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ORIGINAL ARTICLE

Distribution and Antibiotic Susceptibility of Bacteria Isolated from Urine Culture

İdrar Kültürlerinden İzole edilen bakterilerin dağılımı ve antibiyotik duyarlılıkları

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Abstract

Aim: Empiric appropriate antibiotic therapy is recommended in patients with symptoms of urinary tract infections (UTIs) as it reduces the morbidity rate. Inappropriate antibiotic use leads to a decrease in treatment effectiveness and the development of late-stage complications. This study aims to retrospectively evaluate the results of urine cultures from patients prediagnosed with UTIs and the antibiotic resistance rate of the bacteria.
Methods: Midstream urine samples from the patients were collected in sterile screw-cap containers and transported to the laboratory following standard procedures to avoid contamination. The urine samples were cultured on appropriate media and incubated at 37°C for 24-48 hours. Bacterial identification was performed using conventional microbiological techniques. Antibiotic susceptibility testing was performed using the Kirby-Bauer disk diffusion method according to European Committee on Antimicrobial Susceptibility Testing guidelines.
Results: In our study, a total of 1357 urine cultures were found to be positive for bacterial growth over one year. 1249 samples were obtained from adults, and 108 from children. The most frequently identified uropathogen in both adults and children was E. coli, with an average occurrence of 57.3%. The second most frequently isolated bacteria were Enterococcus spp. in adults and Klebsiella spp. in children. In adults, the most resistant antibiotics were found to be ampicillin(77.2%) and amoxicillin-clavulanic acid (63.3%), while the most sensitive antibiotics were carbapenems(1%). The highest resistance rate in P. aeruginosa strains was observed against ceftazidime(% 38.9%), while all strains were susceptible to colistin, tigecycline, and amikacin.
Conclusions: The findings of this study underscore the importance of performing routine urine cultures to identify the specific pathogens causing UTIs and their susceptibility to antibiotics. Empirical treatment based on local antibiogram data is essential to ensure effective management and reduce unnecessary antibiotic use.

Keywords: Antibacterial resistance, carbapenems, colistin, Escherichia coli, urinary tract infection

Öz

Amaç: Semptomları bulunan idrar yolu enfeksiyonları (İYE) hastalarında ampirik uygun antibiyotik tedavisi önerilmektedir, çünkü bu, morbidite oranını azaltmaktadır. Uygunsuz antibiyotik kullanımı, tedavi etkinliğinde azalmaya ve geç evre komplikasyonlarının gelişmesine yol açmaktadır. Bu çalışmanın amacı, İYE tanısı konmuş hastalardan alınan idrar kültürlerinin sonuçlarını retrospektif olarak değerlendirmesi ve bakterilerin antibiyotik direnç oranlarını incelemektir.
Gereç ve Yöntemler: Hastalardan alınan orta akım idrar örnekleri, kontaminasyonu önlemek amacıyla standart prosedürlere uygun olarak steril vidalı kaplarda toplanmış ve laboratuvara taşınmıştır. İdrar örnekleri uygun besiyerlerine ekilip, 37°C'de 24-48 saat inkübe edilmiştir. Bakteriyel tanı, konvansiyonel yöntemler kullanılarak yapılmıştır. Antibiyotik duyarlılık testi, EUCAST rehberinde ki önerilere göre Kirby-Bauer disk difüzyon yöntemi ile gerçekleştirilmiştir.
Bulgular: Çalışmamızda, bir yıl boyunca 1357 idrar kültüründe bakteri üremesi saptanmıştır. Bu örneklerin 1249'u yetişkinlerden, 108'i ise çocuklardan alınan örneklerden üremiştir. Hem yetişkinlerde hem de çocuklarda en sık tespit edilen üropatogen Escherichia coli olup, ortalama izolasyon oranı %57,3 olarak hesaplanmıştır. Yetişkinlerde ikinci sırada Enterococcus. spp, çocuklarda ise Klebsiella spp. izole edilmiştir. Yetişkinlerde en fazla direnç tespit edilen antibiyotikler ampisilin (%77,2) ve amoksisilin-klavulanik asit (%63,3) iken, en duyarlı antibiyotikler karbapenemler (%1) olmuştur. Pseudomonas aeruginosa suşlarında en yüksek direnç oranı, ceftazidime (%38,9) karşı gözlemlenmiş, ancak tüm suşlar kolistin, tigesiklin ve amikasin için duyarlı bulunmuştur.
Sonuçlar: Bu çalışmanın bulguları, İYE'ye neden olan spesifik patojenlerin ve bunların antibiyotiklere duyarlılığının belirlenmesi için rutin idrar kültürlerinin yapılmasının önemini vurgulamaktadır. Lokal antibiyogram verilerine dayalı ampirik tedavi, etkin yönetimin sağlanması ve gereksiz antibiyotik kullanımının azaltılması için esastır.

Anahtar Kelimeler: Antibakteriyel direnç, Karbapenemler, Kolistin, Escherichia coli, İdrar yolu enfeksiyonu

Introduction

Urinary tract infections (UTIs) are the second or third most common infectious diseases in the community, occurring in approximately 20% of individuals (1). While many bacterial species and fungi can cause UTIs, it has been reported that Escherichia coli and Klebsiella spp. are responsible for approximately 90% of these infections (2). Extended-spectrum β-lactamases (ESBLs) are transferable β-lactamases that hydrolyze penicillins, third and fourth-generation cephalosporins, and monobactams, originally observed in members of the Enterobacteriaceae family. The most effective β-lactam antibiotics against E. coli and Klebsiella spp.,

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which produce these enzymes, are carbapenems (3). In recent years, colistin has become widely used in the treatment of infections caused by multidrug-resistant bacteria; however, the rising resistance to colistin over the past decade has led to difficult-to-treat infections (4). Turkey is one of the countries with a high frequency of ESBL. It has been reported that more than half of hospital-acquired UTIs and about a quarter of community-acquired infections are caused by ESBL-positive E. coli or K. pneumoniae. The failure to develop new antimicrobials that could be effective against these resistant pathogens, combined with the high mortality and morbidity associated with these strains, has made the control of ESBL and carbapenem resistance an even more critical issue (2).

Empiric appropriate antibiotic therapy is recommended for patients with symptoms of UTIs, as it reduces the morbidity rate. Inappropriate antibiotic use leads to decreased treatment effectiveness and the development of later-stage complications (5). Resistance, which develops due to the widespread and incorrect use of antibiotics, is a significant problem. The main factors contributing to the development of this resistance include the inappropriate dosing and duration of antibiotics, the presence of recurrent UTIs, a history of previous hospitalization, and the prophylactic administration of broad-spectrum antibiotics. As is well known, the gold standard for diagnosing urinary UTIs is a urine culture sample taken before starting antibiotic therapy (6). Therefore, urine culture results should always be considered, and regional bacterial resistance patterns should be taken into account when deciding on the empiric antibiotics to be used (5). This study aims to investigate the results of urine cultures sent from patients suspected of having urinary tract infections and the antibiotic resistance patterns of the bacteria grown.

Materials and Methods

The study includes patients undergoing urine culture testing between 01.01.2024 and 31.12.2024. Samples with contamination, non-infectious conditions, or insufficient patient data were excluded. One of the samples sent from the same patient at the same time was included in the study. Midstream urine samples from the patients were collected in sterile screw-cap containers and transported to the laboratory with the following standard procedures to avoid contamination. All samples were processed within 30 min of collection.

The urine samples were cultured on appropriate media (Eosin Methylene Blue, 5% Sheep Blood agar) and incubated at 37°C for 24-48 hours. Bacterial identification was performed using standard microbiological techniques, including Gram staining, colony morphology, and biochemical tests (e.g., catalase, oxidase, indole, urease, citrate test, and Triple Sugar Iron Agar). Antibiotic susceptibility testing was performed using the Kirby-Bauer disk diffusion method according to European Committee on Antimicrobial Susceptibility Testing (EUCAST) guidelines. The zones of inhibition were measured and interpreted based on EUCAST breakpoints. Ethical approval was obtained from the Non-Interventional Ethics Committee (Approval number: KAÜ-TFEK 2025/01/06).

Results

In our study, a total of 1357 urine cultures were found to be positive for bacterial growth over one year. Of these, 1249 samples were obtained from adults, and 108 from children. The average age of the children was calculated as 6.5 (SD=±5) years, while the average age of the adults was 62.3 (SD=±17) years. In the adult group, 648 samples (51.8%) were isolated from males and 601 samples (48.2%) were from females. In the pediatric group, 34 samples (31.5%) were from boys, and 74 samples (68.5%) from girls. The most frequently identified uropathogen in both adults and children was E. coli, with an average occurrence of 57.3%. The second most frequently isolated bacteria were Enterococcus spp. in adults and Klebsiella spp. in children. The distribution of the isolated uropathogens is presented in Table 1.

Table 1. Distribution of uropathogens

Bacteria	Adults		Children	
	n	%	n	%
E. coli	716	57.3	62	57.4
Enterococcus spp,	162	13	15	13.9
Klebsiella spp,	154	12.3	17	15.7
CNS	67	5.4	-	-
Proteus spp.	42	3.3	11	10.2
Enterobacter spp.	40	3.2	-	-
Pseudomonas aeruginosa	36	2.9	1	0.9
Others	32*	2.6	2**	1.9
Total	**1249**	**100**	**108**	**100**

** S. aureus (15), A. baumannii (7), C. freundii (4), Streptococcus spp. (4), S. marcescens (1), M. morganii (1)*

*** S. aureus (2), CNS: Coagulase-negative staphylococcus*

In the adult patient group, the most resistant antibiotics were found to be ampicillin (77.2%) and amoxicillin-clavulanic acid (63.3%), while the most sensitive antibiotics were meropenem, ertapenem, and imipenem from the carbapenem group (1%). In pediatric patients, similar to adults, the most resistant antibiotics were ampicillin (60.2%) and amoxicillin-clavulanic acid (45.4%), while no resistance was detected against

carbapenem group antibiotics (Table 2).

Table 2. Antibiotic resistance rate of the Enterobacteriaceae strains

Bacteria/ Antibiotics	E. coli		Klebsiella		Proteus		Citro-bacter	Entero-bacter
	A	C	A	C	A	C	A	A
Amikacin	21	0	14	1	1	1	0	1
AMC	444	37	115	7	12	5	3	31
Ampicillin	533	45	144	15	23	5	3	35
Cefepime	187	11	66	3	2	1	0	7
Cefixime	274	19	77	4	7	1	3	20
Ceftazidime	230	15	74	3	7	1	2	8
Ceftriaxone	237	15	72	3	4	1	3	10
Ciprofloxacin	252	8	48	0	8	0	2	8
Ertapenem	1	0	10	0	0	0	0	1
Meropenem	1	0	10	0	0	0	0	1
Imipenem	1	0	10	0	0	0	0	1
Fosfomycin	103	5	48	2	5	1	1	10
Nitrofurantoin	140	2	46	4	42	11	1	12
Gentamicin	86	3	29	0	8	2	0	6
Levofloxacin	248	8	48	0	8	0	2	8
SXT	286	1	76	0	23	0	1	8
TPZ	34	23	23	5	1	4	0	4

AMC: Amoxicillin-clavulanic acid, SXT: Trimethoprim-sulfamethoxazole, TPZ: Piperacillin-tazobactam,
A: Adult, C: Children

Acinetobacter baumannii was not detected in the pediatric group, whereas seven strains were isolated in adults. These strains were resistant to all antibiotics, but sensitive only to colistin and tigecycline. The highest resistance rate in P. aeruginosa strains was observed against ceftazidime (% 38.9%), while all strains were susceptible to colistin, tigecycline, and amikacin. The antibiotic resistance patterns of P. aeruginosa strains are presented in Table 3.

Table 3. Antibiotic resistance rate of Pseudomonas strains

Bacteria/Antibiotic	Pseudomonas (n=36)	
	Resistant	%
Ceftazidime	14	38.9
Cefepime	8	22.2
Gentamicin	5	13.9
Piperacillin-Tazobactam	5	13.9
Ciprofloxasin	4	11.1
Meropenem	1	2.8
Imipenem	1	2.8
Amikacin	0	0
Tigecycline	0	0
Colistin	0	0

When the antibiotic susceptibilities of Enterococcus species were investigated, the most sensitive antibiotics were found to be linezolid (0) and vancomycin (3), while the most resistant antibiotics were the fluoroquinolone group, including levofloxacin (84) and ciprofloxacin (84).(Table 4)

Table 4. Resistance rate of Enterococcus strains

Bacteria/Antibiotic	Enterococcus			
	A (n=162)	%	C (n=15)	%
Levofloxacin	84	51.9	4	26.7
Ciprofloxasin	84	51.9	4	26.7
Ampicillin	40	24.7	2	13.3
Imipenem	32	19.8	2	13.3
Nitrofurantoin	19	11.7	0	0
Vancomycin	3	1.9	0	0
Linezolid	0	0	0	0

A: Adults, C: Children

Discussion

The investigation of bacterial distribution from urine cultures and their associated antibiotic susceptibility patterns provides critical insight into the epidemiology of UTIs and the effectiveness of available treatments. UTIs, one of the most common bacterial infections worldwide, are often associated with a variety of pathogens, including E. coli, Klebsiella spp., Enterococcus spp., and Proteus spp. Understanding which bacteria are most prevalent and how they respond to antibiotics is essential for effective treatment and managing the growing concern of antimicrobial resistance (7, 8). In a study by Islam et al., the culture of urine samples from 920 patients showed significant growth of uropathogens, with 849 (92%) monomicrobial (single bacterial species) and 71 (8%) polymicrobial growth (a combination of two different bacterial species). In this study, E. coli (51.6%) was the most common agent. The distribution of other pathogens was reported as follows: Streptococcus spp. (15.7%), Klebsiella spp. (12.1%), Enterococcus spp. (6.4%), Pseudomonas spp. (4.4%), coagulase-negative Staphylococcus (2%), Enterobacter spp. (1.8%), Proteus spp. (1.6%), Acinetobacter spp. (1%), Staphylococcus saprophyticus (1.1%), S. aureus (0.6%), Corynebacterium spp. (0.3%), Serratia spp. (0.3%), and S. paucimobilis (0.3%)(9). Şenol et al. analysed 314 patient samples with positive cultures, and E. coli was the most frequently isolated pathogen in 220 cases, followed by Klebsiella spp. in 38 cases. These two pathogens were responsible for 82.1% of all culture-positive patients and approximately half of the patients investigated in the study (10). In another study, 784

urine samples were evaluated, and bacterial growth was observed in 222 samples (28.3%). E. coli was the most frequently isolated pathogen (63%). However, in this study, Klebsiella spp. was the most commonly isolated pathogen in neonatal unit patients (11). In our study, the distribution of bacteria isolated from urine cultures reflects the bacterial diversity typically observed in UTI patients. As in many studies, E. coli was the most frequently isolated pathogen, accounting for up to 57.3% of UTIs in both adults and children. This is consistent with the fact that E. coli is a normal inhabitant of the intestinal flora and is frequently the causative agent of UTIs due to its ability to colonize the urinary tract, often facilitated by factors such as poor hygiene or urinary retention (12). Other Gram-negative organisms like Klebsiella spp. (12.6%), Proteus spp. (3.9%), and P. aeruginosa (2.7%) were isolated less frequently but were still significant contributors to UTIs, especially in more complicated cases or in patients with underlying conditions like diabetes or catheter use. Gram-positive organisms, notably Enterococcus spp., were also isolated, although less frequently than Gram-negative bacteria. Enterococcus spp. are of particular concern due to their ability to develop resistance to a broad range of antibiotics, including vancomycin, which complicates treatment options.

In a study, there were 451 non-duplicate Enterobacteriaceae isolates recovered from the 431 patients. E. coli was the predominant uropathogen, accounting for 72% of isolates (n = 323), followed by Klebsiella (15%, n = 66) and Proteus species (7%, n = 32). The overall resistance rate for Ampicillin, TMP-SMX, and levofloxacin was 55%, 24%, and 17%, respectively. In this study, there was no resistance to ertapenem (13). In our study, in Enterobacteriaceae strains, the most resistant antibiotics in both adults and children were ampicillin and amoxicillin-clavulanic acid, with resistance rates of 77.2% and 63.3% in adults, respectively. In pediatric patients, similar resistance rates were observed for ampicillin (60.2%) and amoxicillin-clavulanic acid (45.4%). In a study of Eshetie et al., 183 Enterobacteriaceae isolates 5, 2.73%) were found to be carbapenemase producers (14). Similar findings have been reported in studies from Morocco (2.8%) (15), Bangladesh (4.8%) (16), Taiwan (2.5%) (17), Belgium (3.5%) (18), and India (5.4%) (19). However, these rates were lower compared to studies from Pakistan (8.6%) (20), Türkiye (10.9%) (21), and the USA (21%) (22). In our study, the most sensitive antibiotics were meropenem, ertapenem, and imipenem from the carbapenem group (1%). Our results showed that in our hospital carbapenemase resistance rate is lower than others. The variations in the prevalence of carbapenemase-producing Enterobacteriaceae (CPE) across different studies may be attributed to factors such as differences in carbapenem usage, cultural practices, traditional healthcare approaches, and the cross-border movement of patients from countries with higher prevalence rates (14). These findings highlight the continued prevalence of resistance to beta-lactam antibiotics in Enterobacteriaceae species, which is a growing concern in clinical settings. However, the carbapenem group, including meropenem, ertapenem, and imipenem, exhibited very low resistance rates (1%) in both adult and pediatric groups, indicating their continued effectiveness as treatment options against these pathogens.

In the case of A. baumannii, this pathogen was absent in the pediatric group, but it was isolated in 7 adult patients. Notably, these strains exhibited resistance to all tested antibiotics, except colistin and tigecycline. The high level of resistance in A. baumannii is concerning, as it is commonly associated with healthcare-associated infections, particularly in critically ill patients. The effectiveness of colistin and tigecycline in treating these strains offers some hope, although these antibiotics should be used cautiously due to their potential nephrotoxicity.

In conclusion, the distribution of bacteria isolated from urine cultures reflects a diverse range of pathogens, with E. coli being the most common. However, the rising antibiotic resistance patterns, especially among Gram-negative bacteria, are a significant concern. The findings of this study underscore the importance of performing routine urine cultures to identify the specific pathogens causing UTIs and their susceptibility to antibiotics. Empirical treatment based on local antibiogram data is essential to ensure effective management and reduce unnecessary antibiotic use. In settings where resistance is high, combination therapy or the use of more targeted drugs may be necessary. Efforts to reduce the prevalence of antibiotic resistance through antimicrobial stewardship, infection control, and public health interventions will be essential in managing UTIs effectively in the future.

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Conflict of Interest

The author declares that there is no conflict of interest.

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