RESEARCH ARTICLE

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Antibiotic Susceptibilities of *Escherichia coli* Strains Isolated From Urine Samples in a Tertiary Hospital in Eastern Turkey

ABSTRACT

Objective: *Escherichia coli* is the most common cause of urinary tract infections. The increase and spread of resistance to antibiotics is a serious problem in our country as well as in the world. The aim of this study was to determine the antimicrobial susceptibility profiles of *E. coli* strains that cause urinary tract infection.

Methods: The antibiotic susceptibilities of 1850 *E. coli* strains isolated from urine samples of patients who applied to Urology service and outpatient clinics of Malatya Education and Research Hospital, which is a tertiary care hospital in eastern part of Turkey, over the 3 years between July 2016 and July 2019, were evaluated retrospectively from computer records using the Vitek 2.0 Compact automated system (BioMérieux, France). Antibiogram results were classified as susceptible, moderately susceptible and resistant.

Result: Of the total 1850 samples, 1300 (70.3%) were female and 550 (29.7%) were male, with a mean age of 52 (18-104) years. 73 (3.9%) of the patients were inpatients and 1777 were outpatients. All the isolated *E. coli* strains were found to be susceptible to ampicillin 39.2%, amoxicillin-clavulanic acid 67.9%, piperacillin-tazobactam 80.8%, cefuroxime 67.1%, cefotaxime 68.8%, cefixime 67.7%, ceftazidime 71.2%, cefepime 73.9%, ertapeneme 97.9%, imipeneme 99.5%, meropeneme 99.7%, amikacin 89.7%, gentamicin 78.4%, norfloxacine 65.8%, ciprofloxacine 65.9%, nitrofurantoin 94.2% and fosfomycin 96.5%. Resistance rates were higher in inpatients as compared to outpatients. Antibiotic susceptibilities were found to be decreased in different age ranges with increasing age.

Conclusion: When selecting the antimicrobial treatment in community-acquired urinary tract infections, considering the antimicrobial resistance data in the region, the choice of cost-effective treatment with high patient compliance and low resistance rates will increase treatment success. It is thought that antibiotic treatment should be determined according to the results of culture antibiograms, especially in nosocomial infections due to high resistance rates.

Keywords: Antibiotic Resistance, *Escherichia coli*, Urinary Tract Infections

Türkiye'nin Doğusunda Üçüncü Basamak Bir Hastanede İdrar Örneklerinden İzole Edilen *Escherichia coli* Suşlarının Antibiyotiklere Duyarlılıkları

ÖZET

Amaç: Üriner sistem enfeksiyonlarının etkenleri arasında en sık *Escherichia coli* izole edilmektedir. Antibiyotiklere karşı gelişen direncin artması ve yayılması bütün dünyada olduğu gibi ülkemizde de ciddi bir sorundur. Çalışmamızda, üriner sistem enfeksiyonu etkeni olan *E. coli* suşlarının antimikrobiyal duyarlılık profillerinin belirlenmesi amaçlanmıştır.

Gereç ve Yöntem: Temmuz 2016–Temmuz 2019 tarihleri arasında 3 yıllık süreçte, Malatya Eğitim ve Araştırma Hastanesi Üroloji servis ve polikliniklerine başvuran hastaların, idrar örneklerinden izole edilen 1850 *Escherichia coli* suşunun, Vitek 2.0 Compact otomatize sistemi (BioMérieux, Fransa) kullanılarak belirlenen antibiyotik duyarlılıkları bilgisayar kayıtları üzerinden retrospektif olarak incelenmiştir. Antibiyogram sonuçları duyarlı, orta duyarlı ve dirençli olarak sınıflandırılmıştır. Verilerin değerlendirilmesi aşamasında orta duyarlı suşlar dirençli olarak kabul edilmiştir.

Bulgular: Toplam 1850 örneğin 1300'ü (%70,3) kadın, 550'si (%29,7) erkek hastaya ait olup tüm hastaların yaş ortalaması 52 (18-104) idi. Hastaların 73'ü (%3,9) yatan hasta, 1777'si poliklinik hastasıydı. İzole edilen tüm *Escherichia coli* suşlarının ampisiline %39,2, amoksisilin-klavulonik asite %67,9, piperasilin-tazobaktama %80,8, sefuroksime %67,1, sefotaksime %68,8, sefiksime %67,7, seftazidime %71,2, sefepime %73,9, ertapeneme %97,9, imipeneme %99,5, meropeneme %99,7, amikasine %89,7, gentamisine %78,4, norfloksasine %65,8, siprofloksasine %65,9, nitrofurantoine %94,2 ve fosfomisine %96,5 duyarlı olduğu saptanmıştır. Yatan hastalarda direnç oranları ayaktan tedavi olanlara kıyasla yüksek bulunmuştur. Değişen yaş aralıklarında yaş ilerledikçe antibiyotik duyarlılıklarının düştüğü görülmüştür.

Sonuç: Toplum kökenli üriner sistem enfeksiyonlarında antimikrobiyal tedavi seçiminde, bölgesel antimikrobiyal direnç verileri göz önüne alınarak; direnç oranlarının düşük, hasta uyumunun yüksek olduğu, maliyet etkin tedavilerin tercihi tedavi başarısını artıracaktır. Özellikle nozokomiyal enfeksiyonlarda yüksek direnç oranları nedeni ile kültür antibiyogram sonucuna göre antibiyotik tedavisinin belirlenmesi gerektiği düşünülmektedir.

Anahtar Kelimeler: Antibiyotik Direnci, *Escherichia coli*, Üriner Sistem Enfeksiyonları

INTRODUCTION

Urinary tract infections (UTIs), which are reported to affect 150 million people annually, are the second most common cause of infectious diseases. The incidence of UTI in all age groups from neonates to elderly increases with age. It is more commonly seen in neonates, pregnant women or elderly patients. Approximately 15% of all prescribed antibiotics are for UTI treatment. The clinical spectrum of infections includes urethritis, cystitis, prostatitis and pyelonephritis. If left untreated, it may cause serious complications such as kidney damage and kidney failure (1, 2).

UTI is usually caused by Gram negative bacteria such as *E. coli*, *Proteus* species, *Pseudomonas aeruginosa*, *Acinetobacter* species, *Klebsiella* species, *Enterobacter* and *Citrobacter* species. Gram-positive bacteria include *Staphylococcus saprophyticus*, *Enterococcus* species and coagulase-negative *Staphylococcus* species. Bacteria responsible for causing UTI, have more aggressive virulence factors. *Escherichia coli* is the most common cause of community-acquired and healthcare related urinary tract infections. Uropathogenic *E. coli* (UPEC) strains show their pathogenicity in the urinary tract by different virulence factors such as fimbria, capsule, flagella, toxins and lipopolysaccharide (1, 3).

Antibiotic susceptibility of uropathogenic bacteria varies over time and in different regions. In almost all uncomplicated UTI cases, antimicrobial treatment is initiated empirically without urine culture results. Inappropriate use of antibiotics has resulted in the development of antibiotic resistance in bacteria worldwide. Antimicrobial resistance is an important public health concern that increases patient care costs, prolongs hospital stay and causes treatment failures. Antimicrobial resistance surveillance studies at national level are of great importance in the fight against resistance problem. (4-6).

Fosfomycin, which is commonly used in the treatment of UTI, is an agent with a broad spectrum of antimicrobial activity that inhibits enolpyruvile transferase irreversibly in the first stage of bacterial cell wall synthesis and is often used in the treatment of uncomplicated urinary tract infections. Since its discovery in 1969, there has been an increasing interest in the use of fosfomycin in the treatment of urinary and systemic infections caused by multi-drug resistant Gram negative bacteria, especially *Enterobacteriaceae*, which are resistant to agents used conventionally (7, 8).

The most effective way to maintain the effectiveness of antibiotics in future generations, to prevent increasing resistance rates and to prevent the spread of resistant bacteria is the rational use of antibiotics. In this study, we aimed to determine the susceptibility of E. coli strains, which are the causative agents of urinary system infection, to the most commonly used antibiotics in the clinic, to raise awareness for the effective use of antibiotics and to guide empirical treatment.

In our study, in vitro antibiotic susceptibility of *E. coli* strains isolated from urology outpatient clinics and wards of our hospital over the 3 years, to drugs such as ampicillin (AM), amoxicillin-clavulanic acid (AMC), piperacillin-tazobactam (TZP), cefuroxime (CXM), cefotaxime (CTX), cefixime (CFM), ceftazidime (CAZ), cefepime (FEP), ertapenem (ETP), imipenem (IPM), meropenem (MEM), amikacin (AN), gentamicin (GN), norfloxacin (NOR), ciprofloxacin (CIP), nitrofurantoin (FT) and fosfomycin (FOS), were investigated retrospectively. The aim of this study was to determine the antimicrobial susceptibility profiles of *E. coli* strains that cause urinary tract infection.

MATERIAL AND METHODS

The patients admitted to the Urology service and outpatient clinics of Malatya Education and Research Hospital, with a capacity of 1040 beds, with the suspicion of UTI and diagnosed as urinary infection between July 2016 and July 2019, were retrospectively evaluated. Patients with urine culture growth were included in the study.

In vitro antimicrobial susceptibility of urine cultures, sent to the Microbiology Laboratory of our hospital and found to have growth, to drugs such as ampicillin (AM), amoxicillin-clavulanic acid (AMC), piperacillin-tazobactam (TZP), cefuroxime (CXM), cefotaxime (CTX), cefixime (CFM), ceftazidime (CAZ), cefepime (FEP), ertapenem (ETP), imipenem (IPM), meropenem (MEM), amikacin (AN), gentamicin (GN), norfloxacin (NOR), ciprofloxacin (CIP), nitrofurantoin (FT) and fosfomycin (FOS), was determined using the Vitek 2.0 Compact automated system (BioMérieux, France). Antibiogram results were classified as susceptible, moderately susceptible and resistant. Moderately susceptible strains were considered to be resistant during the evaluation of the data.

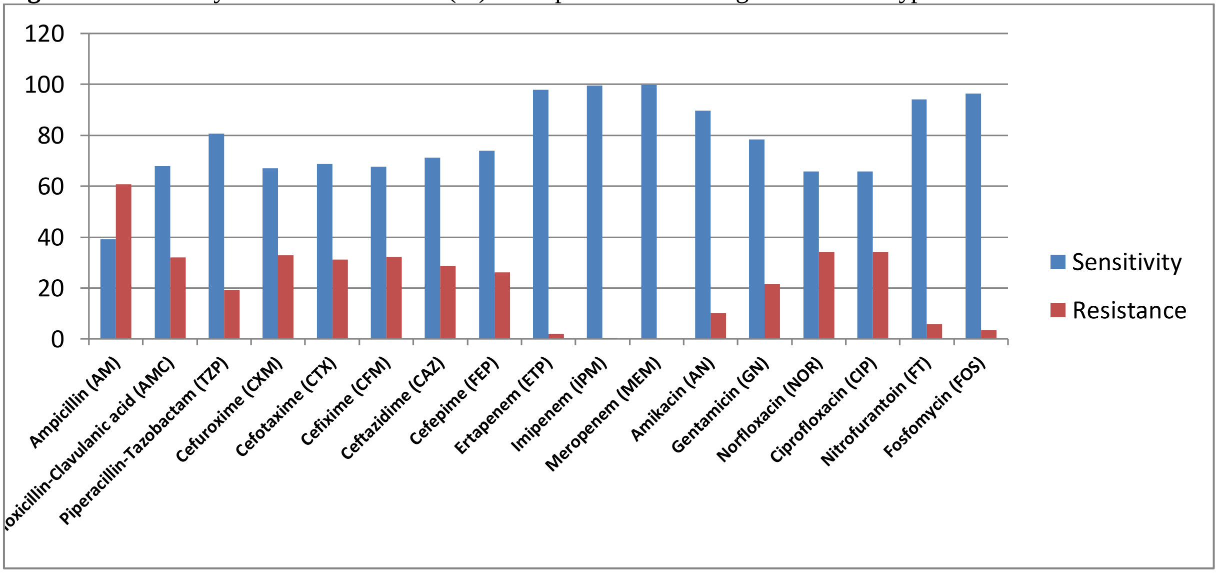
The approval was obtained from Malatya *Clinical Research Ethics Committee* on June 3th, 2020 with the protocol number 2020/55.

All necessary data for the study were obtained from hospital information system. SPSS 22 program was used for data analysis. Data were analyzed by Pearson Chi-square, Yates chi-square and Fisher chi-square tests. $p<0.05$ was considered to be significant. Percentage (%) of descriptive statistics was used in order to show the distribution of antibiotic susceptibility and resistance.

RESULTS

1850 patients (1300 females and 550 males) with *E. coli* growth in their urine culture were included in the study, and the mean ages were 52 ± 19.4 (18-104). The susceptibility of isolated *E. coli* to antibiotics was very high for carbapenems such as meropenem, imipenem and ertapenem (99.7%, 99.5% and 97.9%, respectively). In terms of susceptibility, these antibiotics were followed by fosfomycin (96.5%), nitrofurantoin (94.2%), amikacin (89.7%), piperacillin-tazobactam (80.8%), gentamicin (78.4%), cefepime (73.9%), ceftazidime (71.2%), cefotaxime (68.8%) and amoxicillin-clavulanic acid (67.9%). Ampicillin 60.8%, norfloxacin 34.2%, ciprofloxacin 34.1%, cefuroxime 32.9% and cefixime 32.3% were the most resistant antibiotics with high resistance rates (Figure 1).

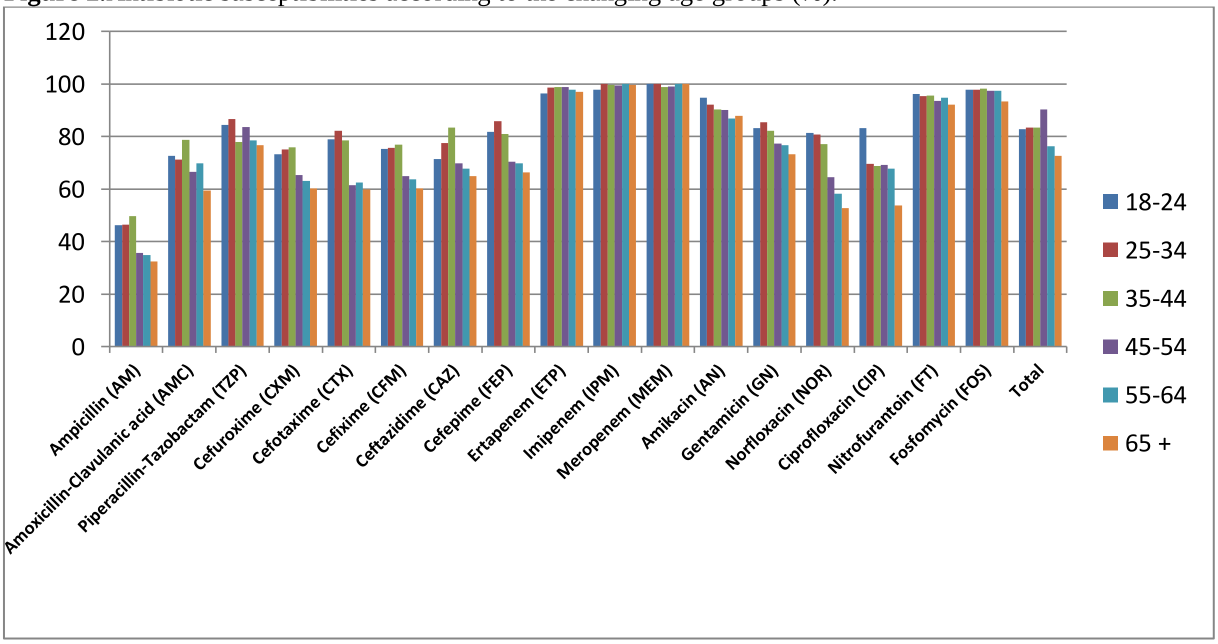
Figure 1. Sensitivity and resistance rates (%) in all patients according to antibiotic types.



Abbreviations: AM, ampicillin; AMC, amoxicillin-clavulanic acid; TZP, piperacillin-tazobactam; CXM, cefuroxime; CTX, cefotaxime; CFM, cefixime; CAZ, ceftazidime; FEP, cefepime; ETP ertapenem; IPM, imipenem; MEM, meropenem; AN, amikacin; GN, gentamicin; NOR, norfloxacin; CIP, ciprofloxacin; FT, nitrofurantoin; FOS, fosfomycin.

We divided our patients into 6 age groups as 18-24, 25-34, 35-44, 45-54, 55-64 and over 65 years of age and showed the effects of age changes on antibiotic susceptibility. In general, we found that the antibiotic susceptibility decreased with increasing age in all antibiotics (Figure 2).

Figure 2. Antibiotic susceptibilities according to the changing age groups (%).



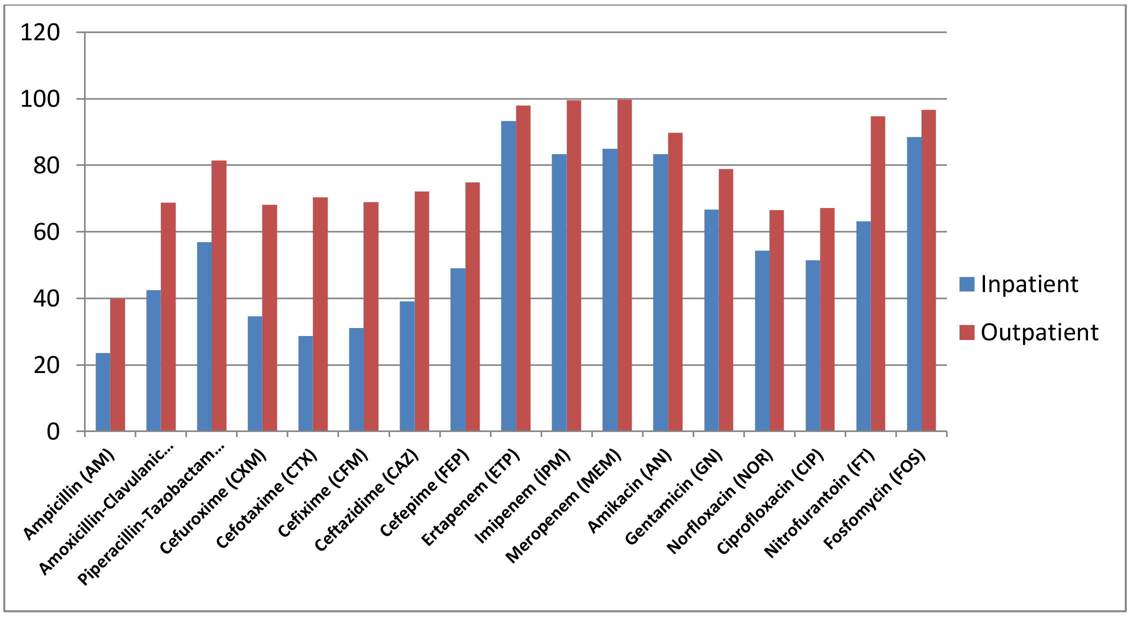
When the antibiotic susceptibilities were examined according to the changing age groups, the relationship between ampicillin, amoxicillin-clavulanic acid, cefuroxime, cefotaxime, cefixime, ceftazidime, cefepime, gentamicin, norfloxacin, ciprofloxacin and fosfomycin antibiotics and age groups, was found to be statistically significant (Table 1).

Table 1. Antibiotic susceptibilities according to the changing age groups.

	N / n (%)	N / n (%)	N / n (%)	N / n (%)	N / n (%)	N / n (%)	
Name of Antibiotic	**18-24**	**25-34**	**35-44**	**45-54**	**55-64**	**65<**	**p**
Ampicillin (AM)	177/82(46,3)	235/109(46,4)	273/136(49,8)	266/95(35,7)	278/97(34,9)	556/18132,5	**<0,001**
Amoxicillin-Clavulanic Acid (AMC)	164/119(72,6)	219/156(71,2)	255/201(78,8)	254/169(66,5)	259/181(69,9)	508/302(59,5)	**<0,001**
Piperacillin-Tazobactam (TZP)	90/76(84,4)	113/98(86,7)	100/78(78)	129/108(83,7)	112/88(78,6)	219/168(76,7)	0,203
Cefuroxime (CXM)	187/137(73,3)	238/179(75,2)	279/212(76)	277/181(65,3)	290/183(63,1)	571/344(60,2)	**<0,001**
Cefotaxime (CTX)	95/75(78,9)	113/93(82,3)	126/99(78,6)	138/85(61,6)	99/82(62,6)	229/137(59,8)	**<0,001**
Cefixime (CFM)	178/134(75,3)	235/178(75,7)	274/211(77)	263/171(65)	279/178(63,8)	554/334(60,3)	**<0,001**
Ceftazidime (CAZ)	119/85(71,4)	152/118(77,6)	211/176(83,4)	183/128(69,9)	218/148(67,9)	428/278(64,9)	**<0,001**
Cefepime (FEP)	148/121(81,8)	198/170(85,9)	233/189(81,1)	220/155(70,4)	223/156(69,9)	467/310(66,4)	**<0,001**
Ertapenem (ETP)	170/164(96,5)	229/226(98,7)	264/261(98,9)	257/254(98,8)	269/263(97,8)	541/525(97)	0,261
Imipenem (IPM)	136/133(97,8)	175/175(100)	226/225(99,6)	201/200(99,5)	228/228(100)	4627460(99,6)	0,069
Meropenem (MEM)	74/74(100)	90/90(100)	87/86(98,8)	115/114(99,1)	102/102(100)	185/185(100)	0,466
Amikacin (AN)	173/164(94,8)	228/210(92,1)	269/243(90,3)	253/228(90,1)	265/230(86,8)	543/478(88)	0,061
Gentamicin (GN)	180/150(83,3)	240/205(85,4)	275/226(82,2)	277/214(77,3)	289/222(76,8)	564/413(73,2)	**0,001**
Norfloxacin (NOR)	145/118(81,4)	203/164(80,8)	233/180(77,2)	220/142(64,5)	228/133(58,3)	463/244(52,7)	**<0,001**
Ciprofloxacin (CIP)	42/35(83,3)	33/23(69,7)	45/31(68,9)	52/36(69,2)	59/40(67,8)	106/57(53,8)	**0,020**
Nitrofurantoin (FT)	188/181(96,3)	241/230(95,4)	278/266(95,7)	280/262(93,6)	291/276(94,8)	568/524(92,2)	0,177
Fosfomycin (FOS)	177/175(97,9)	237/232(97,9)	271/266(98,2)	270/263(97,4)	281/274(97,5)	552/515(93,3)	**<0,001**

Inpatients and outpatients were also evaluated in our study. 73 (3.9%) of the patients were inpatients and 1777 were outpatients. In all comparisons for all antibiotics, antibiotic susceptibility was observed to be higher in outpatients than in inpatients (Figure 3).

Figure 3. Antibiotic susceptibilities in inpatients and outpatients (%).

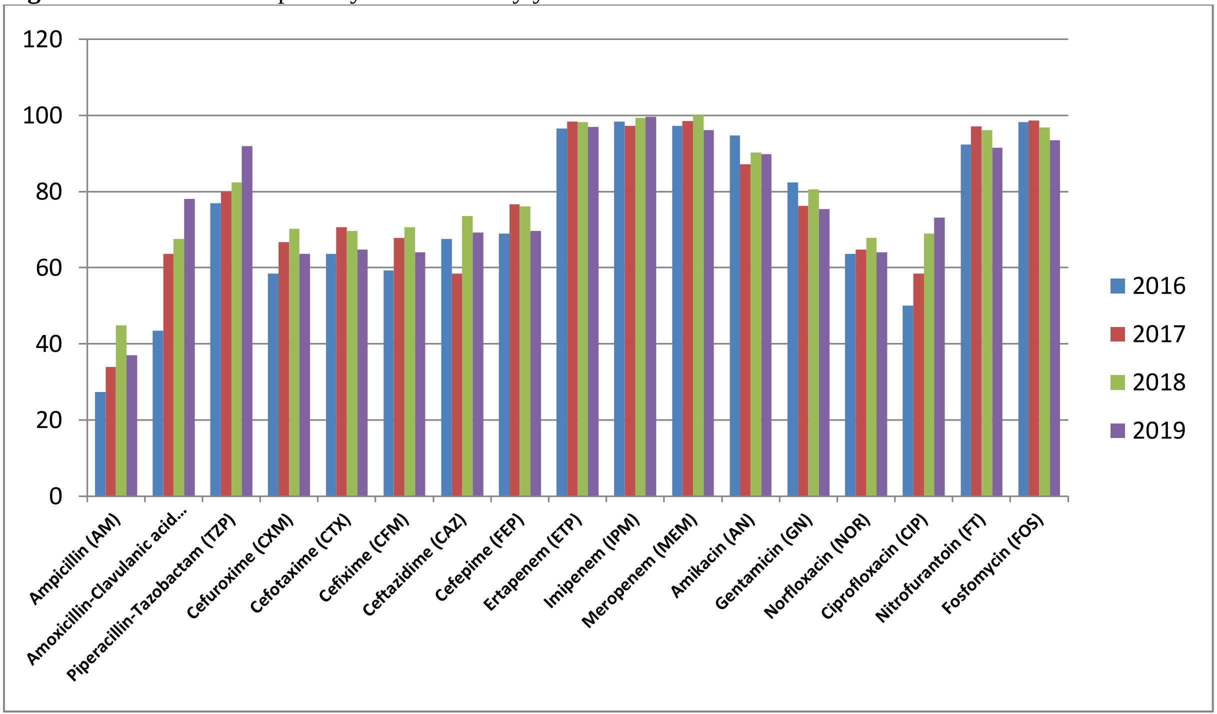


When the antibiotic susceptibilities in inpatients and outpatients were observed, the relationship between them in terms of ampicillin, amoxicillin-clavulanic acid, piperacillin-tazobactam, cefuroxime, cefotaxime, cefixime, ceftazidime, cefepime, imipenem, meropenem, gentamicin, nitrofurantoin and fosfomycin antibiotics, was found to be statistically significant (Table 2). In our study, six months data for 2016 and 2019 and all data for 2017 and 2018, were evaluated separately. We have shown antibiotic susceptibility distribution by years atFigure 4.

Table 2. Antibiotic susceptibilities in inpatients and outpatients.

	N / n (%)	N / n (%)	
Antibiotic Name	**Inpatient**	**Outpatient**	**p**
Ampicillin (AM)	55/13 (23,6)	1722/687 (39,9)	**0,022**
Amoxicillin-Clavulanic acid (AMC)	47/20 (42,5)	1599/1099 (68,7)	**<0,001**
Piperacillin-Tazobactam (TZP)	51/29 (56,9)	730/595 (81,5)	**<0,001**
Cefuroxime (CXM)	52/18 (34,6)	1776/1211 (68,2)	**<0,001**
Cefotaxime (CTX)	28/8 (28,6)	767/539 (70,3)	**<0,001**
Cefixime (CFM)	45/14 (31,1)	1722/1187 (68,9)	**<0,001**
Ceftazidime (CAZ)	46/18 (39,1)	1265/913 (72,2)	**<0,001**
Cefepime (FEP)	53/26 (49,1)	1437/1077 (74,9)	**<0,001**
Ertapenem (ETP)	45/42 (93,3)	1669/1635 (98,0)	0,071
Imipenem (IPM)	60/50 (83,3)	1370/1363 (99,5)	**<0,001**
Meropenem (MEM)	40/34 (85,0)	633/631 (99,7)	**<0,001**
Amikacin (AN)	60/50 (83,3)	1670/1500 (89,8)	0,161
Gentamicin (GN)	72/48 (66,7)	1756/1385 (78,9)	**0,020**
Norfloxacin (NOR)	46/25 (54,3)	1443/960 (66,5)	0,119
Ciprofloxacin (CIP)	33/17 (51,5)	316/212 (67,1)	0,971
Nitrofurantoin (FT)	57/36 (63,2)	1779/1684 (94,7)	**<0,001**
Fosfomycin (FOS)	52/46 (88,5)	1723/1664 (96,6)	**0,010**

Figure 4. Antibiotic susceptibility distribution by years.



When the antibiotic susceptibility and resistance rates were examined by years, it was found that the change in the resistance of isolates against ampicillin, amoxicillin-clavulanic acid, cefuroxime, cefixime, ceftazidime, cefepime, imipenem, gentamicin, norfloxacin, nitrofurantoin, and fosfomycin was statistically significant (Table 3).

DISCUSSION

Antibiotic is the most commonly used as well as misused drug in our country as in the world. Overuse and misuse of antimicrobials bring about resistance problems. Antimicrobial resistance reduces the efficacy of antimicrobial drugs and makes the treatment of the patients difficult, costly, and even impossible. Turkey is the country with the highest consumption level of antibiotic in the world. In addition, it is the second country with the highest antimicrobial resistance rate among the countries with data in the world. For these reasons, antimicrobial resistance is a serious threat for our country (9).

Table 3. Antibiotic susceptibility distribution by years.

	N / n (%)				
Antibiotic Name	**2016**	**2017**	**2018**	**2019**	**p**
Ampicillin (AM)	113/31 (27,4)	438/149 (34,0)	780/350 (44,9)	462/ 171 (37,0)	**<0,001**
Amoxicillin-Clavulanic acid (AMC)	113/49 (43,4)	386/246 (63,7)	715/483 (67,5)	453/354 (78,1)	**<0,001**
Piperacillin-Tazobactam (TZP)	96/74 (77,0)	388/310 (79,9)	256/211 (82,4)	26/24 (92,0)	0,294
Cefuroxime (CXM)	113/66 (58,4)	435/290 (66,7)	839/589 (70,2)	463/295 (63,7)	**0,019**
Cefotaxime (CTX)	102/65 (63,7)	358/253 (70,7)	155/108 (69,7)	649/420 (64,7)	0,195
Cefixime (CFM)	113/67 (59,3)	438/297 (67,8)	778/550 (70,7)	460/295 (64,1)	**0,023**
Ceftazidime (CAZ)	40/27 (67,5)	82/48 (58,5)	732/539 (73,6)	464/321 (69,2)	**0,022**
Cefepime (FEP)	103/71 (68,9)	381/292 (76,6)	570/434 (76,1)	442/308 (69,7)	**0,039**
Ertapenem (ETP)	113/109 (96,5)	383/377 (98,4)	779/765 (98,2)	463/449 (97,0)	0,293
Imipenem (İPM)	125/123 (98,4)	182/177 (97,2)	728/724 (99,4)	461/459 (99,6)	**0,019**
Meropenem (MEM)	36/35 (97,2)	390/384 (98,5)	267/267 (100,0)	26/25 (96,1)	0,114
Amikacin (AN)	113/107 (94,7)	415/362 (87,2)	746/673 (90,2)	464/417 (89,9)	0,111
Gentamicin (GN)	125/103 (82,4)	414/316 (76,3)	834/672 (80,6)	460/347 (75,4)	**0,049**
Norfloxacin (NOR)	102/65 (63,7)	358/232 (64,8)	602/408 (67,8)	436/279 (64,0)	**<0,001**
Ciprofloxacin (CIP)	12/6 (50,0)	82/48 (58,5)	219/151 (69,0)	26/19 (73,1)	0,184
Nitrofurantoin (FT)	119/110 (92,4)	438/412 (97,1)	838/805 (96,1)	457/418 (91,5)	**0,007**
Fosfomycin (FOS)	113/11 (98,2)	384/379 (98,7)	837/810 (96,8)	460/430 (93,5)	**0,001**

E. coli is the most common bacterial pathogen among community-acquired and hospital-acquired UTI agents. Today, as in the world, there is a dramatic increase in resistance to some antibiotics used in the treatment of urinary tract infections caused by uropathogen *E. coli* strains in our country. Due to the rapid spread of antimicrobial resistance problem, treatment failures are encountered while treating UTI caused by *E. coli*. Treatment failures lead to prolongation, recurrence or chronicity of the infection, thus leading to increased treatment costs and reduced life quality of the patient.

The differences are observed in antibiotic susceptibility or resistance of *E.coli* strains, which are primary pathogens, between regions and even between centers of the same region as a result of the differences in the frequency and policies of antibiotic use. It is noteworthy that resistance rates are higher in inpatients than in outpatients. Periodic detection of antibiotic resistance is important in terms of determining effective treatment and preventing loss of time and money in treatment. The Infectious Diseases Society of America recommends regional surveillance to monitor changes in the susceptibilities of uropathogens in certain regions (1). According to the EARSS-Net 2016 report, the mean resistance of invasive *E. coli* isolates of the European Union (EU) countries was determined to be 12.4% for third generation cephalosporins, 10.4% for aminoglycosides and 0.1% for carbapenem. Our data are well above EU averages (10).

In a study conducted in US showing antibiotic resistance in UTIs in 2018, it was reported that the susceptibility of nitrofurantoin had not changed for 10 years and it was around 92.2%, the susceptibility of fosfomycin was 98.9%, the resistance to fluoroquinolones increased to 11.8%, the amoxicillin-clavulanic acid resistance was 4% and the susceptibility levels in cephalosporins were approximately 90%. These sensitivity rates in America are quite good compared to the data of our country (2).

In a multicenter study conducted in Russia in 2019, *E. coli* (49.2%) was the most frequently isolated species among uropathogens. Resistance to ampicillin was 50%, resistance to levofloxacin was 28.8%, and resistance to cefuroxime was found to be 21%, whereas resistance to imipenem (0.7%), amikacin (0.9%), nitrofurantoin (4.5%) and fosfomycin (1.2%) were found to be very low (11). Resistance data of our country are quite above these rates.

According to the 2016 surveillance data of the National Antimicrobial Resistance Surveillance System (NAMRSS) including 4342 *E. coli* isolates, ceftriaxone/cefotaxime resistance from 3rd generation cephalosporins was found to be 51.1%, ceftazidime resistance was 54.2%, gentamicin resistance from aminoglycosides was 29.3% and amikacin resistance was 8.7% in the invasive *E. coli* isolates. Ciprofloxacin resistance from fluoroquinolone group was found to be 54.2%, levofloxacin resistance was 53.5%, and imipenem, meropenem and ertapenem resistance from the carbapenem group were 5.2%, 3.1% and 8.2%, respectively. Colistin resistance was found to be 3% in 2742 isolates. Multidrug resistance (resistance to fluoroquinolones, 3rd generation cephalosporins and aminoglycosides) was found in 25% of isolates (10). In our study, amikacin resistance was found to be 10.3% higher than this study, whereas, the resistance rates to all other antibiotics were found to be lower.

In a study conducted by Yousefi Rad et al. in Ankara, 29.2% of 677 *E. coli* strains were found to be resistant to ciprofloxacin, 64.8% to ampicillin, 38.6% to trimethoprim / sulfamethoxazole, 13.9% to ceftriaxone, 4.6% to amikacin and 6.1% to nitrofurantoin (12).

In a study conducted by Deveci et al. in Mardin Kiziltepe, all *E. coli* strains isolated from urine samples were susceptible to fosfomycin, whereas their resistance to ciprofloxacin, imipenem, piperacillin-tazobactam and ceftazidime were found to be 33.3%, 49.1%, 36.8% and 45.6%, respectively (13).

In a study conducted by Gozukucuk et al. in Istanbul, 191 *E. coli* strains were isolated and the resistance rates were found to be 40% in trimethoprim-sulfamethoxazole, 19.8% in ciprofloxacin, 19.2% in ceftriaxonde and 12.4% in nitrofurantoin (14). In our study, nitrofurantoin resistance with 5.8% was lower than this study, whereas, Ciprofloxacin resistance was higher with 34.1%.

In a study of 285 *E. coli* isolates in the province of Van, Zengin et al. found the resistance rates of ampicillin, amoxicillin-clavulanic acid, cefuroxime axetil, ceftazidime, ceftriaxone, cefaperozone/sulbactam, gentamicin, amikacin, ciprofloxacin, norfloxacin to be 55%, 42%, 30%, 15%, 18%, 6%, 10%, 5%, 33%, 34% and 45%, respectively. All strains were found to be susceptible to meropenem and imipenem (15). In our study, common antibiotics were generally found to have higher resistance.

In a study conducted by Tekin et al. in Diyarbakir, 3279 *E. coli* strains were isolated from urine samples and 97.8% of the isolated strains were susceptible to fosfomycin, 41.1% to ciprofloxacin, 39.8% to trimetoprim-sulfamethoxazole and 22.2% were found to be susceptible to amoxicillin-clavulanic acid (16). Higher susceptibilities were determined in our study.

In a study conducted by Yilmaz et al. in Izmir, 8975 isolated *E. coli* strains were resistant to antimicrobial drugs; ampicillin 66.9%, cefazolin 42.9%, cefuroxime 30.9%, ceftazidime 14.9%, ceftriaxone 28%, cefepime 12%, amoxicillin-clavulanic acid 36.9%, trimethoprim sulfamethoxazole (TMP-SXT) 20% , ciprofloxacin 49.9%, amikacin 0.3%, gentamicin 24%, nitrofurantoin 0.9% and fosfomycin 4.3%, whereas, there was no resistance detected to imipenem and meropenem (17). All these studies show that the susceptibility results of different time and centers are quite different from each other. In our study, resistance rates were found to be the highest in ampicillin which is an aminopenicillin, ciprofloxacin and norfloxacin from fluoroquinolone group, cefuroxime, cefixime, cefotaxime, ceftazidime and cefepime which are the 2nd, 3rd and 4th generation cephalosporins, and amoxicillin-clavulanic acid which is a penicillin group. Amikacin susceptibilities were found to be lower in our study as compared to other studies conducted in our country. Considering the socioeconomic structure of our region, the use of unconscious antibiotics and the selection of antibiotics for the treatment without adequate evaluation of the susceptibility data by the physician, may be considered among the causes of resistance development. Therefore, we believe that regular surveillance of available antibiotic data at different time intervals will help to select the appropriate antibiotic and prevent the increase of antibiotic resistance rates in our region.

In particular, the resistance developed to amoxicillin-clavulanic acid and fluoroquinolones prescribed empirically in routine treatment, has led to the frequent use of both more expensive and parenterally administered cephalosporins. This situation has both increased treatment and care costs and reduced patient compliance, and inappropriate and excessive use of these antibiotics has led to new antimicrobial resistance problems.

When the results obtained from our hospital data are evaluated, fosfomycin may be the first choice in the empirical treatment of community-acquired urinary tract infections. It can be used as the first choice in the empirical treatment of UTIs developed with *E. coli* strains, due to its high patient compliance with its single-dose ease of use, extremely low resistance rates, high clinical eradication rates, and low side effects. We also believe that nitrofurantoin should be among the drugs that can be preferred in uncomplicated UTI due to its low resistance rates and ease of use. It is thought that antibiotic treatment should be determined according to the results of culture antibiogram, especially in nosocomial infections due to their high resistance rates.

The principal limitation of this study are that we conducted this research in a single center and that we included only adult patients in the study. Another limitation related to our research work can not be added to the post-treatment patient data.

CONCLUSION

As a result, high resistance rates have been observed to various antibiotics commonly used in the empirical treatment of urinary tract infections in the past years. Regular surveillance of regional and temporal antibiotic susceptibility data will guide the empirical treatment of urinary tract infections caused by *E. coli* . Our study is the most comprehensive and recent study in our province. Considering the data of our hospital, due to low resistance rates, fosfomycin and nitrofurantoin may be preferred primarily in primary care and the empirical treatment of uropathogen *E. coli* bacteria. According to the obtained results, new antibiotic usage policies should be developed urgently and regional antibiotic resistance rates should be prevented.

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