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Urinary tract infection pathogens diagnosed in Basra city hospitals

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ABSTRACT

Background. *Urinary tract infection (UTI) is the growth of pathological bacteria within the urinary tract, and is one of the most common types of bacterial infections worldwide. Bacterial resistance to antibiotics is a major public health concern. Antibiotic-resistant bacterial infections exacerbate the situation in developed, developing and underdeveloped countries.*

Objective. *The aim of this research is to identify the frequency of different bacterial pathogens and their sensitivity to different types of antibiotics in patients suffering from UTI in Basra city hospitals.*

Method. *This cross-sectional study included 505 samples positive for bacterial growth. It was conducted by data extraction from hospital laboratory records, where information was obtained about bacterial examination of urine samples taken from patients with urinary tract infection. The samples were cultured and antibiotic sensitivity was tested by laboratory workers, in order to determine the appropriate treatment for patients.*

Results and conclusions. *The average age of patients was 43.5 years, of whom (60.4%) were females. The most common bacteria was Escherichia coli (40.6%). In antibiotic susceptibility testing process, gentamicin (5.7%), ciprofloxacin (4.7%), trimethoprim (4.7%), trimethoprim/sulfamethoxazole (4.1%), and cefepime (3.9%) were the most frequently used antibiotics, while cefotetan (0.06%), ampicillin-sulbactam (0.09%), mupirocin (0.2%), cefazolin (0.2%), fosfomycin and amoxicillin (0.2%) were the least used. The highest sensitivity shown by cultured bacteria was to linezolid (95.5%), ertapenem (91.7%), teicoplanin (79.4%), nitrofurantoin (75.2%) and amikacin (72.4%). The highest resistance shown by cultured bacteria was to cefazolin (100%), oxacillin (94.6%), fusidic acid (91.2%), ampicillin (90.4%), and amoxicillin (88.2%).*

Keywords: urinary tract infection, antibiotic sensitivity, pathogenic bacteria, Basra

INTRODUCTION

A urinary tract infection is the growth of pathological bacteria within the urinary tract. It is one of the most common types of bacterial infections worldwide, especially in developing countries, where it causes high rates of morbidity, mortality, and material losses. Urinary tract infections affect approximately 150 million people annually, and are less common in males [1]. Signs and symptoms of the disease include dysuria, frequent urination, nocturia, pyuria, fever, and sometimes suprapubic pain, and hematuria. It may lead to bacteremia and death. Urinary tract infections are mostly caused by aerobic gram-negative bacilli enterobacteria. These include *Escherichia coli,* which forms the highest percentage, followed by other species in varying proportions, *Klebsiella, Proteobacteria, Enterobacteriaceae, Citrobacter,* and other common Gram-positive intestinal pathogens, such as *Staphylococcus epidermidis, Staphylococcus aureus, Enterococcus faecalis,* and *Staphylococcus saprophyticus* [2]. Urinary tract infections are classified into two types, complicated and un-

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complicated. Complicating factors are associated with risk factors and diseases such as urinary tract obstruction, urinary tract abnormalities, renal failure, kidney stones, indwelling catheters, renal transplantation, pregnancy, and immunosuppression. As for uncomplicated ones, they affect people who are healthy and do not have urinary tract abnormalities, and are associated with risk factors such as age, sex, diabetes, sexual activity, and some methods of contraception [3].

Bacterial resistance to antibiotics is a major public health concern because the basis of treatment for UTI is the use of antibiotics, and treatment is often prescribed empirically. Injudicious and inappropriate use of antibiotics and long courses of treatment are a cause of recurrence of infection because bacteria develop resistance against the antibiotic used, making treatment difficult, expensive, less effective or even impossible, prolonging the disease and increasing the mortality rate. To ensure treatment of the disease, periodic monitoring and continuous scientific research must be carried out in this field [4]. There is a difference in the pattern of sensitivity to antibiotics between different countries and between different cities in the same country [5]. One of the most important challenges of the current century is the emergence of bacterial resistance to antibiotics. In the mid-1940s, two years after the use of penicillin, the first penicillin-resistant strain, Escherichia coli, appeared. Due to the appearance of resistance genes in these bacteria, the antibiotics become ineffective against them. The indiscriminate use of antibiotics forces bacteria to adapt. Therefore, it has become necessary to choose the appropriate antibiotic for each type of infection to reduce health damage and side effects of medications and save time and effort [6].

Antibiotic treatment depends on knowing the type of causative bacteria, the sex and age of the patient, and the patient's clinical condition, in addition to knowing the susceptibility patterns to the antibiotics used in the relevant geographical area [7]. Therefore, this research was conducted to study the most common pathogenic bacteria associated with urinary tract infections and the pattern of sensitivity to antibiotics in patients managed by Basra City hospitals, southern Iraq. That is to provide information to microbiologists and doctors to help them effectively treat urinary tract infections. Aim of study To determine the most frequent bacteria responsible for urinary tract infections in patients managed at Basra city hospitals, Iraq and their sensitivity to certain antibiotics.

MATERIALS AND METHODS

This cross-sectional study was conducted in five major hospitals in the city of Basra, Iraq. Al-Sadr Teaching Hospital, Al-Basra Teaching Hospital, Al-Mawani' Teaching Hospital, Al-Shifa' and Al-Zubair general hospitals to estimate the prevalence of bacteria causing urinary tract infections and their resistance to antibiotics. Data were collected after obtaining approval from the Centre of Training and Human Development in Basra Directorate of Health. The study included outpatient and inpatient patients who presented with signs and symptoms of UTI of all ages and both sexes during a one-year period, from August 2022 to August 2023.

Data were collected from microbiology laboratory records of patients with UTI symptoms such as age, sex of the patient, type of bacteria, and antibiotic sensitivity. Isolation and identification of urinary pathogenic bacteria was performed by standard microbiological methods or by Vitek system. The disc diffusion test and the Vitek 2 system were used to determine antimicrobial resistance patterns of the isolated bacteria. The current study included the database of 505 samples for bacterial growth.

RESULTS

Records contained 505 patients' data (244 in Al-Sadr Teaching Hospital, 108 in Al-Basra Teaching Hospital, 73 in Al-Mawani' Teaching Hospital, 40 in Al-Shifa General Hospital and 40 in Al-Zubair General Hospital.

Patients' data were taken during the period from August 2022 and August 2023. Females were more than males and the median age of them was 43.5 years, with a minimum age of 1 years and maximum age of 90 years (Table 1).

TABLE 1. *Demographic characteristics of the patients*

Variable	Frequency	Percent
Hospital		
Al-Sadr Teaching Hospital	244	48.3
Al-Basra Teaching Hospital	108	21.4
Al-Mawani' Teaching Hospital	73	14.5
Al-Shifa Hospital	40	7.9
Al-Zubair Hospital	40	7.9
Sex		
Male	200	39.6
Female	305	60.4
Method of identification		
Vitek	280	55.4
Manual	225	44.6
Gram stain results		
Gram-negative bacteria	351	69.5
Gram-positive bacteria	154	30.5
Total	505	100
	Mean± SD	**Median (Min. - Max.)**
Age (Year):	42.58±24.296	43.5 (1-90)

TABLE 2. *Frequency of isolated uropathogens*

Name of bacteria	Number of isolates	Percentage
Escherichia coli	205	40.6
Staphylococcus species	113	22.4
Klebsiella pneumonia	79	15.6
Pseudomonas aeruginosa	33	6.5
Streptococcus species	25	5.0
Enterobacter cloacae	23	4.5
Enterococcus faecalis	16	3.2
Proteus mirabilis	11	2.2
Total	505	100

It can be seen in Table 3 that Gentamycin (5.7%), Ciprofloxacin (4.7%), Trimethoprim (4.7%), Trimethoprim/Sulfamethoxazole (4.1%) and Cefepime (3.9%) were the most frequent antibiotics, out of 53 antibiotics, used to investigate the sensitivity of the bacteria cultured. On the other hand, Cefotetan (0.06%), Ampicillin-sulbactam (0.09%), Mupirocin (0.2%), Cefazolin (0.2%), Fosfomycin and Amoxicillin (0.2%) were the least used. The highest sensitivity shown by the cultured bacteria was to Linezolid (95.5%), Ertapenem (91.7%), Teicoplanin (79.4%), Nitrofurantoin (75.2%) and Amikacin (72.4%). The highest resistance shown by the cultured bacteria was to Cefazolin (100%), Oxacillin (94.6%), Fusidic acid (91.2%), Ampicillin (90.4%) and Amoxicillin (88.2%).

DISCUSSION

UTIs are among the most common bacterial infections. They affect women, children and men from all age groups. Escherichia coli is the most common pathogen in urinary tract infections. The current study showed that the percentage of females who consult hospitals due to urinary tract infections was more than the males', and this is consistent with many previous studies in different cities in Iraq such as Basra, Duhok, Najaf, and Baghdad [8-11]. This result was also consistent with other studies reported from different parts of the world showing a statistical predominance of females such as Uganda, Pakistan, Bangladesh, Tanzania, etc [12-14]. This could be due to difference in the incidence and/or prevalence between both sexes as result of anatomical and/or physiological differences [15], due to difference in severity and frequency/recurrence of infection, or due to psychological or social differences. In our study, 69.5% of infections were due to Gram-negative bacilli. Another study reported similar findings, where the Gram -negative bacilli emerged as the most common pathogen associated with urinary tract infections [16].

The current study showed that Escherichia coli was the most prevalent bacteria in UTI patients who consulted the hospitals (40.6%). These results agreed with several previous studies in Iraq [17-20]. Also, the results corroborate the results of Martin et al., which showed that the most prevalent bacterial UTI pathogen was *Escherichia coli* (41.9%), followed by *S. aureus* (31.4%) [21]. This can be due to the ability of these bacteria to attach to the surface of epithelial cells and they possess many virulence factors, such as fimbria, which help to invade urinary tract cells [25]. Some *E. coli* strains can diverge from their commensal groups and acquire a more pathogenic nature. These strains acquire specific virulence factors (via horizontal transfer of DNA from plasmids, transposons, pathogens, and phages), which endow bacteria with an increased ability to adapt to new domains, increasing their ability to cause a wide range of diseases [26].

Staphylococcus species was the second most common isolate (22.4%). This result was consistent with other reported studies [12,13,21]. That was attributed to the fact that this bacteria has the ability to produce three virulence factors (biofilms, hemolysis, and adhesion) [27]. Klebsiella pneumonia was isolated as the third pathogen (15.6%) causing urinary tract infection. This result was consistent with other studies [1,13]. This bacteria contains virulence factors such as fimbriae that facilitate attachment to epithelial cells as well as a capsule to prevent phagocytosis [28]. In this study all isolated bacteria were exposed to different antibiotics to test their sensitivity/resistance. Most of the isolated bacteria were resistant to cefazolin (100%), oxacillin (94.6%), ampicillin (90.4%), amoxicillin (88.2%) and cefuroxime (87.2%) due to their ability to produce beta-lactamase that destroys the lactam ring in these antibiotics [32]. The antibiotics linezolid (95.5%), ertapenem (91.7%), teicoplanin (79.4%), nitrofurantoin (75.2%) and amikacin (72.4%) were the most effective antibiotics on all the bacteria isolated.

The results of the current study showed that the Gram-negative bacteria *Escherichia coli* are 100% resistant to amoxicillin, cefazolin, rifampicin, and vancomycin, 94% to ampicillin, 84% to cefixime and cefuroxime, and 82% for both piperacillin and ticarcillin. This may be due to the large amount of these antibiotics that are prescribed (by local doctors or self-prescription) or dispensed by local pharmacies. Therefore, it is needed to avoid using these antibiotics to treat urinary tract infections caused by Escherichia coli and effective antibiotics such as ertapenem, fosfomycin, nitrofurantion, and amikacin need be used. This is consistent with previous studies that showed that *Escherichia coli* bacteria were sensitive to aminoglycosides such as amikacin [23,33]. These results are also consistent with previous results that showed resistance to the penicillin group, such as ampicillin [16,23]. These results are also consistent with previous results that showed resistance

TABLE 3. *The antibiotics used in the sensitivity testing of the bacterial growth*

Antibiotic	Sensitive No. (%)	Intermediate No. (%)	Resistant No. (%)	Total No. (%)
Amikacin	184 (72.4)	31 (12.2)	39 (15.4)	254 (3.6)
Ampicillin	11 (8.8)	1 (0.8)	113 (90.4)	125 (1.8)
Amoxicillin/Clavulanate	10 (13.5)	5 (6.8)	59 (79.7)	74 (1.1)
Aztronam	63 (31.5)	6 (3.0)	131 (65.5)	200 (2.9)
Azithromycin	37 (21.5)	2 (1.2)	133 (77.3)	172 (2.5)
Amoxicillin	1 (5.9)	1 (5.9)	15 (88.2)	17 (0.2)
Ampicillin-sulbactam	1 (16.7)	0 (0)	5 (83.3)	6 (0.09)
Chloramphenicol	105 (70.5)	5 (3.4)	39 (26.2)	149 (2.1)
Ceftazidime	89 (32.5)	7 (2.6)	178 (65.0)	274 (3.9)
Ceftazidime/Avibactam	27 (57.4)	0(0)	20 (42.6)	47 (0.7)
Cefixime	12 (17.9)	2 (3.0)	53 (79.1)	67 (0.9)
Cefazolin	0(0)	0(0)	16 (100.0)	16 (0.2)
Ciprofloxacin	136 (41.5)	8 (2.4)	184 (56.1)	328 (4.7)
Ceftriaxone	43 (30.3)	4 (2.8)	95 (66.9)	142 (2.0)
Clarithromycin	9 (33.3)	0(0)	18 (66.7)	27 (0.4)
Clindamycin	50 (49.0)	2 (2.0)	50 (49.0)	102 (1.5)
Cefotaxime	35 (22.3)	2 (1.3)	120 (76.4)	157 (2.2)
Cefuroxime	5 (12.8)	0(0)	34 (87.2)	39 (0.6)
Cefotetan	1 (25.0)	0(0)	3 (75.0)	4 (0.06)
Cefepime	95(33.9)	10 (3.6)	175 (62.5)	280 (3.9)
Cefoxitin	60 (36.8)	6 (3.7)	97 (59.5)	163 (2.3)
Doxycycline	82(50.9)	5 (3.1)	74 (46.0)	161(2.3)
Erythromycin	18 (13.7)	3 (2.3)	110 (84.0)	131 (1.9)
Ertapenem	22 (91.7)	0(0)	2 (8.3)	24 (0.3)
Fosfomycin	13 (76.5)	0(0)	4 (23.5)	17 (0.2)
Fusidic acid	3 (8.8)	0(0)	31 (91.2)	34 (0.5)
Gentamycin	216 (54.1)	14 (3.5)	169 (42.4)	399 (5.7)
Imipenem	152 (54.5)	10 (3.6)	117 (41.9)	279 (3.9)
Kanamycin	31 (44.9)	7 (10.1)	31 (44.9)	69 (0.9)
Linezolid	64 (95.5)	0(0)	3 (4.5)	67 (0.9)
Levofloxacin	107 (44.4)	5 (2.1)	129 (53.5)	241(3.4)
Lomefloxacin	15 (27.3)	0(0)	40 (72.7)	55 (0.8)
Meropenem	199 (77.7)	6 (2.3)	51 (19.9)	256 (3.7)
Minocycline	68 (53.5)	22 (17.3)	37 (29.1)	127 (1.8)
Moxalactam	17 (45.9)	8 (21.6)	12 (32.4)	37 (0.5)
Mupirocin	8 (53.3)	3 (20.0)	4 (26.7)	15 (0.2)
Nalidixic acid	29 (22.5)	9 (7.0)	91 (70.5)	129 (1.8)
Nitrofurantoin	115 (75.2)	9 (5.9)	29 (19.0)	153 (2.2)
Norfloxacin	41 (31.1)	1 (0.8)	90 (68.2)	132 (1.9)
Ofloxacin	25 (50.0)	0(0)	25 (50.0)	50 (0.7)
Oxacillin	4 (5.4)	0(0)	70 (94.6)	74 (1.1)
Piperacillin	41 (19.2)	4 (1.9)	169 (79.0)	214 (3.1)
Piperacillin/Tazobactam	108 (59.3)	11 (6.0)	63 (34.6)	182 (2.6)
Rifampicin	61 (64.2)	1 (1.1)	33 (34.7)	95 (1.4)
Streptomycin	16 (53.3)	2 (6.7)	12 (40.0)	30 (0.4)
Trimethoprim/Sulfamethoxazole	138 (47.9)	2 (0.7)	148 (51.4)	288 (4.1)
Tetracycline	84 (33.7)	11 (4.4)	154 (61.8)	249 (3.6)
Teicoplanin	50 (79.4)	1 (1.6)	12 (19.0)	63 (0.9)
Ticarcillin	22 (15.7)	3 (2.1)	115 (82.1)	140 (2.0)
Ticarcillin/Clavulanic acid	52 (41.6)	9 (7.2)	64 (51.2)	125 (1.8)
Trimethoprim	45 (35.2)	5 (3.9)	78 (60.9)	128 (1.8)
Tobramycin	163 (49.8)	18 (5.5)	146 (44.6)	327 (4.7)
Vancomycin	70 (70.7)	4 (4.0)	25 (25.3)	99(1.4)
Total	3053 (43.6)	265 (3.8)	3715 (53)	7003

to the cephalosporins group, such as cefixime [34]. The present results showed that the Gram-positive bacteria Staphylococcus species resistant to cefotaxime, cefepime, fosfomycin and Kanamicin (100%), to oxacillin (94%), to fusidic acid (91%), to azithromycin (90%) and to nalidixic acid (83%). A possible explanation for this situation is that these antibiotics have been used for long periods of time and have been abused. Over time, the bacteria developed new resistance mechanisms against it. On the other hand, the study showed that the most effective antibiotics against urinary tract infections caused by Staphylococcus species were ampicillin, piperacillin/tazobactam, linezolid, amikacin, minocycline, and teicoplanin. This is consistent with previous studies that showed that *Staphylococcus aureus* bacteria are sensitive to linezolid [35]. These results are also consistent with previous findings that have shown resistance to nalidixic acid [23]. Also, the results showed that Gram-negative bacteria *Klebsiella pneumonia* are 100% resistant to amoxicillin/clavulanate, ampicillin-sulbactam, cefuroxime, fosfomycin, oxacillin, and rifampicin, 96% to ticarcillin, 95% to tetracycline, 91% to amoxicillin and ampicillin. Conversely, the study showed that the most effective antibiotics against urinary tract infections caused by Klebsiella pneumonia were cefotetan, ertapenem and amikacin. This agrees with previous studies that showed *Klebsiella pneumonia* bacteria were sensitive to aminoglycosides such as amikacin [16,23]. These results are also consistent with previous findings that have shown resistance to ampicillin [23]. The resistance of *Pseudomonas aeruginosa* was 100% to amoxicillin/clavulanate, ampicillin-sulbactam, cefixime, cefuroxime, erythromycin, lomefloxacin, ofloxacin, oxacillin and tetracycline.

On the other hand, the sensitivity of *Pseudomonas aeruginosa* was to amoxicillin, chloramphenicol and doxycycline. Among the cephalosporins, it was shown that *Pseudomonas aeruginosa* is 100% resistant to cefixime. This result is consistent with previous research stated that cefixime is ineffective against Gram-negative bacteria [33]. Regarding Streptococcus species, it was 100% resistant to aztronam, gentamycin, imipenem, lomefloxacin, meropenem, nalidixic acid and norfloxacin. However, it was most effective against urinary tract infections caused by Streptococcus species were linezolid, piperacillin, trimethoprim, nitrofurantoin and tobramycin. *Enterobacter cloacae* was found to be 100% resistant to ampicillin, ampicillin-sulbactam, cefixime, cefazolin, cefuroxime, cefotetan, cefoxitin, erythromycin, norfloxacin, and oxacillin. Again, this may be due to antibiotic abuse. Sensitivity was found to ceftazidime/avibactam, doxycycline, ertapenem, linezolid, nitrofurantion, and ofloxacin. This agrees with previous studies showed that Enterobacter cloacae bacteria were sensitive to nitrofurans such as nitrofurantoin [33]. When *Enterococcus faecalis* was considered, it was found 100% resistant to aztronam, ceftazidime, clarithromycin, cefepime, erythromycin, norfloxacin, and streptomycin. Abuse can be claimed the reason. Effective antibiotics were found trimethoprim/sulfamethoxazole, ampicillin-sulbactam, doxycycline, chloromphenicol, gentamycin, imipenem, kanamycin, and linezolid. This is consistent with previous studies, which found that Enterococcus faecalis was sensitive to carbapenems such as imipenem [33]. Moreover, this study showed that Gram-negative bacteria Proteus mirabilis were 100% resistant to ceftriaxone, cefotaxime, cefuroxime, doxycycline, kanamycin, minocycline, trimethoprim/sulfamethoxazole, ticarcillin, and ticarcillin/clavulanic acid. Effective antibiotics were fosfomycin, ceftazidime/avibactam, meropenem, and amikacin. This is consistent with previous studies showed that Proteus mirabilis bacteria were sensitive to aminoglycosides such as amikacin [33], and consistent with previous findings showed Proteus mirabilis resistance to cephalosporin such as ceftriaxone [16].

CONCLUSION

UTIs are among the most common bacterial infections. It affects women, children and men of all age groups. *Escherichia coli* is the most common pathogen. In patients who consult hospitals because of UTI, it is more common in females than in males. The study provided useful information about the pattern of bacterial resistance. In antibiotic sensitivity testing, Gentamycin, Ciprofloxacin, Trimethoprim, Trimethoprim/Sulfamethoxazole and Cefepime were the most frequent antibiotics tested; while, Cefotetan, Ampicillin-sulbactam, Mupirocin, Cefazolin, Fosfomycin and Amoxicillin were the least used. The highest sensitivity shown by the cultured bacteria was to Linezolid, Ertapenem, Teicoplanin, Nitrofurantoin and Amikacin. The highest resistance shown by the cultured bacteria was to Cefazolin, Oxacillin, Fusidic acid, Ampicillin and Amoxicillin.

Recommendations

Effective management of UTI is extremely important through rapid identification of the type of bacteria causing the disease and selection of appropriate antibiotics. Continuous monitoring of bacterial resistance is very essential, which is done by performing antibiotic susceptibility testing on a regular and periodic basis to get updated reports on antibiotic resistance.

The patient should also not take antibiotics without a prescription from a specialist doctor. Doctors should be provided with the latest information about the local prevalence of bacteria causing urinary tract infections, which will help them determine appropriate and

effective antibiotic treatment for this disease. Dispensing antibiotics must follow fixed and international controls, which reduces the problems of resistance and the economy. New and effective antimicrobial compounds must be found.

Furthermore, it is necessary to discover and study the genes responsible for antibiotic resistance patterns in order to evaluate resistance patterns at the protein and genome levels. It is very important to conduct more recent and ongoing studies in this field for each geographical region separately and at different times.

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Author's contribution:
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REFERENCES

1. Ghaima KK, Khalaf ZS, Abdulhassan AA, Salman NY. Prevalence and antibiotic resistance of bacteria isolated from urinary tract infections of pregnant women in Baghdad hospitals. *Biomed Pharmacol J.* 2018;11(4):1989-94. https://doi.org/10.13005/bpj/1573
2. Hossain G, Hossain E, Ahammed F, Kabir MR, Karmaker G, Chowdhury IA, Mursalin MM, Das A. Bacteriological profile and sensitivity pattern of urinary tract infection patients in north east part of Bangladesh. *Inter J Adv Med.* 2020;7(11):1614-9.
3. Hadi AM, Sheri FH, Jaccob AA. Urinary tract infection prevalence and antibiotic resistance a retrospective study in Basra governorate, Iraq. *Al Must J Pharma Sci.* 2014;14(2):129-135. https://doi.org/10.32947/ajps.v14i2.155
4. Sapkota J, Mishra B, Jha B, Sharma M. Bacteriological profile and their antimicrobial susceptibility pattern in central venous catheter tip culture. *Journal of Pathology of Nepal.* 2017;7(1):1059-61. https://doi.org/10.3126/jpn.v7i1.16670
5. Fasugba O. Antimicrobial resistance in urinary tract infections caused by Escherichia coli (Doctoral dissertation, Australian Catholic University). 2017.
6. Jalilian S, Farahani A, Mohajeri P. Antibiotic resistance in uropathogenic Escherichia coli isolated from urinary tract infections out-patients in Kermanshah. *Inter J Public Health.* 2014;4(1):75-7.
7. Dawood WS. Molecular and susceptibility Study of Antibiotic Resistance Genes in E. coli Isolated from Selected Iraqi Patients. *SRP.* 2020; 11(9):214-3.
8. Ali ET, Abdullah AS, Rana MA. Antibiotic Susceptibility Manner of the Bacteria Causes Urinary Tract Infections in Basra, South Iraq. *J Pure Appl Microbiol.* 2020;14(1):541-6. https://doi.org/10.22207/JPAM.14.1.56
9. Hussein NR, Daniel S, Salim K, Assafi MS. Urinary tract infections and antibiotic sensitivity patterns among women referred to Azadi teaching hospital, Duhok, Iraq. *Avicenna J Clin Microbiol Infect.* 2017; 5(2):27-30. http://doi.org/10.34172/ajcmi.2018.05
10. Majeed HT, Aljanaby AA. Antibiotic susceptibility patterns and prevalence of some extended spectrum beta-lactamases genes in gram-negative bacteria isolated from patients infected with urinary tract infections in Al-Najaf City, Iraq. *Avicenna J Med Biotechnol.* 2019;11(2):192-201.
11. Kahlmeter G. Prevalence and antimicrobial susceptibility of pathogens in uncomplicated cystitis in Europe. The ECO· SENS study. Inter. *Int J Antimicrob Agents.* 2003;22:49-52. http://doi.org/10.1016/s0924-8579(03)00229-2
12. Abbas HM, Al-Mathkhury HJ. Isolation and identification of bacteria from Iraqi women with recurrent urinary tract infection. *Plant Archives.* 2020; 20(2):1838-1842.
13. Ullah A, Shah SR, Almugadam BS, Sadiqui S. Prevalence of symptomatic urinary tract infections and antimicrobial susceptibility patterns of isolated uropathogens in kohat region of Pakistan. M*OJ Bio Med.* 2018;3(4):85-99. http://doi.org/10.15406/mojbm.2018.03.00082
14. Schmider J, Bühler N, Mkwatta H, Lechleiter A, Mlaganile T, Utzinger J, Mzee T, Kazimoto T, Becker SL. Microbiological characterisation of community-acquired urinary tract infections in Bagamoyo, Tanzania: a prospective study. Trop Med Infec Dis. 2022;7(6):100. http://doi.org/10.3390/tropicalmed7060100
15. Abdullah IM. Multiple drugs resistance among urinary tract infection patients in Duhok city–Kurdistan Region–Iraq. *Duhok Med J.* 2019;13(1):22-31.
16. Mehboob M, Hakim M, Ullah O, Lodhi SS, Anees M, Khalil I, Shuja MN. Identification and characterization of urinary tract infections bacteria and its antibiotic sensitivity. *Bio Sci Rev.* 2021;3(3):43-62. https://doi.org/10.32350/BSR.0303.04
17. Alwaeli ZA. A Comparative Study of Antibiotic Resistance of Bacteria That Cause Urinary Tract Infection in Diabetic and Non-Diabetic Patients in Najaf City. *Ann Rom Soc Cell Biol.* 2021;25(6):8591-8600.
18. Khalaf SA, Mahmood NN, Saleh MA. Detection of tetM, armA, blaPER-1 and blaIMP genes in E. coli isolates among the gram negative bacteria that cause urinary tract infections. *IOP Science.* 2021;1999(1):012021. http://doi.org/10.1088/1742-6596/1999/1/012021
19. Lafta IJ, DAM, Multidrug Resistant Enteric Bacteria Isolated From Patients with Urinary Tract Infections. *Ann Rom Soc Cell Biol.* 2021;25(6):2588-600.
20. Al-Naimi IA, Abbas MA. Research article recurrent urinary tract infections in iraqi leukemic patients. *Int J Adv Res.* 2016;4(3):1433-9.
21. Odoki M, Almustapha Aliero A, Tibyangye J, Nyabayo Maniga J, Wampande E, Drago Kato C, Agwu E, Bazira J. Prevalence of bacterial urinary tract infections and associated factors among patients attending hospitals in Bushenyi district, Uganda. *Int J Microbiol.* 2019(1):1-8. http://doi.org/10.1155/2019/4246780
22. Alhamdany MH. Antibiotic susceptibility of bacteria isolated from patients with diabetes mellitus and recurrent urinary tract infections in Babylon Province. *Irak Med J Babylon.* 2018;15(1):63-8.
23. Alakhali KM, Alzomor A, Alavudeen S, Khan N, Dawbaa S. Bacterial resistance of antibiotics used in urinary tract infection. *Asian J Pharm Clin Res.* 2013;6(1):87-91.
24. Al-Awkally NA, Ibrahim HK, Ali MD, Muthanna FM, Al-Awkally AM, Yousuf A. Study of antibiotic sensitivity pattern in urinary tract infection. *Int J Health Sci.* 2022;6:8896-913. https://doi.org/10.53730/ijhs.v6nS3.8113

25. Bazzaz BS, Fakori M, Khameneh B, Hosseinzadeh H. Effects of omeprazole and caffeine alone and in combination with gentamicin and ciprofloxacin against antibiotic resistant staphylococcus aureus and escherichia coli strains. *J Pharmacopuncture.* 2019;22(1):49-54. http://doi.org/10.3831/KPI.2019.22.006
26. Bien J, Sokolova O, Bozko P. Role of uropathogenic Escherichia coli virulence factors in development of urinary tract infection and kidney damage. *Int J Neph.* 2012:1-15. https://doi.org/10.1155/2012/681473
27. Al-Rawi AM, Al-Mudallal NH, Taha AA. Iron Oxide Nanoparticles as Anti-Virulence Factors of Gram-positive and Gram-negative Bacteria. *SAR J Path. Micro.* 2023; 4(4):48-57.
28. Clopés J, Winkler RG. Flagellar arrangements in elongated peritrichous bacteria: bundle formation and swimming properties. *Eur Phys J E Soft Matter.* 2021;44:1-2. http://doi.org/10.1140/epje/s10189-021-00027-8
29. Alwaeli AZ. Detection of the Some Dominant Aerobic Microorganisms in Burn Injury and Testing their Susceptibility for Different Antibiotics in Najaf. *Indian J Forensic Med Toxicol.* 2021;15(1):737-43. https://doi.org/10.37506/ijfmt.v15i1.13505
30. Mnif MF, Kamoun M, Kacem FH, Bouaziz Z, Charfi N, Mnif F, et al. Complicated urinary tract infections associated with diabetes mellitus: pathogenesis, diagnosis and management. Indian J Endocrinol Metab. 2013;17(3):44. http://doi.org/10.4103/2230-8210.111637
31. Urmi UL, Jahan N, Nahar S, Rana M, Sultana F, Hossain B, et al. Gram-positive uropathogens: empirical treatment and emerging antimicrobial resistance. *Biomed Res.* 2019;4:1-4.
32. Takahashi P, Trang N, Chutka D, Evans J. Antibiotic prescribing and outcomes following treatment of symptomatic urinary tract infections in older women. *J Am Med Dir Assoc.* 2002;3(6):352-5. http://doi.org/10.1097/01.JAM.0000035737.87188.87
33. Salman HA, Alhameedawi KA, Muhamad SM, Taha Z. Prevalence of Multi-Antibiotic Resistant Bacteria Isolated from Children with Urinary Tract Infection from Baghdad, Iraq. *Microbiol Biotechnol Lett.* 2022;50(1):147-56. https://doi.org/10.48022/mbl.2110.10011
34. Noor U, Suliman M, Shams H, Sultan A, Khan SH. Prevalence and Phenotypic Detection of Carbapenem and Multi Drug Resistant of E. Coli in Urinary Tract Infection Patients in District Swat: Detection of Carbapenem and Multi Drug Resistant of E. coli. *Pakistan J Health Sci.* 2022;30:243-7. https://doi.org/10.54393/pjhs.v3i06.367
35. Baloch BK, Ali K, Memon N, Hassan S, Jan MS, Aziz JB, Kaleem S. Antibiotic Antibiogram in Patients with Complicated Urinary Tract Infections in Nephrology Unit of South Waziristan. *Cureus.* 2022;14(10):1-6. http://doi.org/10.7759/cureus.29803