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ORIGINAL ARTICLE
ORİJİNAL ARAŞTIRMA

Distribution of Agents and Evaluation of Antibiotic Sensitivity and Resistance in Urinary System Infections in Children: A Single Centre Experience

Çocuklarda Üriner Sistem Enfeksiyonlarında Etkenlerin Dağılımı ve Antibiyotik Duyarlılığı ve Dirençlerinin Değerlendirilmesi: Tek Merkez Deneyimi

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ABSTRACT

Aim: Urinary tract infections (UTIs) are one of the most common bacterial infections and potentially serious bacterial infection in childhood. We aimed to determine the common agents and antibiotic sensitivity and resistance status according to the results of urine culture in children diagnosed with UTI.

Material and Method: In this retrospective study, we evaluated causative agents and antimicrobial sensitive and resistance in positive urine isolates from the children admitted to our hospital's Pediatrics Clinic between January 2017 and August 2022.

Results: A total of 702 urine cultures were positive, of which 239 (34%) were boys and 463 (66%) were girls. The median age of the patients was 1.1 years (interquartile range, 5.4). The four most frequently detected microorganisms in urine cultures were *Escherichia coli* (52.3%), *Klebsiella pneumoniae* (16.1%), *Enterococcus faecalis* (7.8%) and *Proteus mirabilis* (6.4%), respectively. *Escherichia coli* (9.7% vs. 42.6%) and Klebsiella pneumoniae (8.3% vs. 7.8%) were the two most common uropathogens both in boys and girls. *Escherichia coli* and *Klebsiella pneumoniae* were highly resistant to ampicillin and 3rd generation cephalosporins, while highly sensitive to aminoglycosides, meropenem and imipenem.

Conclusion: In our study, in consistent with the literature, Escherichia coli was found to be the most common uropathogen in children with urinary tract infection. We suggest that when arranging the treatment of children with urinary tract infections in our region, antibiotic resistance should be considered.

Keywords: Antibiotic resistance, children, *Escherichia coli*, urine culture, urinary tract infection

ÖZ

Amaç: Üriner sistem enfeksiyonları, çocukluk çağında en sık görülen ve potansiyel olarak ciddi bakteriyel enfeksiyonlardan biridir. İdrar yolu enfeksiyonu tanısı alan çocuklarda idrar kültürü sonuçlarına göre sık görülen etkenleri ve antibiyotik duyarlılık ve direnç durumlarını belirlemeyi amaçladık.

Gereç ve Yöntem: Bu retrospektif çalışmada, Ocak 2017-Ağustos 2022 tarihleri arasında hastanemiz Çocuk Kliniği'ne başvuran çocuklardan alınan idrar izolatlarında etken maddeler ile antimikrobiyal duyarlılık ve direnç pozitifliği değerlendirildi.

Bulgular: Hastaların 239 (%34)'u erkek, 463 (%66)'ü kız olmak üzere toplam 702 idrar kültüründe pozitiflik saptandı. Hastaların ortanca yaşı 1,1 idi (çeyrekler arası aralık, 5,4). İdrar kültürlerinde en sık saptanan dört mikroorganizma sırasıyla *Escherichia coli* (%52,3), *Klebsiella pneumoniae* (%16,1), *Enterococcus faecalis* (%7,8) ve *Proteus mirabilis* (%6,4) idi. *Escherichia coli* (%9,7'ye karşı %42,6) ve *Klebsiella pneumoniae* (%8,3'e karşı %7,8) hem erkeklerde hem de kızlarda en yaygın iki üropatojendi. *Escherichia coli* ve *Klebsiella pneumoniae* ampisilin ve 3. kuşak sefalosporinlere karşı oldukça dirençli iken, aminoglikozidler, meropenem ve imipenem'e karşı oldukça duyarlı idi.

Sonuç: Çalışmamızda literatürle uyumlu olarak idrar yolu enfeksiyonu geçiren çocuklarda en sık üropatojenin Escherichia coli olarak saptandı. Bölgemizde idrar yolu enfeksiyonu olan çocukların tedavisi düzenlenirken antibiyotik direncinin göz önünde bulundurulmasını öneriyoruz.

Anahtar Kelimeler: Antibiyotik direnci, çocuklar, *Escherichia coli*, idrar kültürü, idrar yolu enfeksiyonu

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INTRODUCTION

Urinary tract infections (UTIs) are one of the most common bacterial infections and potentially serious bacterial infection in childhood, affecting around 1.7% of boys and 8.4% of girls before the age of 7 years. They account for 5% to 14% of pediatric emergency department visits (1-3). During the first year of life UTIs affect boys and girls equally, but after that age most cases occur in girls (4). As the microorganism enters the urinary system, some children excrete the bacteria in the urine without any symptoms, some have cystitis characterized by inflammation in the bladder mucosa, and very few children have a febrile UTI due to the systemic activation of the inflammatory process. *Escherichia coli* is the most common bacterium causing urinary infection and this bacteria was followed by *Klebsiella pneumoniae*, *Proteus mirabilis*, *Enterococcus faecalis*, and *Pseudomonas aeruginosa*. *Escherichia coli* have *P. fimbriae*, which facilitates the formation of infection and prevents its excretion with the urine. The laboratory evaluation for suspected UTI includes urine dipstick and microscopic analysis and urine culture. Non-adherent bacteria, on the other hand, can cause urinary infection in children with renal malformations such as abnormal urine flow and post-void residual urine (5).

UTIs are problematic to diagnose in young children. The most important difficulties are the absence of specific findings at this age, the inability to collect uncontaminated urine samples. However, since UTI is accompanied by specific symptoms after infancy, it is easily diagnosed and treated (5,6). The NICE guideline states that all infants and children with an unexplained fever of ≥38°C lasting more than 24 hours should be considered for a UTI, as well as non-specific findings such as fever, lethargy, irritability, malaise, vomiting, malnutrition, abdominal pain, jaundice and growth retardation, or especially in older children. Emphasizes the need for urinalysis in the presence of signs and symptoms suggestive of UTI such as pollakiuria, dysuria, haematuria, flank pain, drip and cloudy urination (7). On the other hand, the AAP guideline states that the clinician should consider a UTI in a febrile infant who does not have a source of infection and requires antibiotic treatment due to the patient's appearance (8). UTI is defined as upper and lower UTI according to the region of the urinary system; Upper UTI (pyelonephritis) is an infection of the kidneys, collecting system and ureters while lower UTI is an infection of the bladder and urethra (5).

Acute complications of UTI are like to those associated with any febrile illness in a young child. These include dehydration, electrolyte abnormalities, and febrile seizures. Renal complications of acute pyelonephritis are uncommon in otherwise healthy children but may include renal abscess or complete occlusion of a pre-existing, partial ureteropelvic junction obstruction. Acute kidney injury may occur because of dehydration or an administration of a nonsteroidal anti-inflammatory drug. Urosepsis also may occur, particularly with Gram-negative infections. The most consequential long-term complication of acute pyelonephritis is renal scarring (9). UTIs can lead to permanent renal injury. Recurrent UTIs lead to chronic kidney disease, hypertension, and ultimately end-stage renal disease (10). Renal insufficiency is a well-known complication, either from pyelonephritis per se, a pre-existing congenital renal anomaly which predisposes the child to UTI. Quantitative urine culture is the gold standard for the diagnosis of UTI (4). Today, prompt antibiotic therapy to prevent of acute complications as well as renal scarring is indicated for symptomatic UTI based on clinical findings and positive urinalysis while waiting for the culture results (9). The antibiotic may have to be adjusted based on the response to treatment and sensitivity testing of the isolated pathogen (4). The choice of antibiotics should take into consideration local data of antibiotic resistance patterns.

UTIs show etiological changes according to gender, age and region. Thus, regional studies of different time periods are increasingly important. Nowadays, the identification of etiological agents and the detection of antibiotic sensitivity and resistance are very critical in the selection of empirical antibiotics to be used in treatment. Therefore, in our study we aimed to determine the common agents and antibiotic sensitivity and resistance status according to the results of urine culture in children diagnosed with urinary tract infection.

MATERIAL AND METHOD

Data were obtained retrospectively in the hospital automation system, with a diagnosis of UTIs in children 0-18 years of age who were admitted to our hospital's Pediatrics Clinic between January 2017 and August 2022. UTI was defined with suggestive symptoms of UTI and results of urinalysis and urine culture. Automated urinalysis was done with flow cytometry. Results of urinalysis were recorded for nitrite positivity, leukocyte esterase positivity, and pyuria. Pyuria was defined as >10 leukocyte/mL. Urine culture with growth of a single organism was defined as UTI. Patients who were thought to be contaminated as a result of urine culture and had missing data were not included in the data analysis. The subjects' gender, ages, species that grew in urine culture, and antibiotic resistance/sensitivities were recorded. Midstream urine samples or clean urine samples collected in urine drainage bags for age were used for urine culture. Midstream or bladder-collected clear urine specimens seeded with 0.01ml capacity

sterile ring loop on 5% sheep blood agar (BD BBL™ Ready-to-Use Media and RTA) and eosin methylene blue medium (BD BBL™ Ready-to-Use Media and RTA), Plates with pure bacterial growth were incubated for at least 24 hours at 37° C temperature. More than 1000 colonies (cfu/mL) and single microorganism growth were accepted as positive culture in suprapubic aspiration and more than 100 000 colonies (cfu/mL) in other samples. UNMIC Combo panels and BD BACTEC FX 40 (FF1988 BD COMPANY USA) device were used for identification of overgrown bacteria and determination of antibiotic susceptibility. The European Committee on Antimicrobial Susceptibility Testing – EUCAST guidelines were used to evaluate the results. The patients were divided into two age groups: children less than 5 years of age and children 5 years of age and older. Ethics committee approval for our study was obtained from the ethics committee of Karatay University Medical Faculty Hospital (approval number 2023/007).

Statistical Analysis

Statistical analyzes in our study were performed using the Statistical Package for Social Sciences (SPSS) version 22 (IBM Corp. Armonk, NY, USA) program. Kolmogorov Smirnov and Shapiro Wilk tests were used to check whether the numerical measurements in the study group provided the assumption of normal distribution. In descriptive statistics, mean±standard deviation was used for parametric data if it fit the normal distribution, or median (interquartile range, (IQR)) if it did not fit the normal distribution, and frequency and percentage values were used for categorical data. Pearson chi-square test was used to compare categorical measures between groups. In the comparison of parametric measurements between the groups, the independent groups T test was used for the variables conforming to the normal distribution, and the Mann Whitney U test was used for the variables not conforming to the normal distribution of the groups. Significance level was accepted as $p<0.05$.

RESULTS

Demographic data of patients and percentage of microorganisms in urine culture

A total of 702 urine samples in which bacterial growth was detected were included in data analysis. The 239 (34%) patients were boy and 463 (66%) patients were girl. While the mean age of the patients was 3.20±3.80 years (median, 1.1 years, IQR 5.4), the mean age of the boys was 1.04±1.87 years (median, 0.4 years, IQR, 0.9) and the mean age of the girls was 4.31±4.05 years (median, 1.1 years, IQR, 6.8). When considering of gender, the mean age of girls was significantly higher than those of boys ($p<0.0001$). The distribution of microorganisms grew in urine culture was shown in **Table 1** and **Figure 1**.

Table 1: Distribution of microorganisms grew in urine culture in all patients

Microorganisms	n	%
Escherichia coli	367	52,3
Klebsiella pneumoniae	113	16,1
Klebsiella oxytoca	37	5,3
Proteus mirabilis	45	6,4
Enterococcus faecalis	55	7,8
Enterococcus faecium	17	2,4
Enterobacter cloacae	12	1,7
Pseudomonas aeruginosa	10	1,4
Staphylococcus epidermidis	23	3,3
Serratia liquefaciens	1	0,1
Serratia marcescens	2	0,3
Enterobacter aerogenes	8	1,1
Citrobacter youngae	2	0,3
Citrobacter freundii	3	0,4
Citrobacter koseri	4	0,6
Citrobacter amalonaticus	1	0,1
Citrobacter braakii	1	0,1
Acinetobacter baumannii	1	0,1
Total	702	100,0

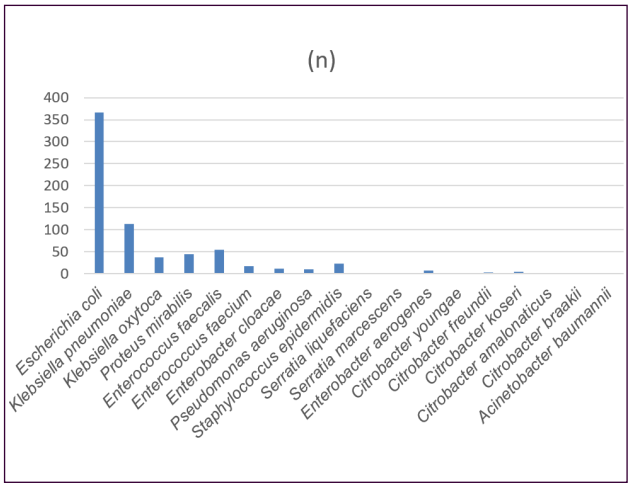

Figure 1. It shows distribution of microorganisms grew in urine culture

The four most frequently detected microorganisms in urine cultures were *Escherichia coli* (52.3%), *Klebsiella pneumoniae* (16.1%), *Enterococcus faecalis* (7.8%) and *Proteus mirabilis* (6.4%), respectively.

Percentage of microorganisms in urine culture distribution by gender

Escherichia coli (9.7% vs. 42.6%) and *Klebsiella pneumoniae* (8.3% vs. 7.8%) were the two most common uropathogens both in boys and girls. When considering of gender, *Escherichia coli* was found to be statistically significantly higher in girls than in boys ($p:<0.0001$). Distribution of microorganisms grew in urine culture by gender was shown in **Table 2** and **Figure 2**.

Table 2: Distribution of microorganisms grew in urine culture by gender

Gender	Boy		Girl	
Microorganisms	**n**	**%**	**n**	**%**
Escherichia coli	68	9,7%	299	42,6%
Klebsiella pneumoniae	58	8,3%	55	7,8%
Klebsiella oxytoca	25	3,6%	12	1,7%
Proteus mirabilis	21	3,0%	24	3,4%
Enterococcus faecalis	30	4,3%	25	3,6%
Enterococcus faecium	4	,6%	13	1,9%
Enterobacter cloacae	7	1,0%	5	,7%
Pseudomonas aeruginosa	0	0,0%	10	1,4%
Staphylococcus epidermidis	14	2,0%	9	1,3%
Serratia liquefaciens	1	,1%	0	0,0%
Serratia marcescens	2	,3%	0	0,0%
Enterobacter aerogenes	4	,6%	4	,6%
Citrobacter youngae	1	,1%	1	,1%
Citrobacter freundii	0	0,0%	3	,4%
Citrobacter koseri	2	,3%	2	,3%
Citrobacter amalonaticus	1	,1%	0	0,0%
Citrobacter braakii	1	,1%	0	0,0%
Acinetobacter baumannii	0	0,0%	1	,1%
Total	239	34,0%	463	66,0%

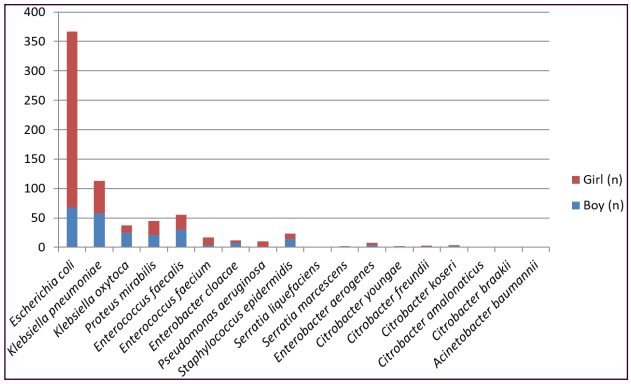

Figure 2. It shows distribution of microorganisms grown in urine culture by gender.

Distribution of microorganisms grown in urine culture by age

Escherichia coli and *Klebsiella pneumoniae* were the most common microorganisms in children less than 5 years of age. When considering of age groups, *Escherichia coli* and *Klebsiella pneumoniae* was found to be statistically significantly higher in children less than 5 years of age than in children older than 5 years (p:<0.0001 for both). Percentage of microorganisms grew in urine culture by age groups was presented in **Table 3** and **Figure 3**.

Antibiotic sensitivity and resistance rates of microorganisms

According to the antibiogram results for *Escherichia coli*, antibiotic resistance rates were approximately 65% to ampicillin, 45% to ceftazidime, 34% to cefixime, and 30% to ceftriaxone, respectively, whereas these rates were 12% to gentamicin, 1.1% to amikacin, 0.5% to meropenem and 0.3% to imipenem. *Klebsiella pneumoniae*'s antibiotic resistance rates were approximately 99% to ampicillin, 60% to ceftazidime, 48% to cefixime, and 41% to ceftriaxone, respectively, whereas these rates were 18% to gentamicin, 6% to amikacin, 3.6% to meropenem and 2.7% to imipenem. *Enterococcus faecalis*'s antibiotic resistance rates were 5% (3/55) to ampicillin and 16.7% (3/18) to ciprofloxacin, respectively.

Table 3: Distribution of microorganisms grew in urine culture by age groups

Gender	Children under 5 years of age		Children ≥5years of age	
Microorganisms	**n**	**%**	**n**	**%**
Escherichia coli	208	29,6%	159	22,6%
Klebsiella pneumoniae	105	15,0%	8	1,1%
Klebsiella oxytoca	36	5,1%	1	,1%
Proteus mirabilis	32	4,6%	13	1,9%
Enterococcus faecalis	44	6,3%	11	1,6%
Enterococcus faecium	12	1,7%	5	,7%
Enterobacter cloacae	12	1,7%	0	0,0%
Pseudomonas aeruginosa	10	1,4%	0	0,0%
Staphylococcus epidermidis	16	2,3%	7	1,0%
Serratia liquefaciens	1	,1%	0	0,0%
Serratia marcescens	2	,3%	0	0,0%
Enterobacter aerogenes	8	1,1%	0	0,0%
Citrobacter youngae	1	,1%	1	,1%
Citrobacter freundii	3	,4%	0	0,0%
Citrobacter koseri	3	,4%	1	,1%
Citrobacter amalonaticus	1	,1%	0	0,0%
Citrobacter braakii	1	,1%	0	0,0%
Acinetobacter baumannii	1	,1%	0	0,0%
Total	496	70,7%	206	29,3%

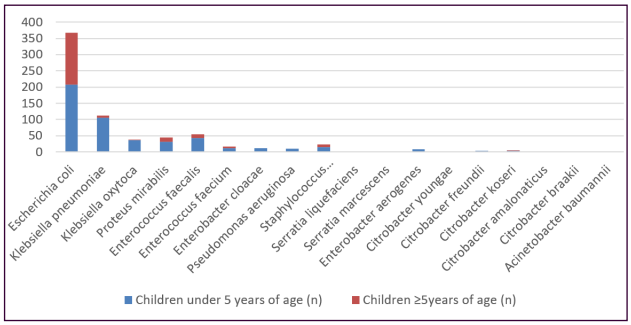

Figure 3. It shows distribution of microorganisms grew in urine culture by age groups.

Proteus mirabilis's antibiotic resistance rates were 56% (24/43) to ampicillin and 35.6% (16/45) to gentamicin, 15.4% (2/13) to imipenem, respectively whereas these rates were 0% (0/23) to ceftazidime, 0% (0/44) to meropenem 2.3% (1/43) to ceftriaxone 4.4% (2/45) to amikacin and 6.7% to cefixime (3/33). The sensitivity and resistance rates of *Escherichia coli* and *Klebsiella pneumoniae* obtained from urine cultures to various antibiotics was shown in **Table 4** and **Figure 4**.

Table 4: The sensitivity and resistance rates of *Escherichia coli* and *Klebsiella pneumoniae* obtained from urine cultures to various antibiotics

Antibiotics	*Escherichia coli*				*Klebsiella pneumoniae*			
	Sensitive (n)	Resistance (n)	Total (n)	Resistance rate (%)	Sensitive (n)	Resistance (n)	Total (n)	Resistance rate (%)
Ampicillin	129	236	365	64,7%	1	112	113	99,1%
Amikacin	361	4	365	1,1%	106	7	113	6,2%
Ceftazidime	126	101	227	44,5%	29	43	72	59,7%
Cefixime	215	110	325	33,8%	52	47	99	47,5%
Ciprofloxacin	325	42	367	11,4%	93	20	113	17,7%
Ceftriaxone	258	108	366	29,5%	66	46	112	41,1%
Fosfomycin	152	4	156	2,6%	59	3	62	4,8%
Nitrofurantoin	317	5	322	1,6%	25	4	29	13,8%
Gentamicin	322	45	367	12,3%	93	20	113	17,7%
Imipenem	365	1	366	0,3%	110	3	113	2,7%
Levofloxacin	157	23	180	12,8%	45	12	57	21,1%
Meropenem	362	2	364	0,5%	108	4	112	3,6%
Tobramycin	155	23	178	12,9%	44	11	55	20,0%

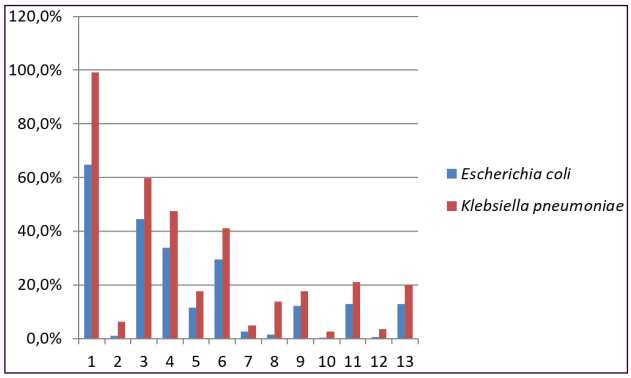

Figure 4: It shows antibiotic resistance rates of *Escherichia coli* and *Klebsiella pneumoniae*

1: Ampicillin, 2: Amikacin, 3: Ceftazidime, 4: Cefixime, 5: Ciprofloxacin, 6: Ceftriaxone, 7: Fosfomycin, 8: Nitrofurantoin, 9: Gentamicin, 10: Imipenem, 11: Levofloxacin, 12:Meropenem, 13:Tobramycin

DISCUSSION

It is known that *Escherichia coli* is the most common pathogen, responsible for approximately 80-90% of pediatric UTIs (2,3). *Klebsiella* (6%–7%), *Proteus* (5%–12%), *Enterococcus* (3%–9%), and *Pseudomonas* (2%–6%) are other common causative organisms in UTIs (1). Several studies have demonstrated that although *Escherichia coli* is the most frequent causative organism at all ages independent of patient demographic characteristics, it is more often found in females, while *K. pneumoniae* and *P. mirabilis* are more common in males (11). In our study, we showed that the most common uropathogen was *Escherichia coli* with a rate of 52%, consistent with the literature. The frequency of UTI was almost twice as common in girls as boys. The fact that the median age was higher in girls than in boys and when considering of gender, we found a statistically significant difference, it shows that UTI is more common at an earlier age in boys, as in the literature.

Antibiotic resistance for UTI-related bacterial pathogens continuously rises, making the definition of the best empiric antibiotic therapy is more difficult (11). Therefore, the choice of an antimicrobial for empirical therapy should be guided by the local, resistant patterns of pathogens (3,9). In recent years, the incidence of uropathogen resistance to commonly used antibiotics for paediatric UTI has increased worldwide. In a single paediatric institution from 2009 to 2014, Erol et al. showed that *Escherichia coli* resistance during the study period increased for ampicillin from 47.1% to 89%, for trimethoprim-sulphamethoxazole from 44.8% to 56% (12).

Several factors can explain the development of antibiotic resistance and its progressive increase, mainly the inappropriate use of these drugs. Antibiotics are among the drugs most commonly prescribed to children in hospital and community settings. Regarding UTIs, one of the most common causes of microbial selection and emergence of resistance is the administration of antibiotics for prophylaxis in children with recurrent UTI episodes, especially when a structural or functional abnormality of the urinary tract has been diagnosed. Usually, recent studies in children with UTI have shown that *Escherichia coli* was the pathogen with the highest incidence of antibiotic resistance and that the production of extended-spectrum beta-lactamases (ESBL) was the most common cause of this emerging phenomenon, although with differences among countries and within the same country (11). In our study, we showed that *Escherichia coli* and *Klebsiella pneumoniae* were highly sensitive both meropenem and imipenem.

The choice of antibiotics depends on resistance patterns in a given institution or region. Cephalosporins and amoxicillin–clavulanic acid are the oral antibiotics most often used. When intravenous treatment is required, no particular antibiotic has been shown to be superior; cephalosporins and aminoglycosides are frequently recommended for UTIs in children (13,14).

The reported rates of microorganisms involved in the ethology of urinary tract infection and the rates of antibiotic sensitivity and resistance vary according to international and national studies. A study by Guidoni et al. at Santa Casa University Hospital of São Paulo from August 1986 to December 1989 and August 2004 to December 2005 in which 257 children were included, *Escherichia coli* was detected at a rate of 77% and high resistance was observed with 55% to ampicillin, while low resistance was reported to 3rd generation cephalosporins with 5%, aminoglycosides 2% and ciprofloxacin 4% (15). However, in our study, we showed that *Escherichia coli* and *Klebsiella pneumoniae* were highly resistant to ampicillin and 3rd generation cephalosporins, while highly sensitive to aminoglycosides. This may be due to the increase in antibiotic resistance over the years.

In a recent study by Vazouras et al. in Greece from August 2010 to September 2015 involving 230 children, the most common microorganism detected in urine culture was *Escherichia coli* (79.2%), followed by *Klebsiella* spp. (7.2%), *Proteus* spp. (5.1%) and *Pseudomonas aeruginosa* (4.7%). In their studies, a high rate of resistance to ampicillin (42.0%) was reported for *Escherichia coli*, while a lower rate of resistance to third-generation cephalosporins (1.7%), nitrofurantoin (2.3%), ciprofloxacin (1.4%) and amikacin (0.9%) (16).

A comprehensive study by Edlin et al. in 2009, using data from 195 United States hospitals including 25,418 children showed that the most common agents detected in urine cultures were *Escherichia coli*, *Proteus mirabilis*, *Klebsiella*, Enterobacter, *Pseudomonas aeruginosa* and *Enterococcus*. In this study, *Escherichia coli* was found to be significantly higher in girls (83%) than in boys. Results of their study found that resistance in *Escherichia coli* was highest for ampicillin (45%) and trimethoprim-sulfamethoxazole (24%), while it was lower for gentamicin (4%), cefuroxime (2%) and ceftriaxone (less than 1%). For *Klebsiella*, resistance to ampicillin was high with 81%, while resistance to cefuroxime 7%, gentamicin 3% and imipenem less than 1% was reported (17).

In a recent study by Gunduz et al. from September 2014 to April 2016 in a single hospital in Ankara, in which 850 positive urine cultures were included, the most common microorganisms were *Escherichia coli* (64.2%), *Klebsiella pneumoniae* (14.9%), *Enterococcus* (5.4%), *Klebsiella oxytoca* and *Proteus mirabilis* (3.9%) and Enterobacter spp. (1.8%). In their study when for *Escherichia coli*, resistance to amikacin (0.2%) and ceftriaxone (2.7%) was quite low for *Klebsiella pneumoniae*, resistance to gentamicin (16.5%) and ceftriaxone (1.1%) (18).

A study of 158 children by Konca et al. at the Pediatric Polyclinics of Adiyaman University between August 2013 and August 2014 showed that *Escherichia coli* (60.1%) and *Klebsiella* spp.(16.5%) were the most common pathogens. In their study, *Escherichia coli* isolates were most susceptible to amikacin (100%), meropenem (100%), imipenem (97.9%), and gentamicin (95.8%). *Escherichia coli* isolates had the highest resistance rate to ampicillin/sulbactam (56.4%), and cefixime (36.8%), respectively. The *Klebsiella* isolates had a high sensitivity to imipenem (100%), amikacin (100%) and imipenem (100%). *Klebsiella* spp. had the highest resistance to ampicillin/sulbactam (78.3%), cefixime (53.8%), cefuroxime sodium (47.6%), and ceftriaxone (38.4%) (19). The reason why our study results differ from these results may be due to different geographical regions and different years.

In a study by Yilmaz et al., according to the results of 1373 urine cultures, growth was detected the most common uropathogens were *Escherichia coli* 940 (68.5%); *Proteus* spp, 183 (13.3%); *Enterococcus* spp, 65 (4.7%); *Klebsiella* 62 (4.5%) and *Pseudomonas aeruginosa* 21 (1.5%). In this study, the highest resistance rates of *Escherichia coli* and *Proteus* spp. were to trimethoprim-sulfamethoxazole (37% and 45%, respectively) and the highest resistance rate of *Klebsiella* spp. was to ampicillin-sulbactam (39%) followed by trimethoprim-sulfamethoxazole (38%) (20). Antibiotic resistance should be considered when starting antibiotic prophylaxis in recurrent UTIs.

The strength of our study was that it included a large number of children over a 5-year period. However, due to the retrospective nature of the study, we could not obtain precise information on the use of antibiotics and the clinical. Also, data on underlying diseases, whether it is recurrent or not, were not collected.

CONCLUSION

In our study, *Escherichia coli* was the most common uropathogen in children with UTIs. *Escherichia coli* was also found to be statistically significantly higher in girls than in boys. *Escherichia coli* and *Klebsiella pneumoniae* were the most common pathogens in children under 5 years of age. In our study, we showed that *Escherichia coli* and *Klebsiella pneumoniae* were highly resistant to ampicillin and 3rd generation cephalosporins, while highly sensitive to aminoglycosides, meropenem and imipenem. We believe that in the treatment of children who are thought to have UTI in our region, treatment should be arranged by taking these results into account.

ETHICAL DECLARATIONS

Ethics Committee Approval: Ethics committee approval for our study was obtained from the Ethics Committee of Karatay University Medical Faculty Hospital (approval number 2023/007).

Informed Consent: Because the study was designed retrospectively, no written informed consent form was obtained from patients.

Referee Evaluation Process: Externally peer-reviewed.

Conflict of Interest Statement: The authors have no conflicts of interest to declare.

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Author Contributions: All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

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