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Prevalence of Multi-Antibiotic Resistant Bacteria Isolated from Children with Urinary Tract Infection from Baghdad, Iraq

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Urinary tract infections (UTIs) are one of the most common infections in different age groups, including children. Bacteria are the main etiological agents of UTIs. The aim of the present study was to isolate, identify, and determine the antibiotic susceptibility of bacteria isolated from children with UTIs from Baghdad, Iraq. Three hundred and two urine samples were collected from children aged 6 months to 12 years. The samples were cultured on blood agar and MacConkey agar. The selected colonies were subjected to biochemical tests and antibiotic susceptibility analysis using the Vitek® 2 Compact automated microbial identification system. In this sample, 299 bacteria were identified, of which, 267 were gram-negative bacteria, and 32 were gram-positive bacteria. *Escherichia coli* (56%) was the most commonly isolated gram-negative bacteria, followed by *Pseudomonas aeruginosa* (14%), *Enterobacter* spp. (10.48%), *Klebsiella pneumoniae* (9.36%), *Proteus* spp. (7.8%), *Acinetobacter baumannii* (1.5%), and *Morganella morganii* (0.37%). *Enterococcus faecalis* (62.5%) was the most commonly detected gram-positive bacteria, followed by *Staphylococcus aureus* (37.5%). *E. coli* and *P. aeruginosa* were the most antibiotic-resistant bacteria. Among the tested antibiotics, meropenem showed 100% sensitivity, followed by imipenem (97.4%), amikacin (91.8%), and tobramycin (83.5%). In contrast, the high frequencies of resistance were observed with cefixime (93.2%), cefotaxime (78.7%), and ceftriaxone/cefotaxime (71.2%). In conclusion, carbapenems and aminoglycosides are highly recommended for the empirical treatment of UTIs, while, Quinolones, penicillins, and cephalosporins are not suggested. Frequent antibiotics susceptibility testing are warranted to determine the resistance pattern of UTI bacteria.

Keywords: **Multidrug resistance, UTI, Vitek 2 compact, antibiotic susceptibility testing**

Introduction

The urinary tract infection (UTI) is among the most prevalent infectious diseases and is considered the main health burden and expensive clinical problem worldwide [1]. Bacteria are the main causative agents of UTI, which can infect people regardless of their ages [2]. UTI is the second most prevalent bacterial infection occurring in children [3]. Around 150 million people were infected with UTI every year, with medical costs of at least 6 billion dollars [4].

The frequency of UTIs varies according to gender and age since women and elderly people are more susceptible than men and younger people [5, 6]. Among childhood,

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the incidence of infection in girls is 7–8% and 2% in boys for the first 8 years of life, particularly in uncircumcised boys [7]. UTI treatment based on a physical examination alone is unreliable; therefore, laboratory tests are necessary [8].

Bacteria (gram negative and gram positive), and certain fungi have been found to contribute in UTI [2, 9, 10]. UTI has become a big dilemma, especially with the rising of antibiotics resistance to their etiological agents [11]. Developing countries are majorly affected by resistant bacteria due to their limited resources and poor medical healthcare [2, 12]. In Iraq, the prescription of antibiotics is widespread and uncontrolled [11, 13]. Yet, not enough data are available on the requirements of the prescribed antibiotics and their results on patients. However, in developed countries, millions of prescriptions of antibiotics were given to patients, most of them were found to be unnecessary and unsuitable [14]. Many reports from different countries recorded the emergence of multi-antibiotic resistant (MAR) UTI etiological bacteria [12, 15, 16]. Therefore, patients with UTI might be improperly treated because of the rise of antibiotic resistance. Long-lasting antibiotic resistance can contribute to economic burdens for government agencies, as extended stays in clinics lead to an elevation in medical expenses and death rates [17–19]. Most recent studies focused on herbal medicine to treat different bacterial infections and reduce antibiotic resistance [20, 21].

Continuous surveillance of antibacterial susceptibility testing of UTI causative agents in Iraq and other developing countries is mandatory in order to enhance the quality of UTI treatment. To date, very limited studies for the determination of antibiotic susceptibility testing from UTI of children are available. A thorough study is, therefore, necessary to recognize the extent of the multi-antibiotic resistant bacteria. Hence, the present investigation aimed to isolate and identify bacteria from children suffering from UTI infection in Baghdad, Iraq, and determine their antibiotics susceptibility pattern.

Materials and Methods

Sample collection

Three-Hundred and two urine samples were collected from children aged (6 months to 12 years) who attended the outpatient department of 3 pediatric hospitals in Baghdad, Iraq, namely Child's Central Teaching Hospital, Kadhimiya Hospital for Children, and Al-Elwea Maternity Hospital. The specimens were collected in the period between June to December 2020.

The reason behind this project was thoroughly discussed and explained with the parents of the selected children, and signed consent forms were obtained. In grown-up children, midstream urine samples were collected in large-mouthed sealed containers. While in infant patients, the samples were collected using adhesive sterile urinary bottles. Separately, the specimens were marked with patient details, i.e. name, age, symptoms, and medical examination. The samples were then transferred to the laboratory for further investigations.

Bacterial identification

The urine samples were cultured into blood agar (HiMedia, India) and MacConkey agar (HiMedia). The plates were aerobically incubated at 37℃ for 24 h, in negative sampling, extending to 48 h. Bacteriuria has been diagnosed with the colony counts of a single microbe $>10^5$ colony-forming unit (CFU)/ml. The identification of the isolates was based on colony morphology, gram staining and then confirmed using biochemical tests performed by Vitek 2 compact system (bioMérieux, France) [13]. Vitek 2 compact system was executed according to the manufacturer's guidelines using kits: Vitek 2 GN ID card and Vitek 2 GP ID card.

Antibiotics susceptibility testing

Antibiotics susceptibility testing was obtained using Vitek 2 compact system using Vitek 2 AST cards for gram negative and gram positive bacteria (bioMérieux). The following antibiotics were investigated in this study Amikacin, Trimethoprim/Sulfamethoxazole, Augmentin, Gentamicin, Cefoperazone, Ceftazidime, Piperacillin, Ceftriaxone/Cefotaxime, Cefotaxime, Ceftriaxone, Nitrofurantoin, Ciprofloxacin, Levofloxacin, Imipenem, Meropenem, Tobramycin, Ampicillin, and Cefixime.

Statistical analysis

Microsoft Office Excel 2013 was employed to determine the statistical analysis.

Results

Of the total sample size, 299 (99%) samples were infected with different bacterial species, while in 3 (0.99%) samples, no bacterial growth was found but *Candida albicans*, *Monilia,* and *Giardia lamblia*. Among the isolated bacteria, 267 (89.29%) were gram negative and 32 (10.7%) were gram positive. The detection of gram negative and gram positive bacteria with their proportion was listed in Table 1. Of the Gram negative bacteria, the prevalence of *E. coli* was the highest (56%) and the least was *Morganella morganii* (0.37%). While in gram positive bacteria, *Enterococcous faecalis* was the most abundant (62.5%) and *Staphylococcus aureus* was the second detected (37.5%).

The antibacterial susceptibility testing against different species of gram negative and gram positive bacteria were demonstrated in Table 2. Of the tested antibiotics, *E. coli* and *Pseudomonas aeruginosa* were resistant to 18 and 19 antibiotics, respectively. At the same time, *A. baumannii* and *M. morganii* showed less resistance among gram negative bacteria with 6 and 5 antibiotics, respectively. In gram positive, *E. faecalis* and *S. aureus* were resistant to 12 and 9 antibiotics, respectively. The present data revealed MAR against gram negative and gram positive bacteria isolated from UTI in children. The resistance number of each antibiotic against gram negative and gram positive were demonstrated in Table 3.

Discussion

The spread of UTI among children among communities is now becoming a global threat. MAR of bacteria associated with UTI infection is continuously observed in patients, which has a dangerous effect on the economy and general health. Therefore, it is essential to constantly evaluate the antibacterial susceptibility of bacteria isolated from UTI of children, which was the present study's objective. To the best of our knowledge, this is one of the very few published reports of the isolation and determination of antibacterial susceptibility testing isolated from UTI in children from Baghdad, Iraq.

Among the specimens collected in the present study, 99% were infected by different bacterial species (Table 1). Many reports demonstrated that the principal etiological agent of UTI is bacteria [22, 23], which was according to the present study. Out of isolated bacteria, the prevalence of gram negative bacteria (89.29%) was higher than gram positive bacteria (10.7%). *E. coli* (56%) was found to be the most incidence among gram negative bacteria, followed by *P. aeruginosa* (14%), *Enterobacter* spp. (10.48%), *K. pneumoniae* (9.36%), *Proteus* spp. (7.8%), *A. baumannii* (1.5%) and *M. morganii* (0.37%) (Table 1). Similar findings in different countries were observed in recent studies where the *E. coli* was found to be the primary etiological agent of UTI in children [24–27]. The identification of the bacterial isolates was obtained by vitek 2 compact, which is considered as one of the accurate methods of diagnosis [13].

In this study, *P. aeruginosa* was the second prevalent bacteria which is not in accordance with other studies demonstrating that *K. pneumoniae* is the second most abundant [25, 27, 28]. Erol *et al.*, reported that *Proteus* spp., was the second isolated bacteria from UTI in children which is contrary to the present study [24]. The present study indicated the isolation of one strain of *M. morganii* from UTI in children. *M. morganii* is a rarely isolated gram negative bacteria causing pediatric UTI [30]. However, one strain of *M. morganii* was also reported to be present in the UTI [31]. Mohammed *et al.*,

Table 1. Detection of Gram negative and Gram positive bacteria.

	Gram negative bacteria						
Genus & Sp.	*E. coli*	*Pseudomonas aeruginosa*	*Enterobacter* spp.	*Klebsiella pneumoniae*	*Proteus* spp.	*Acinetobacter baumannii*	*Morganella morganii*
No. & percentile	150 (56%)	38 (14%)	28 (10.48%)	25 (9.36%)	21 (7.8%)	4 (1.5%)	1 (0.37%)

	Gram positive bacteria	
Genus & Sp.	*Enterococcus faecalis*	*Staphylococcus aureus*
No. & percentile	20 (62.5%)	12 (37.5%)

Table 2a. Antibacterial susceptibility testing against different species of gram negative.

		Gram negative bacteria													
Classes of antibiotics	Antibiotics	*E. coli* (150)		*Pseudomonas aeruginosa* (38)		*Klebsiella pneumoniae* (25)		*Proteus* spp. (21)		*Enterobacter* spp. (28)		*Acinetobacter baumannii* (4)		*Morganella morganii* (1)	
		S	R	S	R	S	R	S	R	S	R	S	R	S	R
Amino-glycosides	Amikacin	142 (94.6%)	8 (5.4%)	29 (76%)	9 (24%)	ND		21 (100%)		23 (83%)	5 (17%)	4 (100%)		1 (100%)	
	Gentamicin	113 (75.3%)	37 (24.7%)	22 (58%)	16 (42%)	17 (68%)	8 (32%)	18 (86%)	3 (14%)	19 (68%)	9 (32%)	4 (100%)		ND	
	Tobramycin	150 (100%)		18 (47%)	23 (53%)	ND			21 (100%)	ND		ND		1 (100%)	
3^{rd} G Cephalosporins	Cefoperazone	60 (40%)	90 (60%)	15 (40%)	23 (60%)	7 (28%)	18 (72%)	12 (57%)	9 (43%)	8 (29%)	20 (71%)	2 (50%)	2 (50%)		1 (100%)
	Ceftazidime	43 (29%)	107 (71%)	23 (61%)	15 (39%)	17 (68%)	8 (32%)	9 (43%)	12 (57%)	14 (50%)	14 (50%)	4 (100%)			1 (100%)
	Cefotaxime	21 (14%)	129 (86.1%)	11 (29%)	27 (71%)	2 (8%)	23 (92%)	18 (86%)	3 (14%)	4 (14%)	24 (86%)		4 (1005)	ND	
	Ceftriaxone	43 (29%)	107 (71%)	11 (29%)	27 (71%)	4 (16%)	21 (84%)	21 (100%)		8 (29%)	21 (71%)	ND		ND	
	Ceftriaxone/ Cefotaxime	25 (17%)	115 (83%)	14 (37%)	24 (63%)	5 (20%)	20 (80%)	15 (71.4%)	6 (28.6%)	7 (25%)	21 (75%)	1 (25%)	3 (75%)		1 (100%)
	Cefixime		150 (100%)		38 (100%)		25 (100%)	17 (81%)	4 (19%)		28 (100%)		4 (100%)	ND	
Quinolones	Ciprofloxacin	80 (53.3%)	70 (47.7%)	13 (34%)	25 (66%)	ND		7 (33.3%)	14 (66.7%)	28 (100%)		4 (100%)		ND	
	Levofloxacin	87 (58%)	63 (42)	ND		ND		21 (100%)		ND		ND		ND	
Penicillins	Piperacillin	78 (52%)	72 (48%)	23 (61%)	15 (39%)	13 (52%)	12 (48%)	16 (76%)	5 (24%)	12 (46.4%)	16 (53.6%)	2 (50%)	2 (50%)	ND	
	Ampicillin	112 (75%)	38 (25%)		38 (100%)	ND		ND			28 (100%)	ND			1 (100%)
	Augmentin	119 (79.3%)	31 (20.7%)	10 (25%)	28 (75%)	14 (56%)	11 (44%)	20 (95%)	1 (5%)	21 (75%)	7 (25%)	4 (100%)		ND	
Carbapenems	Imipenem	150 (100%)		32 (84%)	6 (16%)	25 (100%)		21 (100%)		28 (100%)		4 (100%)			1 (100%)
	Meropenem	150 (100%)		38 (100%)		ND		21 (100%)		ND		ND		1 (100%)	
Sulfonamides	Trimethoprim/ Sulfamethoxazole	59 (39.3%)	91 (60.7%)	5 (13%)	33 (87%)	5 (20%)	20 (80%)	7 (33.3%)	14 (66.7%)	6 (21.4%)	22 (78.6%)		4 (100%)	ND	
Nitrofuran	Nitrofurantoin	144 (96.2%)	6 (3.8%)		38 (100%)	25 (100%)		8 (38%)	13 (62%)	25 (89%)	3 (11%)	4 (100%)		ND	

ND=Not determined; S=Sensitive; R=Resistant.

reported less prevalence of *A. baumannii* from UTI specimens, which is comparable to the data of the present study [31].

In the present study, *E. faecalis* (62.5%) was the most prevalent among the Gram positive bacteria followed by *S. aureus* (37.5%) (Table 1). It is consistent with a previous report identifying *Enterococcus* spp., and *S. aureus* from urinary tract infected children [25]. However, other studies related to pediatric UTI could not isolate *E. faecalis*, but they isolated *Staphylococcus* coagulase-positive bacteria [27]. On the other hand, Erol *et al.*, isolated *Enterococcus* spp., from children's UTI [24]. *S. aureus* is a comparatively rarely causing UTI. However, the present study shared a similar outcome of isolation of *S. aureus* with the previous report [32].

Antibacterial sensitivity testing has been designated

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Table 2b. Antibacterial susceptibility testing against different species of gram positive.

Classes of antibiotics	Antibiotics	Gram Positive bacteria			
		Staphylococcus aureus (12)		*Enterococcus faecalis* (20)	
		S	R	S	R
Aminoglycosides	Amikacin	10 (83.3%)	2 (16.7%)	ND	
	Gentamicin	9 (75%)	3 (25%)	9 (45%)	11 (55%)
3rd G Cephalosporins	Ceftriaxone/Cefotaxime	7 (60%)	5 (40%)	9 (46.1%)	11 (53.9%)
	Cefotaxime	12 (100%)		10 (50%)	10 (50%)
	Ceftriaxone	12 (100%)		5 (25%)	15 (75%)
	Cefoperazone	9 (75%)	3 (25%)	13 (67%)	7 (33%)
Penicillins	Penicillin		12 (100%)		20 (100%)
	Ampicillin	ND		10 (51.3%)	10 (48.7%)
	Augmentin	12 (100%)		10 (50%)	10 (50%)
	Piperacillin		12 (100%)	13 (67%)	7 (33%)
Quinolones	Ciprofloxacin	ND		20 (100%)	
	Levofloxacin	ND		20 (100%)	
Sulfonamides	Trimethoprim/Sulfamethoxazole	8 (67%)	4 (33%)	9 (45%)	11 (55%)
Nitrofuran	Nitrofurantoin	12 (100%)		11 (54%)	9 (46%)
Carbapenems	Imipenem	ND		20 (100%)	

ND=Not determined; S=Sensitive; R=Resistant.

in numerous studies worldwide, but very few reports in Iraq regarding pediatric UTIs. The present study showed the antibiotic resistance and sensitivity to bacteria isolated from UTI in children. The antibiotic susceptibility pattern of gram negative and Gram positive bacteria in the current report were variable. Antimicrobial susceptibility testing recognizes *P. aeruginosa* and *E. coli* as the highest resistant Gram negative bacteria (Table 2). Our results were comparable to that reported in recent studies that presented *E. coli* as the most resistant gram negative bacteria, but is contrary to the findings that demonstrated *P. aeruginosa* as less resistant [15, 33, 34]. This is a dangerous indication of increasing the resistance rate of *P. aeruginosa*.

Of the tested antibiotics, *E. coli* and *P. aeruginosa* were resistant to 18 and 19 antibiotics, respectively. In contrast, *A. baumannii* and *M. morganii* showed less resistance among gram negative bacteria with 6 and 5 antibiotics, respectively (Table 2). The present study indicated the MAR against gram negative and gram positive bacteria (Table 2). In this concern, numerous similar reports point to MAR against UTI's etiological agents [35, 36].

Aminoglycosides antibiotics group (amikacin, gentamicin, and tobramycin) have been the best treatment choice for UTI, especially against antibiotic-resistant Enterobacteriaceae, for the past years [38]. The resistance rate of *E. coli* (5.4%), *P. aeruginosa* (24%), *Enterobacter* spp., (17%), and *S. aureus* (16.7%) to amikacin. In comparison, 100% sensitivity of *A. baumannii*, *Proteus* spp., and *M. morganii* was shown to amikacin (Table 2). Our study is contrary to the previous report, which displayed 100% resistance of *A. baumannii*, *P. aeruginosa*, *Proteus* spp., and *M. morganii* to amikacin. Whereas the resistance rate of *E. coli*, and *Enterobacter* spp., against amikacin were 68% and 25%, respectively [30]. However, a study showed less resistance of *E. coli* (3.4%), *P. aeruginosa* (7%), and *Proteus* spp., (2%) to amikacin, compared to our study [25]. Gentamicin resistance rate in the present study was as follow (high to low) *E. faecalis* (55%), *P. aeruginosa* (42%), *K. pneumoniae* (32%), *Enterobacter* spp., (32%), *E. coli* (24.7%), *Proteus* spp., (14%) and *S. aureus* (13%), while *A. baumannii* showed 100% susceptibility (Table 2). Muhammad *et al*., demonstrated an elevation of resistance rate of *E. coli* (69.7%), *K. pneumoniae* (48.1%), *Proteus* spp., (66.7%), *P. aeruginosa* (33.3%), and *S. aureus* (57.1%) to gentamicin compared to the present report. Whereas *Enterococcus*

(25%) showed less resistance compared with ours [2]. However, a study in Ethiopia was contradicted the present data with respect to *Klebsiella* (82.4%) and *Acinetobacter* (100%). Moreover, *Proteus* spp., was 100% susceptible to gentamicin [28]. Tobramycin showed a resistance rate as follows; *Proteus* spp. (100%) and *P. aeruginosa* (53%), while *E. coli* and *M. morganii* were 100% susceptible to tobramycin (Table 2). Li *et al.*, demonstrated a higher resistance rate (33%) compared to our study. A study conducted earlier demonstrated less resistance of *Proteus* spp. (31%) and *P. aeruginosa* (3%) to tobramycin, but more resistant in respect to *E. coli* (11%) compared with our report [34]. The current study indicated that among aminoglycosides antibiotics, amikacin showed higher susceptibility against UTI's bacterial agents.

Trimethoprim/Sulfamethoxazole (TS) is frequently prescribed antibiotics for UTI and other diseases [38]. In the present study, *A. baumannii* was the most resistant to TS (100%) followed by *P. aeruginosa* (87%), *Klebsiella* spp., (80%), *Enterobacter* spp., (78.6%), *E. coli* (60.7%), *E. faecalis* (55%) and *S. aureus* (33%). The resistance rate of UTI's bacteria to TS has been increased compared to the previous report, which demonstrated *A. baumannii* (25%), *P. aeruginosa* (3%), *Klebsiella* spp., (35%), *Enterobacter* spp., (32%) and *E. coli* (47%) [34]. Similar findings were reported earlier regarding TS resistance to *E. coli* (47%) and *K. pneumoniae* (36.8%). While in the same study reported different resistance rates of *E. faecalis* (70%), *S. aureus* (13%), *A. baumannii* (60%) and *P. aeruginosa* (100%) [30].

Third-generation cephalosporins (cefoperazone, ceftazidime, ceftriaxone/cefotaxime, ceftriaxone, cefotaxime, and cefixime) were tested their susceptibility against different UTI's bacteria (Table 2). The majority of gram negative bacteria exhibited a comparable average resistance rate to cephalosporins (Table 2). These findings were consistent with previous results that found significant resistance of gram negative bacteria to cephalosporins [31, 39, 40]. Among cephalosporin, *E. coli*, *P. aeruginosa*, *Klebsiella* spp., *Enterobacter* spp., and *A. baumannii* showed 100% resistance against cefixime (Table 2). The present study contradicts the earlier findings that indicated cefixime as an active antibiotic against gram negative bacteria [41]. On the other hand, in gram positive bacteria, the sensitivity of

Table 3a. Resistance number (%) of antibiotics against gram negative bacteria.

Antibiotics	Resistance No. (%)
Amikacin	22 (8.2%)
Trimethoprim/Sulfamethoxazole	184 (69%)
Augmentin	78 (29.2%)
Gentamicin	73 (27.3%)
Cefoperazone	163 (61%)
Cefixime	249 (93.2%)
Ceftazidime	157 (59%)
Piperacillin	122 (45.7%)
Ceftriaxone/Cefotaxime	190 (71.2%)
Cefotaxime	210 (78.7%)
Ceftriaxone	176 (66%)
Nitrofurantoin	60 (22.5%)
Imipenem	7 (2.6%)
Ciprofloxacin	109 (40.9%)
Tobramycin	44 (16.5%)
Ampicillin	105 (39.3%)
Cephalosporin	150 (56.2%)
Levofloxacin	63 (23.6%)

Table 3b. Resistance number (%) of antibiotics against gram positive bacteria.

Antibiotics	Resistance No. (%)
Amikacin	2 (6.3%)
Trimethoprim/Sulfamethoxazole	15 (46.9%)
Gentamicin	14 (43.8%)
Cefoperazone	10 (31.3%)
Cefotaxime	6 (18.8%)
Piperacillin	19 (59.4%)
Penicillin	32 (100%)
Ceftriaxone/Cefotaxime	16 (50%)
Cefotaxime	10 (31.3%)
Augmentin	10 (31.3%)
Ceftriaxone	15 (46.9%)
Nitrofurantoin	9 (28.1%)
Ampicillin	10 (31.3%)

S. aureus to cephalosporins is higher than *E. faecalis* which showed high resistance to cephalosporins (Table 2). Our results in this regard are in comparison with the recent report showing the resistance of *E. faecalis* to cephalosporins [40]. Cephalosporins showed a high resistance (66–93%) against gram negative bacteria

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(Table 3).

Penicillins group (ampicillin and piperacillin) showed a variable resistance rate against gram negative bacteria. However, *P. aeruginosa*, *Enterobacter* spp., and *M. morganii* demonstrated 100% resistance against to ampicillin (Table 2). This is comparable with previously reported data [18, 42]. With respect to *M. morganii*, the finding of the current study (Table 2) was similar to Al-Naqshbandi *et al*., which demonstrated 100% resistance of *M. morganii* to ampicillin [31]. *E. coli* showed 75% sensitivity against ampicillin, which is contrary to a study that demonstrated the highest resistance (82.79%) of *E. coli* to ampicillin [43]. In the present study, *E. coli* showed 48% resistance against piperacillin (Table 2). This result is supported by a recent study that showed 97% resistance of *E. coli* to piperacillin [25]. Among gram positive bacteria, *S. aureus* and *E. faecalis* showed 100% resistance against penicillin. Similar studies were reported a high level of resistance to penicillin [44, 45]. Moreover, *S. aureus* and *E. faecalis* displayed a high rate of resistance 100% and 33% to piperacillin, respectively (Table 2). Mishra *et al*., reported a similar result in respect to the resistance rate of *E. faecalis* to piperacillin (32%), while *S. aureus* of the same study showed very little resistance (39%) compared to our results (100%) [15]. Gram positive bacteria, demonstrated high resistance rate (100%) to penicillin (Table 3). However, pencillin and ampicillin were shown 100% susceptibility against oral bacteria [46, 47].

Augmentin is one of the regular UTI-prescribed antibiotics composed of a combination of two antibiotics (amoxicillin and clavulanic acid). In the existent study, *P. aeruginosa* exhibited the highest rate of resistance to augmentin (75%) followed by *Klebsiella* spp., (44%), *Enterobacter* spp., (25%), *E. coli* (20.7%), and *Proteus* spp., (5%), while *A. baumannii* showed 100% sensitivity (Table 2). This is in accordance with recent reports which showed the resistance rate of *E. coli* to augmentin as 16–20% [48, 49]. Moreover, the present findings are contrary to the earlier results, which found the resistance rate of *E. coli* to augmentin as 80% [50, 51]. *A. baumannii* showed more susceptibility (100%) compared to the previous reports, which demonstrated 100% resistance of *A. baumannii* to augmentin [18, 31]. Muhammad *et al*., declared the resistance pattern of *E. coli* (78.8%), *P. aeruginosa* (25%) and *Klebsiella* spp., (59%) to augmentin. Moreover, *S. aureus* obtained in this study was 98% susceptible than reported earlier (15.4%) [2].

In Iraq, one of the developing countries, penicillins and cephalosporins are frequently used for different diseases. Therefore, according to the present findings, we strongly recommend not using these antibiotics for treating UTI. However, this is in accordance with the study conducted in Pakistan [52]. The ineffectiveness of these antibiotics does not represent the end of consuming these antibiotics in many different countries for treating UTI. Moreover, piperacillin and cefepime showed high resistance to many other gram negative bacteria such as *Salmonella enterica* subsp. *enterica* serovar Typhi [13].

Carbapenems group (imipenem and meropenem) are the antibiotic of choice in treating UTIs [53]. *E. coli*, *P. aeruginosa*, *Klebsiella* spp., *Proteus* spp., *Enterobacter* spp., *A. baumannii*, and *E. faecalis* showed 100% sensitivity to imipenem, while *M. morganii* demonstrated 100% resistance against this antibiotic (Table 2). Meropenem showed 100% sensitivity to *E. coli*, *P. aeruginosa*, *Proteus* spp., and *M. morganii* (Table 2). The present investigation is contrary to a previously reported study that indicated 43% of total isolated *E. coli* were resistant to imipenem [52]. Studies conducted earlier declared carbapenems as the most active antibiotics against UTI bacteria [25, 39]. The present study indicated the effectiveness of the carbapenems antibiotic group against UTI causing bacteria; hence, it is suggested as a reliable choice of treatment. On the other hand, carbapenems also exhibited a high rate of sensitivity against enteric fever bacteria [13].

Quinolones antibiotic group (ciprofloxacin and levofloxacin) showed variations in respect to the rate of resistance. Ciprofloxacin demonstrated resistance rates as follows, *E. coli* (47.7%), *P. aeruginosa* (66%), and *Proteus* spp. (66.7%). While *Enterobacter* spp., *A. baumannii* and *E. faecalis* demonstrated 100% sensitivity (Table 2). A previous study in Canada showed higher resistance (75%) of *E. coli* to ciprofloxacin compared to the present data [54]. This is due to the extensive use of ciprofloxacin in the prevention and treating UTI. However, a study in Brazil demonstrated 36% *E. coli* strains resistant to ciprofloxacin [55]. Moreover, *Proteus* spp., and *E. faecalis* showed 100% sensitivity against levofloxacin, while 42% of isolated *E. coli* showed resistance (Table 2). A similar resistance rate (47.9%) to levofloxacin was found in Iran among *E. coli* [56]. The available data of the present study is discouraging the empirical usage of quinolones as the danger of treatment flop rises when resistance rates exceed 10% to 20% [57, 58].

Nitrofurantoin has a variable resistance rate among the bacteria, *P. aeruginosa* (100%) was the highest, followed by *Proteus* spp. (62%), *E. faecalis* (46%). Whereas *E. coli* and *Enterobacter* spp., showed a low resistance rate, 3.8%, and 11%, respectively. *Klebsiella* spp., and *A. baumannii*, demonstrated 100% sensitivity to nitrofurantoin (Table 2). Muller *et al.*, reported the effectiveness of nitrofurantoin in the prevention of UTI [59]. This data is comparable with the previous systematic review showing the efficiency of nitrofurantoin against *E. coli* [60]. The current study demonstrated a similar finding with that of Gardiner *et al.*, about the activity of nitrofurantoin against *E. coli* and *Klebsiella* spp., but not in *E. faecalis* which showed high resistance in our study (46%). However, *Proteus* spp., and *P. aeruginosa* were also resistant to nitrofurantoin, which is in accordance with the present study [61].

The current study concluded the presence of multi antibiotics resistance against several bacteria isolated from UTI in children from Baghdad, Iraq. *E. coli* was the most detected gram negative bacteria from UTI in children. Carbapenems (imipenem and meropenem) and aminoglycosides (amikacin and tobramycin) are highly recommended for the empirical treatment of UTI. While quinolones, penicillins, and cephalosporins antibiotics were not suggested to be used in treating UTI due to their resistance. The present study and future similar studies will assist doctors in prescribing the right antibiotics by updating their information about the prevalence and antibiotic susceptibility of UTIs causing bacteria in children. Hence, regular antibiotic susceptibility testing is required to keep up-to-date reports of antibiotics resistance.

Conflict of Interest

The authors have no financial conflicts of interest to declare.

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