *K. pneumoniae* strains [7]. In our study, gentamicin (16.3%) and ertapenem (10.2%) were identified as the most sensitive antibiotics. This finding is consistent with other studies that identified aminoglycosides and carbapenems as the most effective agents [7]. However, the annual increase in gentamicin resistance highlights the need for careful use of this antibiotic and emphasizes the importance of considering alternative treatment options. It is crucial for each country to have its own epidemiological data, as it enables physicians to be aware of current antibiotic resistance rates in their regions and to adjust treatments and prophylaxis accordingly. In addition, it should not be overlooked that every empirically initiated treatment must be reviewed based on the antimicrobial susceptibility profile. This strategy plays a significant role in reducing resistance rates and enhancing treatment success.

Study Limitations

The study was retrospective and conducted at a single center. The data obtained only included urine cultures from patients admitted to the ED and did not include those treated in outpatient clinics or other clinical settings. Furthermore, more detailed information regarding the patients' clinical courses, the antibiotics used, and the outcomes of these treatments could not be evaluated within the scope of the study. Additionally, changes in antibiotic resistance rates could not be fully analyzed in relation to hospital policies, trends in antibiotic usage, and variations in patient profiles.

Conclusion

In our study, we found that *E. coli* and *K. pneumoniae* are frequently isolated pathogens that exhibit high resistance rates to commonly used antibiotics. The increase in antibiotic resistance highlights the need for careful consideration in the selection of empirical treatments and underscores the critical role of susceptibility testing in the treatment process. Given that resistance rates can vary over time, it is crucial to regularly monitor antibiotic resistance profiles at each center and update treatment strategies accordingly.

Ethics

Ethics Committee Approval: The local ethics committee approved the study at University of Health Sciences Türkiye Ankara Atatürk Sanatoryum Training and Research Hospital, Scientific studies Ethics Committee (approval number: 2024-BÇEK/125, date: 31.07.2024).

Informed Consent: Retrospective study.

Footnotes

Authorship Contributions

Surgical and Medical Practices: H.Ö.O., Y.Ç., Concept: H.Ö.O., E.E., Y.Ç., Design: H.Ö.O., E.E., Y.Ç., Data Collection or Processing: H.Ö.O., İ.E., Z.H.T., Analysis or Interpretation: H.Ö.O., E.E., Literature Search: H.Ö.O., İ.E., Z.H.T., Writing: H.Ö.O., E.E., Y.Ç.

Conflict of Interest: No conflict of interest was declared by the authors.

Financial Disclosure: The authors declared that this study received no financial support.

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