Middle East J Rehabil Health Stud. 2020 July; 7(3):e103529. doi: 10.5812/mejrh.103529.

Published online 2020 July 13. **Research Article**

Bacterial Strains and Antimicrobial Susceptibility Patterns in Male Urinary Tract Infections in Duhok Province, Iraq

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Received 2020 April 08; **Revised** 2020 May 09; **Accepted** 2020 May 28.

Abstract

Background: Urinary tract infection (UTI) is one of the most common infectious diseases at the community level, worldwide.
Objectives: This study aimed to assess the prevalence and antimicrobial susceptibility patterns of the main pathogens responsible for male UTI in the community.
Methods: Urine samples were collected from 211 subjects with UTI between January 2017 and February 2020. The samples were inoculated directly on MacConkey and Blood agar and then incubated at 37°C for 24 h. Samples with a colony count of $\geq 10^5$ CFU/mL bacteria were considered positive. Bacterial colonies were determined by standard culture and biochemical characteristics, and their susceptibility to different antibiotics was identified by the Vitek-2 compact equipment.
Results: The vast majority of the bacteria were Gram-negative (170 [80.6%]), while 41 (19.4%) of them were Gram-positive. The highest infection was by *Escherichia coli* (52.6%), followed by *Pseudomonas aeruginosa* (14.2%). *Staphylococcus* spp. were the most common Gram-positive bacteria (13.8%). The highest susceptibility of *Escherichia coli* isolates was found to imipenem (96.4%), and the highest resistance rate was to ampicillin (96.4%). *Pseudomonas aeruginosa* was resistant to all commonly used antibiotics, and around 86% was susceptible to ertapenem (86.7%). It was also found that *Staphylococcus* strains were resistant to benzylpenicillin (100%) and sensitive to linezolid (100%), tigecycline (100%), and nitrofurantoin (100%).
Conclusions: *E. coli* isolates were the most frequent pathogens causing UTI in males, followed by *P. aeruginosa* and *Staphylococcus* spp. The vast majority of isolates were resistant to commonly prescribed antibiotics such as ampicillin, ceftriaxone, cefepime, benzylpenicillin, oxacillin, and erythromycin. This is an alarming situation, and an urgent plan to control antibacterial resistance is required in the region.

Keywords: Bacterial Strains, UTI, Male, Sensitivity Test, Duhok, Iraq

1. Background

Urinary tract infection (UTI) is one of the most common bacterial diseases (1). Globally, 150 million people are diagnosed with UTI annually (2), which costs more than 6 billion US dollars. UTIs are a spectrum of diseases ranging from simple cystitis to serious infections such as pyelonephritis and other complications in humans (3). In general, UTI is more common in females than in males, as the female urethra is structurally found less effective to prevent the bacterial entry (4). Besides, the frequency rate of UTI depends on different factors, including age, previous use of antibiotics, hospitalization, and catheterization.

It is known that more than 95% of urinary tract infections are caused by a single bacterial species. *E. coli* is the most frequent infecting organism in acute infections (5). In recent reports carried out in Iraq, it was found that *E. coli*, *Staphylococcus* spp., and *K. pneumonia* were the most common infectious agents causing UTI, which were also resistant to the most commonly used antibiotics (6, 7).

The early treatment of UTI with empirical antibiotics decreases the rate of morbidity (8). In order to administer an appropriate empirical therapy, it is critical to know the main bacteria causing urinary tract infection as well as their respective antimicrobial susceptibility pattern (9). Determining microorganisms and their antibiotic sensitivity patterns allows good treatment outcomes, controls the increase of antimicrobial prescription and helps to control antimicrobial resistance, which is a public health problem worldwide. In addition, pathogens recovered from males were shown to be more resistant to antibiotics when compared with pathogens isolates from female patients. Thus, while choosing an empirical antimicrobial therapy, gender should be taken into account (10).

2. Objectives

In this study, we aimed to evaluate the distribution of pathogens associated with UTI in male patients and determine the pathogens' antimicrobial susceptibility patterns in Duhok Province, Iraq.

3. Methods

The present study was approved by the Ethics Committee of the College of Medicine, University of Zakho, Kurdistan, Iraq (code: 4/154/NW/02.05.2019) and was carried out in Duhok Province, Kurdistan Region, Iraq from January 2017 to February 2020. All patients (aged 10 - 65 years old) completed the consent form before being recruited in the study. Inclusion criteria included male gender, positive microbiological evidence of UTI (bacterial growth of higher than 10^5 CFU/mL), and willingness to be recruited in the study.

A total of 211 urine samples were collected from male patients with UTI visiting private health centers. Midstream-clean catch urine was collected from patients in a sterile disposable container (5 mL) to avoid contamination. Then, the urine samples were inoculated on Blood and MacConkey agars (Oxoid Ltd, Bashingstore, Hampire, UK) and incubated at 37°C for 24 h. Cultures showed no growth at the end of 24 h incubation and were further incubated for 48 h. Bacterial isolates were initially classified using Gram-staining, and then the isolates were identified depending on the standard microbiological culture and biochemical characteristics. The identification of bacteria was performed according to the Clinical and Laboratory Standards Institute (CLSI) guidelines (11, 12). Vitek-2 Microbial Analysing system (bioMerieux, US) was used for antimicrobial sensitivity testing.

4. Results

4.1. Pathogens

A total of 211 male subjects met our inclusion criteria and were recruited in the study. Out of these, 170 (80.6%) isolates were Gram-negative bacteria, and 41 (19.4%) were Gram-positive (Table 1). The most commonly isolated organisms were *E. coli* (52.6%), *P. aeruginosa* (14.2%), *Klebsiella pneumonia* (6.2%), *Staphylococcus haemolyticus* (5.7%), and *Staphylococcus epidermidis* (4.3%) (Table 1).

Table 1. Frequency of Bacterial Isolates From Urine Specimens in this Study (Male = 211)

Isolated Bacteria	Value[a]
Gram negative bacteria (n = 170 [80.6%])	
Escherichia coli	111 (52.6)
Pseudomonas aeruginosa	30 (14.2)
Klebsiella pneumonia	13 (6.2)
Proteus mirabilis	9 (4.3)
Morganella morganii	4 (1.9)
Actinobacter baumanni	3 (1.4)
Gram positive bacteria (n = 41 [19.4%])	
Staphylococcus haemolyticus	12 (5.7)
Staphylococcus epidermidis	9 (4.3)
Enterococcus faecalis	6 (2.8)
Streptococcus agalactiae	6 (2.8)
Staphylococcus lentus	5 (2.4)
Staphylococcus aureus	3 (1.4)
Total	211 (100)

[a]Values are expressed as No. (%).

4.2. Bacterial Susceptibility

The comparison of the susceptibility pattern of Gram-negative and -positive pathogens to various antimicrobial agents from all the specimens is summarized in Tables 2 and 3, respectively. *E. coli* showed high resistance to ampicillin (96.4%), cefepime (72.9%), ceftriaxone (72.1%), and aztreonam (70.3%). There was a high susceptibility pattern of *E. coli* to imipenem (95.5%) and ertapenem (94.6%). *P. aeruginosa* showed high resistance to ciprofloxacin (83.3%), and ampicillin (76.7%), while it was highly sensitive to ertapenem (86.7%). Additionally, *K. pneumonia* was highly susceptible to imipenem (100%), gentamicin (100%), and ertapenem (100%), and 92.3% of the isolated strains were resistant to ampicillin. It was also found that around 78% of *Proteus mirabilis* isolates were resistant to ampicillin, cefepime, and ceftriaxone, and 100% were susceptible to imipenem, amikacin, and ertapenem (Table 2).

Staphylococcus spp. were responsible for about 13.8% of UTI cases. Out of these, *S. haemolyticus* (5.7%) and *S. epidermidis* (4.3%) were the most frequent Gram-positive bacteria, which showed high resistance to benzylpenicillin (100%) and 100% susceptibility to nitrofurantoin, linezolid, and tigecycline (Table 3). In addition, around 83% of the isolated *E. faecalis* strains were resistant to benzylpenicillin, oxacillin, levofloxacin, moxifloxacin, erythromycin, and clindamycin, but highly sensitive to linezolid (100%), nitrofurantoin (100), tigecycline (100%), rifampicin (100%),

Table 2. Antibiotic Susceptibility Pattern of Gram-Negative Uropathogens[a, b]

Antibiotic	Number of Bacteria					
	E. coli	*P. aeruginosa*	*K. pneumonia*	*P. mirabilis*	*M. morganii*	*A. baumanni*
Ampicillin	107 (96.4)	23 (76.7)	12 (92.3)	7 (77.8)	4 (100)	2 (66.7)
Amoxicillin/clavulanic acid	46 (41.4)	17 (56.7)	6 (46.2)	1 (11.1)	4 (100)	1 (33.3)
Piperacillin/tazobactam	50 (45.0	15 (50)	4 (30.8)	3 (33.3)	1 (25)	1 (33.3)
Cefazolin	52 (46.8)	9 (30)	1 (7.7)	4 (44.4)	1 (25)	2 (66.7)
Cefixime	62 (55.9)	20 (66.7)	3 (23.1)	4 (44.4)	1 (25)	1 (33.3)
Ceftriaxone	80 (72.1)	19 (63.3)	4 (30.8)	7 (77.8)	1 (25)	2 (66.7)
Cefepime	81 (72.9)	15 (50)	8 (61.5)	7 (77.8)	1 (25)	2 (66.7)
Aztreonam	78 (70.3)	10 (33.3)	7 (53.8)	4 (44.4)	1 (25)	2 (66.7)
Ertapenem	6 (5.4)	4 (13.3)	0 (0)	0 (0)	0 (0)	0 (0)
Imipenem	5 (4.5)	11 (36.7)	0 (0)	0 (0)	0 (0)	1 (33.3)
Amikacin	12 (10.8)	10 (33.3)	5 (38.5)	0 (0)	1 (25)	0 (0)
Gentamicin	51 (45.9)	14 (46.7)	0 (0)	1 (11.1)	0 (0)	1 (33.3)
Tobramycin	56 (50.5)	11 (36.7)	3 (23.1)	1 (11.1)	0 (0)	1 (33.3)
Ciprofloxacin	70 (63.1)	25 (83.3)	5 (38.5)	2 (22.2)	0 (0)	2 (66.7)
Levofloxacin	66 (59.5)	21 (70)	4 (30.8)	4 (44.4)	0 (0)	1 (33.3)
Nitrofurantoin	18 (16.2)	8 (26.7)	6 (46.2)	4 (44.4)	0 (0)	1 (33.3)
Trimethoprim/sulfamethoxazole	61 (54.9)	7 (23.3)	9 (69.2)	4 (44.4)	0 (0)	1 (33.3)

[a] *Escherichia coli*, *Pseudomonas aeruginosa*, *Klebsiella pneumonia*, *Proteus mirabilis*, *Morganella morganii*, *Actinobacter baumanni*.
[b] Values are expressed as No. (%).

and vancomycin (100%) (Table 3). The resistance rates of *S. agalactiae*, *S. lentus*, and *S. aureus* to other commonly used antibiotic agents are presented in Table 3.

5. Discussion

UTI is one of the most widespread infections worldwide (1). *E. coli* is considered as the most frequent uropathogen involved in community-acquired UTI (being implicated in more than half of all the UTI cases) (13). The prevalence of UTI varies according to gender, age, geographical and regional locations, previous use of antibiotics, hospitalization, and catheterization (9).

Geographic variations in pathogen occurrence and antibiotic susceptibility profiles require frequent monitoring to provide information to guide the therapeutic options. Therefore, this study aimed to investigate the frequency of microorganisms responsible for UTIs and their antimicrobial susceptibility patterns in males in Duhok Province, Iraq. The majority of studies have reported that Gram-negative bacteria cause 90% of UTI cases, while Gram-positive bacteria cause only 10% of the cases (14, 15).

In the present study, we found that Gram-negative bacteria were a common cause of UTIs among males (80.6%); this was in agreement with reports of other studies conducted in Iran and Iraq (3, 6, 16). This could be due to the presence of unique structure in Gram-negative bacteria, which facilitates attachment to the uroepithelial cell, resulting in high prevalence in UTIs.

Following the classification of the detected pathogenic bacteria, our data showed that among the isolated Gram-negative pathogens, *E. coli* was the most frequent isolate, and *A. baumanni* was the least detected one in our community. *E. coli* is the most common isolated etiological agent responsible for 80% - 90% of uncomplicated UTIs, which could be due to the fact that it belongs to the normal flora of the human intestine, and therefore, it easily colonizes the urinary tract and can exhibit multidrug resistance (15). Likewise, other studies reported that *E. coli* was the most common pathogen causing UTIs in males (17, 18). Likewise, several previous studies conducted in Iraq showed that *E. coli* was the most common causative microorganism responsible for UTIs (7, 19).

However, the resistance pattern of *E. coli* to antibiotics has been very different in various studies. In a study con-

Table 3. Antibiotic Susceptibility Pattern of Gram-Positive Uropathogens[a, b]

Antibiotic	Number of Bacteria					
	S. haemolyticus	**S. epidermidis**	**E. faecalis**	**S. agalactiae**	**S. aureus**	**S. lentus**
Benzylpenicillin	12 (100)	9 (100)	5 (83.3)	4 (80)	2 (66.7)	5 (100)
Oxacillin	11 (91.7)	7 (77.8)	5 (83.3)	3 (60)	0 (0)	5 (100)
Gentamicin	2 (16.7)	1 (11.1)	2 (33.3)	1 (20)	0 (0)	2 (40)
Tobramycin	6 (50)	3 (33.3)	1 (16.7)	3 (60)	0 (0)	2 (40)
levofloxacin	8 (66.7)	1 (11.1)	5 (83.3)	2 (40)	0 (0)	3 (60)
Moxifloxacin	3 (25)	1 (11.1)	5 (83.3)	2 (40)	1 (33.3)	2 (40)
Erythromycin	10 (83.3)	4 (44.4)	5 (83.3)	2 (40)	0 (0)	3(60)
Clindamycin	6 (50)	3 (33.3)	5 (83.3)	5 (100)	0 (0)	5 (100)
Linezolid	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	3 (60)
Teicoplanin	2 (16.7)	2 (22.2)	2 (33.3)	0 (0)	0 (0)	1 (20)
Vancomycin	2 (16.7)	1 (11.1)	0 (0)	0 (0)	0 (0)	2 (40)
Tetracycline	6 (50)	4 (44.4)	5 (83.3)	0 (0)	0 (0)	2 (40)
Tigecycline	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Nitrofurantoin	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Rifampicin	1 (8.3)	1 (11.1)	0 (0)	3 (60)	0 (0)	1 (20)
Trimethoprim/sulfamethox	5 (41.7)	2 (22.2)	3 (50)	1 (20)	1 (33.3)	0 (0)

[a] *Staphylococcus haemolyticus, Staphylococcus epidermidis, Enterococcus faecalis, Streptococcus agalactiae, Staphylococcus lentus, Staphylococcus aureus.*
[b] Values are expressed as No. (%).

ducted in Iran 2006, Sharifian et al. found the highest susceptibility rate of *E. coli* to ceftriaxone (97.8%) and cefotaxime (95.2%) (20). Other studies carried out in Iraq reported that *E. coli* was highly sensitive to imipenem and meropenem (16). In this study, however, *E. coli* showed high sensitivity to imipenem and ertapenem. This could be due to the antimicrobial agents used in the community under medical prescription. However, *E. coli* showed full resistance to ampicillin, cefepime, ceftriaxone, and aztreonam. Such high resistance rates to antibiotics in our community can be explained partially by the high rate of antibiotics abuse in the region.

Our results also showed that *P. aeruginosa* was the second the most common bacterium that caused UTI in males, which is in agreement with the findings of a previous study in Iran (11). Another report from Ethiopia found that *P. aeruginosa* was the second most common cause of UTI in males (21). The bacterium *P. aeruginosa* is emerging as an opportunistic pathogen of UTI in the community and has been associated with 10.0% - 25% of male cases (8). The prevalence rate *P. aeruginosa* in the present study was higher than that reported in other studies conducted in Turkey (22), Iran (23), and Italy (4). Such variations reported in different studies might be due to the differences in sample collection, study design, and inclusion criteria. The sensitivity pattern of *P. aeruginosa* was alarming as the vast majority of isolated strains in this study were resistant to all the commonly used antibiotics, which is in line with reports from other studies conducted in Iraq (6, 16).

In our study, *K. pneumonia* was shown to be responsible for about 6.2% of UTI cases and was highly sensitive to imipenem (100%), gentamicin (100%), and ertapenem (100%), while 92.3% of the isolated strains were resistant to ampicillin. This is in agreement with previous findings indicating *K. pneumonia* as a common cause of UTI (24, 25). Additionally, we found that more than two-thirds of *P. mirabilis* isolates were resistant to ampicillin, cefepime, and ceftriaxone, while 100% of the isolates were susceptible to imipenem, amikacin, and ertapenem. Furthermore, *M. morganella* and *A. baumanni* were the least frequent causes of UTI among males in the present study. These organisms showed high resistance to commonly used antibiotics such as ampicillin (100%) and amoxicillin/clavulanic acid (100%) and high susceptibility to most of the antibiotics tested, which is in agreement with data published by others (19).

In terms of Gram-positive bacteria, *Staphylococcus* spp. were responsible for about 13.8% of UTI cases, including

S. haemolyticus (5.7%), *S. epidermidis* (4.3%), and *S. aureus* (1.4%). In agreement with this finding, previous studies reported that *Staphylococcus* spp. as the most common causative agents among Gram-positive bacteria causing UTIs (7, 19). In a previous study in Iraq, it was found that about 50% of the bacteria causing UTIs were Gram-positive, and the majority of them were *Staphylococcus* spp. (6). Both *S. haemolyticus* and *S. epidermidis* showed high resistance rates to benzylpenicillin (100%). These strains were 100% susceptible to nitrofurantoin, linezolid, and tigecycline. Additionally, *S. aureus* was highly sensitive to all the commonly used antibiotics in this study. In contrast, other studies conducted in Iraq showed that *S. aureus* was resistant to the most commonly used antibiotics (26-28).

In this study, a few cases of UTI resulted from *S. agalactia* showing 100% susceptibility to linezolid, teicoplanin, vancomycin, tetracycline, tigecycline, and nitrofurantoin and high resistance to benzylpenicillin (80%). This was in agreement with a previous study that demonstrated that *S. agalactia*e was less frequently associated with UTI, with an isolation rate ranging from 3.96% to 5.7% (8). Furthermore, these results were similar to other studies that found that *S. agalactia*e strains were highly sensitive to vancomycin and nitrofurantoin (29, 30). In the present study, *E. faecalis* was responsible for 2.8% of the UTI cases. Antibiotic susceptibility test showed that *E. faecalis* was highly resistant to benzylpenicillin, oxacillin, levofloxacin, moxifloxacin, erythromycin, clindamycin, and tetracycline. These findings were in contrast to the results of a previous study conducted in Iraq, recruiting 151 subjects of both genders, which reported that *E. faecalis* was the second most common infectious agent causing UTIs (23.4%) (6). These differences could be attributed to the differences in sample size, study design, inclusion, and exclusion criteria.

The small number of samples was one of the limitations of the present study that may not show the actual amount of occurrence in the population. Secondly, the study was conducted mainly among male patients, and age groups less than 10 years were not analyzed in the study. Therefore, further studies using a molecular technique to diagnose and evaluate the sensitivity of bacteria should be conducted in the region to overcome these limitations.

5.1. Conclusions

From the results of the present study, it is concluded that the main pathogen causing UTIs among males is *E. coli*, followed by *P. aeruginosa* and *Staphylococcus* spp. Our results showed that the majority of isolates were resistant to commonly prescribed antibiotics such as ampicillin, ceftriaxone, cefepime, benzylpenicillin, oxacillin, and erythromycin. This is an alarming situation, and an urgent plan to control this threatening development of antibacterial resistance is required.

Footnotes

Authors' Contribution: Conception of study idea: IN, AB, and NH. Data collection and laboratory analysis; AB, NH, and IN. Interpretation of the results: IN, KS, SA, and HA. Wrote the main manuscript text: IN and NH. All the authors reviewed the main manuscript.

Conflict of Interests: None to declare.

Ethical Approval: The study was approved by the Ethics Committee of the College of Medicine, University of Zakho, Kurdistan, Iraq.

Funding/Support: No funding or support.

Informed Consent: Consent was obtained from all the patients recruited in this study.

References

1. Ronald AR, Nicolle LE, Stamm E, Krieger J, Warren J, Schaeffer A, et al. Urinary tract infection in adults: research priorities and strategies. *Int J Antimicrob Agents*. 2001;**17**(4):343–8. doi: 10.1016/s0924-8579(01)00303-x. [PubMed: 11295419].
2. Foxman B. Epidemiology of urinary tract infections: incidence, morbidity, and economic costs. *Am J Med*. 2002;**113 Suppl 1A**:5s–13s. doi: 10.1016/s0002-9343(02)01054-9. [PubMed: 12113866].
3. Khoshbakht R, Salimi A, Shirzad Aski H, Keshavarzi H. Antibiotic Susceptibility of Bacterial Strains Isolated From Urinary Tract Infections in Karaj, Iran. *Jundishapur J Microbiol*. 2012;**6**(1):86–90. doi: 10.5812/jjm.4830.
4. Magliano E, Grazioli V, Deflorio L, Leuci AI, Mattina R, Romano P, et al. Gender and age-dependent etiology of community-acquired urinary tract infections. *ScientificWorldJournal*. 2012;**2012**:349597. doi: 10.1100/2012/349597. [PubMed: 22629135]. [PubMed Central: PMCPmc3351074].
5. Ronald A. The etiology of urinary tract infection: Traditional and emerging pathogens. *Disease-a-Month*. 2003;**49**(2):71–82. doi: 10.1067/mda.2003.8.
6. Assafi M, Ibrahim N, Hussein N, Taha A, Balatay A. Urinary Bacterial Profile and Antibiotic Susceptibility Pattern among Patients with Urinary Tract Infection in Duhok City, Kurdistan Region, Iraq. *Int. J. Pure Appl. Sci. Technol*. 2015;**30**:54–63.
7. Abdulrahman I. Antimicrobial Susceptibility Pattern of Pathogenic Bacteria Causing Urinary Tract Infections at Azadi Hospital In Duhok CityRegion of Iraq. *Science Journal of University of Zakho*. 2018;**6**. doi: 10.25271/2018.6.2.435.
8. De Francesco MA, Ravizzola G, Peroni L, Negrini R, Manca N. Urinary tract infections in Brescia, Italy: etiology of uropathogens and antimicrobial resistance of common uropathogens. *Med Sci Monit*. 2007;**13**(6):Br136–44. [PubMed: 17534228].
9. Emiru T, Beyene G, Tsegaye W, Melaku S. Associated risk factors of urinary tract infection among pregnant women at Felege Hiwot Referral Hospital, Bahir Dar, North West Ethiopia. *BMC Res Notes*. 2013;**6**:292. doi: 10.1186/1756-0500-6-292. [PubMed: 23885968]. [PubMed Central: PMCPmc3750516].

10. Linhares I, Raposo T, Rodrigues A, Almeida A. Frequency and antimicrobial resistance patterns of bacteria implicated in community urinary tract infections: a ten-year surveillance study (2000-2009). *BMC Infectious Diseases*. 2013;**13**(1):19. doi: 10.1186/1471-2334-13-19.
11. Mansour A, Mahdinezhad M, Pourdangchi Z. Study of bacteria isolated from urinary tract infections and determination of their susceptibility to antibiotics. *Jundishapur Journal of Microbiology*. 2009;**2**(3):118–23.
12. Beyene G, Tsegaye W. Bacterial uropathogens in urinary tract infection and antibiotic susceptibility pattern in jimma university specialized hospital, southwest ethiopia. *Ethiop J Health Sci*. 2011;**21**(2):141–6. doi: 10.4314/ejhs.v21i2.69055. [PubMed: 22434993]. [PubMed Central: PMCPmc3275859].
13. Laupland KB, Ross T, Pitout JD, Church DL, Gregson DB. Community-onset urinary tract infections: a population-based assessment. *Infection*. 2007;**35**(3):150–3. doi: 10.1007/s15010-007-6180-2. [PubMed: 17565455].
14. Gupta K, Hooton TM, Stamm WE. Increasing antimicrobial resistance and the management of uncomplicated community-acquired urinary tract infections. *Ann Intern Med*. 2001;**135**(1):41–50. eng. doi: 10.7326/0003-4819-135-1-200107030-00012. [PubMed: 11434731].
15. Weekes LM. Antibiotic resistance changing management of urinary tract infections in aged care. *Med J Aust*. 2015;**203**(9):352. doi: 10.5694/mja15.01005. [PubMed: 26510798].
16. Hussein NR, Daniel S, Salim K, Saleh Assafi M. Urinary Tract Infections and Antibiotic Sensitivity Patterns Among Women Referred to Azadi Teaching Hospital, Duhok, Iraq. *Avicenna J Clin Microbiol Infect*. 2018;**5**(2):27–30. doi: 10.34172/ajcmi.2018.05.
17. Ranjbar R, Haghi-Ashtiani MT, Jafari N, Abedini M. The Prevalence and Antimicrobial Susceptibility of Bacterial Uropathogens Isolated from Pediatric Patients. *Iranian Journal of Public Health*. 2009;**38**.
18. Mirsoleymani SR, Salimi M, Shareghi Brojeni M, Ranjbar M, Mehtarpoor M. Bacterial pathogens and antimicrobial resistance patterns in pediatric urinary tract infections: a four-year surveillance study (2009-2012). *Int J Pediatr*. 2014;**2014**:126142. doi: 10.1155/2014/126142. [PubMed: 24959183]. [PubMed Central: PMCPmc4052188].
19. Al-Naqshbandi AA, Chawsheen MA, Abdulqader HH. Prevalence and antimicrobial susceptibility of bacterial pathogens isolated from urine specimens received in rizgary hospital - Erbil. *J Infect Public Health*. 2019;**12**(3):330–6. doi: 10.1016/j.jiph.2018.11.005. [PubMed: 30522892].
20. Sharifian M, Karimi A, Tabatabaei SR, Anvaripour N. Microbial sensitivity pattern in urinary tract infections in children: a single center experience of 1,177 urine cultures. *Jpn J Infect Dis*. 2006;**59**(6):380–2. [PubMed: 17186957].
21. Ayelign B, Abebe B, Shibeshi A, Meshesha S, Shibabaw T, Addis Z, et al. Bacterial isolates and their antimicrobial susceptibility patterns among pediatric patients with urinary tract infections. *Turk J Urol*. 2018;**44**(1):62–9. doi: 10.5152/tud.2017.33678. [PubMed: 29484230]. [PubMed Central: PMCPmc5821286].
22. Demir M, Kazanasmaz H. Uropathogens and antibiotic resistance in the community and hospital-induced urinary tract infected children. *J Glob Antimicrob Resist*. 2020;**20**:68–73. doi: 10.1016/j.jgar.2019.07.019. [PubMed: 31340182].
23. Pouladfar G, Basiratnia M, Anvarinejad M, Abbasi P, Amirmoezi F, Zare S. The antibiotic susceptibility patterns of uropathogens among children with urinary tract infection in Shiraz. *Medicine (Baltimore)*. 2017;**96**(37). e7834. doi: 10.1097/md.0000000000007834. [PubMed: 28906365]. [PubMed Central: PMCPmc5604634].
24. Motamedifar M, Sedigh Ebrahim-Saraie H, Mansury D, Khashei R, Hashemizadeh Z, Rajabi A. Antimicrobial Susceptibility Pattern and Age Dependent Etiology of Urinary Tract Infections in Nemazee Hospital, Shiraz, South-West of Iran. *Int J Enteric Pathog*. 2015;**3**(3):1–26931. doi: 10.17795/ijep26931.
25. Azizi A, Tayebah V, Farid K, Amirian T, Amirian F, Marziaeh A. Antimicrobial susceptibility patterns of community- acquired Gram-negative uropathogens. *African journal of microbiology research*. 2014;**8**:332–6. doi: 10.5897/AJMR2013.6254.
26. Habeeb A, Hussein N, Assafi M, Al-Dabbagh S. Methicillin resistant Staphylococcus aureus nasal colonization among secondary school students at Duhok City-Iraq. *J Microbiol Infect Dis*. 2014;**4**. doi: 10.5799/ahinjs.02.2014.02.0128.
27. Hussein N, Alyas A, Majeed M, Assafi M. Prevalence Rate and Prevalent Genotypes of CA-MRSA in Kurdistan Region: First Report from Iraq. *International Journal of Pure and Applied Sciences and Technology*. 2015;**27**:44–9.
28. Hussein NR, Assafi MS, Ijaz T. Methicillin-resistant Staphylococcus aureus nasal colonisation amongst healthcare workers in Kurdistan Region, Iraq. *J Glob Antimicrob Resist*. 2017;**9**:78–81. doi: 10.1016/j.jgar.2017.01.010. [PubMed: 28419870].
29. Demilie T, Beyene G, Melaku S, Tsegaye W. Urinary bacterial profile and antibiotic susceptibility pattern among pregnant women in north west ethiopia. *Ethiop J Health Sci*. 2012;**22**(2):121–8. [PubMed: 22876076]. [PubMed Central: PMCPmc3407835].
30. Rigvava S, Kharebava S, Giorgobiani T, Dvalidze T, Goderdzishvili M. Identification and antibiotic susceptibility patterns of streptococcus agalactiae. *Georgian Med News*. 2019;(297):149–53. [PubMed: 32011312].