RESEARCH ARTICLE

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Evaluation of Antibiograms of *Escherichia coli* Strains Isolated from Urinary Cultures

ABSTRACT

Objective: Our aim in this study is to determine the antimicrobial resistance profiles of *Escherichia coli* strains known to cause urinary tract infections most frequently in the region, to obtain microbiological data about their current status, and to contribute to the development of clinical strategies for the prevention and management of these infections.

Methods: Our study includes patients with *E. coli* isolated from urine cultures. In the study, urine cultures and antibiograms of patients between January 2019 and January 2020 were scanned retrospectively. 662 patients over the age of 18 were included in the study. The files of the patients included in the study, the information registered in the system and the pre-filled forms were examined by examining age, gender, reproductive status in urine cultures, ESBL status, antibiograms, hospitalization status, admission outpatient clinic, reason for hospitalization, chronic and additional diseases, symptom status, the blood, nitrite, leukocyte parameters in the urinary dipstick test and the antibiotic treatment started were recorded.

Results: The antibiotics most frequently resistant to *E. coli* strains were cefuroxime (88.5%), tobramycin (75%), ceftazidime (72.9%), cefepime (59.5%) and ampicillin (57.5%). The antibiotics with the highest sensitivity were imipenem (100%), amikacin (99.1%), meropenem (98.2%), nitrofurantoin (96.3%) and fosfomycin (96.3%). It was observed that 25.7% of *E. coli* strains were ESBL positive.

Conclusions: Our findings showed that *E. coli* strains, which are the most common causative agents of urinary tract infections, have high resistance to many antibiotics commonly used in treatment. Considering the local resistance rates in empirical treatment and starting the treatment by making a urine culture will guide the treatment. As a result of our research, we think that the use of fosfomycin and nitrofurantoin in uncomplicated infections and the use of carbapenems and aminoglycoside antibiotics in complicated infections and upper urinary tract involvement are appropriate in the empirical treatment of urinary tract infections.

Keywords: *E. coli*, Urine culture, Urinary tract infection, Antimicrobial resistance.

İdrar Kültürlerinden İzole Edilen *Escherichia coli* Suşlarının Antibiyogramlarının Değerlendirilmesi

ÖZET

Amaç: Bu çalışmadaki amacımız idrar yolu enfeksiyonuna en sık neden olduğu bilinen *Escherichia coli* suşlarının bölgedeki antimikrobiyal direnç profillerini belirlemek ve güncel durumu hakkında mikrobiyolojik verileri elde etmek, bu enfeksiyonların önlenmesi ve yönetiminde klinik stratejiler geliştirilmesine katkıda bulunmaktır.

Gereç ve Yöntem: Çalışmamız idrar kültürlerinden *E. coli* izole edilen hastaları kapsamaktadır. Çalışmada 2019 ocak-2020 ocak tarihleri arasındaki hastaların idrar kültür ve antibiyogramları retrospektif olarak taranmıştır. On sekiz yaş üstü 662 hasta çalışmaya dahil edilmiştir. Hastaların dosyaları, sistemde kayıtlı olan bilgileri ve önceden doldurulmuş formları incelenerek yaş, cinsiyet, idrar kültürlerinde üreme durumu, GSBL durumu, antibiyogramları, hospitalizasyon durumu, başvuru polikliniği, yatan hastalarda yatış sebebi, kronik ve ek hastalıkları, semptom durumu, tam idrar tahlilindeki kan, nitrit, lökosit parametreleri ve başlanan antibiyotik tedavisi kaydedildi.

Bulgular: *E. coli* suşlarının en sık dirençli olduğu izlenen antibiyotikler sırasıyla sefuroksim (%88,5), tobramisin (%75), seftazidim (%72,9), sefepim (%59,5) ve ampisilin (%57,5) idi. Duyarlılığı en yüksek antibiyotikler ise sırasıyla imipenem (%100), amikasin (%99,1), meropenem (%98,2), nitrofurantoin (%96,3) ve fosfomisin (%96,3) idi. *E. coli* suşlarının %25,7'sinin GSBL pozitif olduğu görüldü.

Sonuç: Bulgularımız idrar yolu enfeksiyonunun en sık etkeni olan *E. coli* suşlarında tedavide sık kullanılan birçok antibiyotiğe yüksek direnç varlığını göstermiştir. Ampirik tedavide yerel direnç oranlarını dikkate alarak ve idrar kültürü yapılarak tedaviye başlanması tedavide yol gösterecektir. Araştırmamız sonucunda idrar yolu enfeksiyonunda ampirik tedavide komplike olmayan enfeksiyonlarda fosfomisin ve nitrofurantoin, komplike enfeksiyonlarda ve üst üriner sistem tutulumunda karbapenemler ve aminoglikozid grubu antibiyotiklerin kullanımının uygun olduğunu düşünmekteyiz.

Anahtar Kelimeler: *E. coli*, İdrar Kültürü, İdrar Yolu Enfeksiyonu, Antimikrobiyal Direnç.

INTRODUCTION

Urinary tract infections (UTI) are the most common bacterial infections encountered by physicians in all age groups (1). The annual global incidence of UTI is approximately 250 million and it is one of the most common medical problems in women (2, 3). It is stated that the second most common infection causing hospitalization after pneumonia is UTI (4).

UTI typically begins with periurethral contamination by an intestinal uropathogen, followed by colonization of the urethra and migration of the pathogen to the bladder, an event that requires extensions such as flagella and pili (5). In the bladder, it is determined whether uropathogens are successful in colonization or are eliminated as a result of complex host-pathogen interactions.

Infection by microorganisms differs according to reasons such as gender, age, duration of catheterization, underlying disease, faulty catheter care and lack of systemic antibiotic therapy (4, 6)

The most common cause of UTI is *Escherichia coli* from the Enterobacteriaceae family with a rate of 80-90% (1, 7, 8).

Classical diagnosis of UTI includes: taking history to identify recurrence experience and complicating factors, identification of symptoms including frequency, urgency and dysuria, physical examination of genitals and evaluation of suprapubic and flank pain, urinalysis using dipstick or microscopy and urine culture (9, 10). There are no leukocytes in the urine of healthy people, so the presence of leukocytes is considered an important criterion for the detection of pyuria. The test most closely related to culture on the dipstick was determined as the nitrite test (11). Urine culture is the gold standard test for the diagnosis of UTI (10,12).

UTIs are usually treated empirically with antibiotics as recommended by primary guidelines. Since the microbial spectrum of uncomplicated cystitis and pyelonephritis mainly consists of *E. coli*, local antimicrobial susceptibility patterns of *E. coli* should be considered in the empirical antimicrobial selection (13). Antibiotic resistance in *E. coli* strains isolated from UTIs is increasing day by day, making it an important public health problem, so it is very important to determine the antibiotic resistance patterns in *E. coli* isolates for correct prescriptions (14). *E. coli* infections that produce extended-spectrum beta-lactamase (ESBL) are particularly difficult to treat and increase morbidity, mortality, and treatment costs (15). ESBLs are beta-lactamases that can confer bacterial resistance to penicillins, first, second, and third generation cephalosporins and aztreonam by hydrolysis of these antibiotics (16, 17).

In this study, it was aimed to determine the antimicrobial resistance profiles of *E. coli* strains in the region, to obtain microbiological data about the current status, and to contribute to the development of clinical strategies for the prevention and management of these infections.

MATERIAL AND METHODS

This study includes patients with *E. coli* growth in their urine cultures who were studied at Erciyes University Medical Faculty Hospitals between January 2019 and January 2020. Urine cultures and antibiograms of the patients were scanned retrospectively.

The file numbers of the patients who could participate in the study were collected between the dates specified by the hospital information support unit, by searching for the word *'Escherichia coli'* in the urine culture results studied in patients over the age of 18.

A total of 662 specimens with a growth of 10^4 colony-forming units/ml and above in culture and for which antibiogram were studied were included in the study. Patients with *E. coli* growth in urine culture and patients over 18 years of age were included in the study.

This study was approved by the Erciyes University Clinical Research Ethics Committee's decision dated 09/09/2020 and numbered 2020/421, stating that there is no ethical objection to the study.

The files of the patients included in the study, the information registered in the system and the pre-filled forms were examined, and their age, gender, antibiograms, ESBL status, hospitalization status, admission outpatient clinic, reason for hospitalization, chronic and additional diseases (Chronic kidney failure , Diabetes Mellitus, hypertension, anemia, coronary artery disease, chronic obstructive pulmonary disease/asthma, malignancy, thyroid diseases, recurrent UTI, nephrolithiasis, kidney transplant, pregnancy, other), symptom status, the blood, nitrite, leukocyte parameters in the urinary dipstick test and antibiotic treatment started were recorded.

Statistical analyzes were performed using the SPSS version 15.0 (Chicago, USA) package program. The conformity of the variables to the normal distribution was examined using visual (histogram and probability graphs) and analytical methods (Kolmogrov Smirnov, Shapiro-Wilk test). Descriptive statistics were expressed as mean and standard deviation in normally distributed numerical data, median and minimum-maximum values in non-normally distributed data, and numbers and percentages in nominal data. Normally distributed numerical variables were analyzed using the “independent groups t-test” between the two groups. Numerical variables that were not normally distributed were analyzed using the "Mann Whitney U test" between the two groups. Chi-square analysis and Fisher Exact test were used to compare nominal data. In the

statistical analyzes in the study, values below $p<0.05$ were considered statistically significant.

RESULTS

This study was completed with the inclusion of 662 patients over the age of 18 who had *Escherichia coli*-produced urine cultures and antibiograms in Erciyes University Medical Faculty Hospitals.

The mean age of the patients in the study was 57.7 ± 17.8 years. The mean age of male patients was 65.5 ± 15.0, and the mean age of female patients was 55.5 ± 17.9. Of the patients, 78.5% (n=520) were female and 21.5% (n=142) were male. The most frequent application place of the patients was found to be the emergency service (33.4%). The treatment method was outpatient treatment in 71.5% (n=473) and inpatient treatment in 28.5% (n=189) patients. In hospitalized patients, the reason for hospitalization was UTI in 69.5% (n=105) of the patients, while it was another reason in 30.5% (n=46). The most common comorbidities in the patients were chronic renal failure (44.7%), hypertension (40.6%), and Diabetes Mellitus (31%). While 71.8% (n=385) of the patients were symptomatic, 28.2% (n=151) were asymptomatic (Table 1).

Table 1. Sociodemographic and clinical characteristics of the patients

Feature		**Amount**
Age	Mean ± SD	57.7 ± 17.8
Gender	N (%)	
	Woman	520 (78.5)
	Men	142 (21.5)
Application Place	N (%)	
	Emergency service	221 (33.4)
	Nephrology	117 (17.7)
	Urology	77 (11.6)
	Infection diseases	77 (11.6)
	Gynecology and Obstetrics	24 (3.6)
	Rheumatology	23 (3.5)
	Endocrinology	21 (3.2)
	Physical therapy and rehabilitation	21 (3.2)
	Internal medicine	19 (2.9)
	Oncology	9 (1.4)
	Other[1]	30 (4.5)
Form of treatment	N (%)	
	outpatient	473 (71.5)
	inpatient	189 (28.5)
Reason for hospitalization	N (%)	
	UTI	105 (69.5)
	Other	46 (30.5)
Additional illness	N (%)	
	Chronic kidney failure	296 (44.7)
	Hypertension	269 (40.6)
	Diabetes Mellitus	205 (31.0)
	Anemia	177 (26.7)
	Coronary artery disease	107 (16.2)
	Chronic obstructive pulmonary disease/asthma	89 (13.4)
	Malignancy	82 (12.4)
	Thyroid diseases	78 (11.8)
	Recurrent UTI	46 (6.9)
	Nephrolithiasis	29 (4.4)
	Kidney transplant	20 (3.0)
	Pregnancy	7 (1.1)
	Other	272 (41.1)
Symptom	N (%)	
	Positive	385 (71.8)
	Negative	151 (28.2)

[1]*Other, cardiology (n=5), gastroenterology (n=4), dermatology (n=3), family medicine (n=3), orthopedics (n=3), neurology (n=3), hematology (n=2), general surgery (n=2), chest diseases (n=2), otolaryngology (n=1), pain outpatient clinic (n=1), neurosurgery (n=1).*

The antibiotics most commonly found to be resistant to *E. coli* strains in antibiograms were cefuroxime (88.5%), tobramycin (75%), ceftazidime (72.9%), cefepime (59.5%) and ampicillin (57.5%). The antibiotics with the highest sensitivity were imipenem (100%), amikacin (99.1%), meropenem (98.2%), nitrofurantoin (96.3%) and fosfomycin (96.3%) (Table 2).

Table 2. Antibiogram results and distribution of the patients

Antibiogram	**N**	**Sensitive**		**Resistant**	
		Number	**Percent**	**Number**	**Percent**
Ciprofloxacin	609	428	70.3	181	29.7
Trimethoprim-sulfamethoxazole	597	385	64.5	212	35.5
Nitrofurantoin	568	547	96.3	21	3.7
Gentamicin	511	422	82.6	89	17.4
Cefixime	473	333	70.4	140	29.6
Fosfomycin	465	448	96.3	17	3.7
Ceftriaxone	418	260	62.2	158	37.8
Ampicillin sulbactam	380	280	73.7	100	26.3
Ertapenem	237	228	96.2	9	3.8
Cefuroxime axetil	216	134	62.0	82	38.0
Amoxicillin-clavulanic acid	171	109	63.7	62	36.3
Piperacillin-Tazobactam	167	141	84.4	26	15.6
Amikacin	113	112	99.1	1	0.9
Ampicillin	80	34	42.5	46	57.5
Ceftazidime	70	19	27.1	51	72.9
Cefotaxime	67	41	61.2	26	38.8
Meropenem	57	56	98.2	1	1.8
Cefepime	37	15	40.5	22	59.5
Imipenem	36	36	100	0	0
Levofloxacin	36	19	52.8	17	47.2
Cefuroxime	26	3	11.5	23	88.5
Tobramycin	16	4	25	12	75
Other					
Cefazolin	8	1	12.5	7	87.5
Cefoxitin	4	2	50	2	50
Azithromycin	1	0	0	1	100
Netilmicin	1	0	0	1	100

It was observed that 25.7% of *E. coli* strains were ESBL positive. Patients were analyzed according to the presence of ESBL in *E. coli* strains. In ESBL-positive patients, the frequency of male gender was significantly higher than in ESBL-negative patients (p=0.001). The frequency of inpatient treatment in ESBL-positive patients was significantly higher than in ESBL-negative patients (p=0.002) (Table 3).

Table 3. The urinary dipstick test results of the patients

Feature		**Number**	**Percent**
The urinary dipstick test			
Leukocyte	*N (%)*		
	Positive	563	88.7
	Negative	72	11.3
Blood	*N (%)*		
	Positive	327	51.5
	Negative	308	48.5
Nitrite	*N (%)*		
	Negative	342	53.9
	Pozitive	292	46.1

In the urinary dipstick results of the patients, 88.7% (n=563) had leukocytes, 51.5% (n=327) blood, and 53.9% (n=342) nitrite (Table 4).

The most commonly preferred antibiotics in the treatment of UTI due to *E. coli* were cefixime (27.4%), fosfomycin (26.9%), ciprofloxacin (15.6%), and ceftriaxone (14.2%) (Table 5).

Demographic, clinical and laboratory results of the patients were analyzed according to their gender. The mean age of male patients was

significantly higher than female patients (p<0.001). The frequency of outpatient treatment was higher in female patients than in male patients (p<0.001). The presence of leukocytes (p=0.012) and blood (p<0.001) was observed more frequently in male patients in the urinary dipstick test. (Table 6).

Table 4. Treatments given to the patients and their distribution

Antibiotic	Number	Percent
Cefixime	156	27.4
Fosfomycin	178	26.9
Ciprofloxacin	89	15.6
Ceftriaxone	81	14.2
Ertapenem	75	13.2
Nitrofurantoin	46	8.1
Piperacillin-Tazobactam	28	4.9
Meropenem	15	2.6
Amoxicillin-clavulanic acid	14	2.5
Trimethoprim-sulfamethoxazole	4	0.7
Levofloxacin	3	0.5
Cefuroxime	3	0.5
Vancomycin	3	0.5
Ampicillin sulbactam	2	0.4
Imipenem	1	0.2

Table 5. Comparison of demographic, clinical and laboratory results of patients according to the presence of ESBL

Feature		ESBL (-)	ESBL (+)	*P*
Age	*Mean ± SD*	57.3 ± 18.3	58.6 ± 16.4	0.420†
Gender	*N (%)*			***0.001***††
	Women	402 (81.7)	118 (69.4)	
	Men	90 (18.3)	52 (30.6)	
Form of treatment	*N (%)*			***0.002***††
	outpatient	367 (74.6)	106 (62.4)	
	inpatient	125 (25.4)	64 (37.6)	
Reason for hospitalization	*N (%)*			0.311††
	UTI	64 (66.7)	41 (74.5)	
	Other	32 (33.3)	14 (25.5)	
Symptom	*N (%)*			0.489††
	Pozitive	282 (71.0)	103 (74.1)	
	Negative	115 (29.0)	36 (25.9)	
The urinary dipstick test				
Leukocyte	*N (%)*			0.718††
	Pozitive	419 (88.4)	144 (89.4)	
	Negative	55 (11.6)	17 (10.6)	
Blood	*N (%)*			0.703††
	Pozitive	242 (51.1)	85 (52.8)	
	Negative	232 (48.9)	76 (47.2)	
Nitrite	*N (%)*			0.833††
	Negative	254 (53.7)	88 (54.7)	
	Pozitive	219 (46.3)	73 (45.3)	
Treatment	*N (%)*			0.147††
	monotherapy	329 (79.1)	113 (73.4)	
	dual therapy	87 (20.9)	41 (26.6)	

†T test for independent groups, ††Chi-square test

Table 6. Comparison of demographic, clinical and laboratory results of patients by gender

Feature		Men	Women	*P*
Age	*Ort ± SS*	65.5 ± 15.0	55.5 ± 17.9	***<0.001***†
Form of treatment	*N (%)*			***<0.001***††
	outpatient	81 (57.0)	392 (75.4)	
	inpatient	61 (43.0)	128 (24.6)	
Reason for hospitalization	*N (%)*			0.269††
	UTI	37 (75.5)	68 (66.7)	
	Other	12 (24.5)	34 (33.3)	
Symptom	*N (%)*			0.243††
	Pozitive	92 (76.0)	293 (70.6)	
	Negative	29 (24.0)	122 (29.4)	
The urinary dipstick test				
Leukocyte	*N (%)*			***0.012***††
	Pozitive	127 (94.8)	436 (87.0)	
	Negative	7 (5.2)	65 (13.0)	
Blood	*N (%)*			***<0.001***††
	Pozitive	89 (66.4)	238 (47.5)	
	Negative	45 (33.6)	263 (52.5)	
Nitrite	*N (%)*			0.656††
	Negative	70 (52.2)	272 (54.4)	
	Pozitive	64 (47.8)	228 (45.6)	
Treatment	*N (%)*			0.522††
	monotherapy	98 (79.7)	344 (77.0)	
	dual therapy	25 (20.3)	103 (23.0)	
ESBL	*N (%)*			***0.001***††
	Negative	90 (63.4)	402 (77.3)	
	Pozitive	52 (36.6)	118 (22.7)	

†T test for independent groups, ††Chi-square test

DISCUSSION

UTI is the most common bacterial infection in the human population and is also one of the most common nosocomial infections (1). UTI treatment is often initiated empirically, and treatment is based on information determined from the antimicrobial resistance pattern of urinary pathogens (2). Antibiotic resistance in *E. coli* isolated from UTIs is increasing day by day and it is very important to determine antibiotic resistance patterns in *E. coli* isolates for correct prescriptions, since this makes it an important public health problem (18).

Since it is the most common pathogen in urinary tract infection, patients with *E. coli* growth in culture were included in our study. In many studies both in our country and in the world, *E. coli* was found to be the most common pathogen in urinary tract infections. (19, 20).

In the study of Teker et al. the mean age of men was found to be significantly higher (21). In a study investigating UTI in men, it was found that positive urine cultures increased with age (22). In our study, the mean age was found to be higher in men, which is consistent with the data.

In our study, the most resistant antibiotic was cefuroxime with a rate of 88.5%. Resistance rates in other cephalosporins vary between 72.9% and 29.6%. In the study of Yüksek et al. (23), 35% resistance to cefuroxime, 32% to cefotaxime, 26% to cefepime; In the study of Alanlı et al. resistance to cefuroxime 22%, cefixime 32%, and ceftriaxone 29% (24) was found. The activity of cephalosporins is significantly reduced in *E. coli* due to ESBL production. We think that cephalosporins are not a suitable option for the treatment of *E. coli* in UTI due to the high resistance rates detected. Even cefixime, a third-generation cephalosporin, was resistant to one-third of the strains in our study. The reason for such high resistance may be that it has a high gram (-) efficiency and is often prescribed in outpatients.

One of the most preferred antibiotics empirically in UTI is the quinolone group. In different studies conducted in our country, ciprofloxacin resistance was found to be 31.3% (83) in 2009, 24.8% (25) in 2014, and 41% (26) in 2019. In a study conducted with isolates collected from 2009 to 2011 in the United States of America, 25.8% resistance to ciprofloxacin was observed (27). If the rate of resistance to ciprofloxacin is below 10%, it is appropriate to choose empirically. (28). It is thought that there is an increase in the development of resistance due to the frequent use of ciprofloxacin in outpatient empirical therapy. In this study, ciprofloxacin resistance was found to be 29.7% and it was thought that it would be more appropriate to use according to the culture result in UTI.

In our study, trimethoprim-sulfamethoxazole resistance was found to be 35.5%. In different studies conducted in Turkey, the resistance rates

are; it varies between 34.9% and 57.5%. (19, 29, 30, 31). Resistance was found at a rate of 32.1% (27) in the USA and 47.3% (32) in Mexico. In the guidelines (28), it is recommended that trimethoprim-sulfamethoxazole should be the first choice for empirical treatment in cases where the rate of resistance does not exceed 20% in the treatment of UTI. When the resistance rates in our study and in our country are examined, it is thought that it should not be used in empirical treatment.

Its effectiveness with minimal drug resistance and side effects makes nitrofurantoin an attractive agent for cystitis (28). Nitrofurantoin resistance was found to be 3.7% in our study. In different studies conducted in our country in 2018 and 2019, nitrofurantoin resistance was found to be 4% (24, 26, 33). Our data were found to be compatible with other studies in our country. In a multicenter study, a sensitivity of 98.8% to nitrofurantoin was reported in *E. coli* isolates, and it is the recommended first-line therapy in national treatment guidelines (34). Nitrofurantoin shows that it can be preferred for empirical treatment in uncomplicated lower urinary tract infections due to low resistance.

Bayram et al. reported 5% (35) resistance, Aşgın et al. reported 4.1% (36) resistance, and Tekin et al. reported 2.2% (37) resistance for fosfomycin in our country.In the study of Naber et al. fosfomycin showed the highest sensitivity rate against *E. coli* with 98.1% (20). In our study, fosfomycin resistance was found to be 3.7%. Due to low resistance, it may be appropriate to use fosfomycin as first-line choice in the empirical treatment of *E. coli*.

In the guideline of the European Association of Urology, it is recommended to prescribe fosfomycin or nitrofuratoin as first-line treatment for uncomplicated cystitis, and not to use aminopenicillins and fluoroquinolones (38).

Aminoglycosides are often preferred in the treatment of serious infections caused by gram-negative bacteria (39). In our study, gentamicin resistance was found to be 17.4% and amikacin resistance was found to be 0.9%. In the study of Sağlam et al. (19) 19.3% resistance rates were found to gentamicin, and 7% in the study of Alanlı et al. (24).

Carbapenems are frequently used in the treatment of infections caused by ESBL-producing *E. coli*. In our study, imipenem was found to be the most sensitive antibiotic with 0% resistance. The ertapenem and meropenem resistances were found to be 3.8% and 1.8%, respectively. In different studies in our country, no resistance was found against imipenem and meropenem (19, 29). The high carbapenem sensitivities of the *E. coli* strains examined in our study can be interpreted as being related to their limited use and for certain indications.

According to the results of our research, it was concluded that while fosfomycin and nitrofurantoin are rational antibiotics that can be used in the treatment of lower urinary tract infections, carbapenems and aminoglycosides are alternatives that can be used in indications such as pyelonephritis and urosepsis. However, side effects such as ototoxicity and nephrotoxicity limit the use of aminoglycosides.

Today, morbidity-mortality and treatment costs are increasing due to the widespread use of antibiotics, especially the number of ESBL-producing strains and the developing antimicrobial resistance. In our study, *E. coli* strains were found to be ESBL positive in 25.7% of the patients. Durmaz et al. reported that ESBL production was 32.8% in a study conducted in 2015 (37). In the study conducted by Bayram et al. in 2010, ESBL production was found to be 29.9% (35). The ESBL rate in our study was found to be similar to the studies in the literature.

ESBL production was found to be significantly higher in male gender. The incidence of UTI in male gender increases with advancing age (40). With advanced age, an increase in prostate diseases, more hospitalizations and more exposure to antibiotics occur. This causes increased resistance, and this may be the reason for the high rate of resistant strains in males. In the study of Doğru et al. ESBL-producing *E. coli* strains were found to be higher in males, making a significant difference (41).

In our study, the most commonly preferred antibiotics in the treatment of UTI due to *E. coli* were cefixime (27.4%), fosfomycin (26.9%), and ciprofloxacin (15.6%). In a study investigating the antibiotic preferences of primary care physicians, quinolone group antibiotics, which were not primarily recommended in cystitis, were preferred most with 57% (42). The clinical picture in UTI is often simple cystitis (6), and in our study, it was seen that the majority of the outpatients were 71.5%. In this case, we can conclude that quinolones and third generation cephalosporins, which should not be preferred, are frequently used in our hospital. The reason for this may be that, since our study was conducted in a tertiary hospital, the possibility of infections caused by resistant and difficult-to-treat strains is high in most applications.

For rational antibiotic use, monitoring of regional and current resistance is of great importance in empirical treatment. Our study shows the current resistance rates in Erciyes University Medical Faculty Hospital in Kayseri province and that there is no similar study in this region in the literature. This is the strength of our work.

Due to the retrospective analysis of the data in our study, the inability to obtain information on the collection method of the studied urine samples is one of the limitations. Another limitation of our

study is that the study reflects the experience of a single center.

CONCLUSION

The most common organism in the etiology of UTI is *E. coli*. In our study, the data of patients with *E. coli* growth in 2019 in Erciyes University hospital in Kayseri province were examined.

We recommend the use of urine cultures, which is the gold standard for diagnosis, as it will prevent inappropriate antibiotic use and the development of resistant strains.

In our study, sensitivity was found to be high in fosfomycin, nitrofurantoin, aminoglycosides and carbapenems. As a result of these data, we recommend the use of fosfomycin and nitrofurantoin in uncomplicated and lower UTIs, carbapenems and aminoglycoside antibiotics in complicated and upper UTIs in empirical treatment.

Finally, our study's results may not be valid for areas with different epidemiological conditions. Therefore, we believe that the periodic determination of hospital antimicrobial resistance rates, and the selection of antibiotics according to antimicrobial sensitivity in the treatment of the agent will prevent the development of resistance.

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