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Prevalence and antimicrobial resistance pattern of bacterial strains isolated from patients with urinary tract infection in Messalata Central Hospital, Libya

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ABSTRACT

Objectives: To investigate the prevalence of urinary tract infection among patients at Messalata Central Hospital, Libya, to identify the causative bacteria, and to explore their resistance pattern to antimicrobials.

Methods: A total number of 1 153 urine samples were collected from patients, who attended daily to Messalata Central Hospital, Libya, in a study extended for one year. Antimicrobial susceptibility testing and isolates typing were done using Phoenix BD (BD diagnostic). Resistance was confirmed manually using agar disk diffusion method.

Results: Of the 1 153 urine samples tested, 160 (13.9%) samples were positive, from which 17 different, solely Gram negative, uropathogens were identified. *Escherichia coli* were the most prevalent (55.6%) bacteria, followed by *Klebsiella pneumoniae* subspecies *pneumoniae* (16.3%), *Proteus mirabilis* (6.3%), *Pseudomonas aeruginosa* (5.6%), *Enterobacter cloacae* and *Klebsiella oxytoca* (2.5%, each), *Citrobacter koseri* and *Providencia rettgeri* (1.9%, each), *Acinetobacter baumannii*, *Enterobacter aerogenes* and *Proteus vulgaris* (1.3%, each), and *Aeromonas caviae*, *Citrobacter freundii*, *Cronobacter sakazakii*, *Enterobacter amnigenus* biogroup 2, *Pseudomonas putida* and *Serratia marcescens* (0.6%, each). The isolated uropathogens showed increased levels of resistance ranged from 10.5% to 64.5%, with an overall resistance of 28.9%. Amikacin was the most effective antimicrobial followed by Imipenem and Meropenem (0%, 0.6% and 2.5% resistance, respectively); while, Cephalothin and Ampicillin were the least (80.6% and 90.0% resistance, respectively) effective.

Conclusions: The obtained results emphasized the emergence of highly resistant bacteria to most of tested antimicrobials and raise the alarm for physicians to change their treatment pattern depending on antimicrobial susceptibility results.

1. Introduction

Urinary tract infection (UTI) is a term applied to a variety of clinical conditions ranging from asymptomatic occurrence of bacteria in the urine to severe kidney infection with resultant sepsis [1]. It is one of the most common bacterial infections encountered by clinicians in developing countries. Worldwide, about 150 million people are diagnosed with UTI each year, resulting in at least 6 billion dollars in health care expenses [2].

Urinary tract infection occurs in all populations and ages, however, various factors including race, genetic factors, age, gender, sexual activity, nocturnal enuresis and circumcision in boys, make bacteriuria more or less to occur for any individual [3]. Moreover, infrequent micturition and incomplete emptying of the bladder in children besides urine and fecal elimination and poor toilet habits are consider possible causes for UTI [4]. Additionally, pregnancy in women and prostate enlargement in men can predispose the infection; however, women, especially sexually active, are more prone to UTIs than males. Furthermore, UTI can be also increased due to prolonged use of antibiotics (antimicrobials), since prolonged use of antibiotics can damage periurethral flora allowing uropathogens to colonize and infect the urinary tract [5,6].

Urinary tract infections are mainly caused by Gram negative bacteria which account for 80–85% and the leading causative organisms are *Escherichia coli* (*E. coli*) (75.5–87% of UTI cases) followed by *Klebsiella* species, in addition to *Citrobacter*,

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Acinetobacter, *Enterobacter*, *Providencia*, *Pseudomonas*, *Serratia* and *Proteus* species; however, *Enterococcus* and *Staphylococcus* species are the causative Gram positive agents for the remainder infections [7,8].

The clinical symptoms of UTIs usually include frequency, urgency, painful urination, sensation of having to urinate after urination, dysuria, pyuria, back pain, abdominal pain. However, bacteria may be present in the urinary tract without any apparent symptoms [9].

Although UTIs are commonly curable with antibiotics, widespread use of antibiotics given empirically without proper antibiotic susceptibility testing has inevitably led to a massive increase in UTIs caused by drug-resistant bacteria. This has made antibiotic choice for empirical and rational treatment very difficult [10]. The emergence of bacterial resistance problem is increasing due to the inappropriate use of antibiotic prophylaxis, self medication with some types of antibiotics and the inadequate dosage of these antibiotics. So, to ensure appropriate therapy, current knowledge of the organisms that cause UTIs and their antibiotic susceptibility is mandatory [11].

In developing countries, like Libya, it is difficult to assess the accurate incidence of UTI besides bacterial resistance due to underreporting, lack of surveillance as well limited published data. Therefore, this study was designed to investigate the prevalence of UTI among patients at Messalata Central Hospital, Libya, to identify causative bacteria and explore their antimicrobial resistance patterns, which may constitute an epidemiological importance regarding the wide-spread of multi-drug resistant bacteria in this country.

2. Materials and methods

2.1. Samples collection, handling and processing

A total of 1 153 urine samples were collected from patients, who attended daily to Messalata Central Hospital, Libya, in a study extended for one year. The collected samples were, individually, labeled with patient information including age, gender, clinical symptoms and results of physical examination, then sent to the microbiological laboratory for isolation and identification of any bacterial pathogen, in which samples were processed immediately within 30 min.

The patient instruction for appropriate collection has been followed to reduce probable contamination. In adult and toilet-trained children, urine samples were collected, using clean-catch midstream specimens, in wide-mouthed sterile containers with tight-fitting lid to prevent leakage. In infants, adhesive urine collection bags were used for specimen collection.

2.2. Cultivation, isolation and identification of uropathogens

Collected samples were, separately, inoculated onto Blood agar (Oxoid, UK) and MacConkey agar (Oxoid, UK), and then plates were incubated, aerobically, at 37 °C for 24 h extended to 48 h in negative samples. Colony counts of a single microorganism of $>10^5$ colony forming units (cfu)/mL were diagnosed as bacteriuria. The Phoenix BD automated identification system (BD Diagnostics, Baltimore, MD, USA) was used in this study, according to the manufacturer's recommendations. The Phoenix BD was designed for both rapid identification (ID) (45 wells with dried biochemical substrates and 2 fluorescent control wells) and antimicrobial susceptibility testing (AST) (up to 84 wells with dried antimicrobial panels) of clinically important bacterial pathogens. The Phoenix identification method uses modified conventional, fluorogenic and chromogenic substrates as a redox indicator for the detection of bacterial growth in the presence of an antimicrobial agent [12]. Briefly, the ID broth was, individually, inoculated with bacterial colonies from a pure culture adjusted to a 0.5 to 0.6 McFarland standard using a CrystalSpec nephelometer (BD Diagnostics). A 25 μL aliquot of this suspension was removed for AST and the remaining suspension was then poured into the ID side of the Phoenix panel. Valid isolate identification required a score greater than 90%; otherwise, no identification was reported. The assay is employed in doubling antimicrobic concentrations which measures minimum inhibitory concentrations (MIC) at 20 min intervals during the testing of panels. Additionally, antimicrobial susceptibility patterns were also confirmed by the agar disk diffusion standard method using Muller Hinton agar (Oxoid, CM0337) supplemented with 5% defibrinated horse blood according to the National Committee of Clinical Laboratory Standards (NCCLS) guidelines [13].

The tested antimicrobials in this study were Amikacin, Gentamicin, Ertapenem, Imipenem, Meropenem, Cephalothin, Cefuroxime, Cefoxitin, Ceftazidime, Ceftriaxone, Cefepime, Aztreonam, Ampicillin, Amoxicillin–Clavulanate, Piperacillin–Tazobactam, Trimethoprim–Sulfamethoxazole, Nitrofurantoin, Ciprofloxacin and Levofloxacin.

2.3. Statistical analysis

Statistical analyses were done by using Microsoft Office Excel 2007, SPSS version 12 (Statistical Package for Social Sciences). Evaluations were carried out at 95% confidence level and $P < 0.05$ was considered statistically significant.

3. Results

3.1. Prevalence of UTI in tested patients

Of the 1 153 urine samples tested, 160 (13.9%) samples were positive for the presence of bacterial pathogens while 993 (86.1%) were negative (Table 1). Each positive sample was

Table 1
Prevalence of urinary tract infection among tested patients in relation to gender and age.

Character	Number	Percentage (%)
Examined patients	1 153	100.0
Infected	160	13.9
Negative	993	86.1
Gender		
Female	96	60.0
Male	64	40.0
Age group		
<1	8	5.0
2–5	25	15.6
6–12	23	14.4
13–18	1	0.6
19–45	56	35.0
46–60	17	10.6
>61	30	18.8

represented by one bacterial isolate. In relation to gender of patients with UTI, 96 (60.0%) were females and 64 (40%) were males (Table 1).

About the distribution of infection among patients' age groups, which ranged between 19 days and 95 years, the highest (35.0%, 56/160) occurrence was in young age adults (19–45 years), followed by elderly (>61 years), then early children (2–5 years), late children (6–12 years), late adults (46–60 years), infants (<1 year), and the lowest (0.6%, 1/160) incidence was among adolescents (13–18 years) (Table 1).

Concerning the distribution of isolated uropathogens in relation to patients' gender, the majority (15 of 17) of bacterial species were isolated from female patients; however, only 12 bacterial species were isolated from male patients (Table 2). The order of prevalence of uropathogens isolated from female patients was *Acinetobacter baumannii (A. baumannii)*, *Aeromonas caviae (A. caviae)*, *Citrobacter freundii (C. freundii)*, *Cronobacter sakazakii* (*C. sakazakii)* and *Serratia marcescens* (100.0%, each) followed by *Enterobacter cloacae (E. cloacae)* and *Klebsiella oxytoca (K. oxytoca)* (75.0%, each), *E. coli* (66.3%), *Enterobacter aerogenes (E. aerogenes)*, *Klebsiella pneumoniae* subspecies *pneumoniae (K. pneumoniae* subspecies *pneumoniae)* and *Proteus vulgaris* (50.0%, each), *Pseudomonas aeruginosa (P. aeruginosa)* (44.4%), *Proteus mirabilis* (*P. mirabilis)* (40.0%) and *Citrobacter koseri (C. koseri*), and *Providencia rettgeri (P. rettgeri)* (33.3%, each); but this order in male patients was *Enterobacter amnigenus* biogroup 2 and *Pseudomonas putida* (100.0%, each), *C. koseri* and *P. rettgeri* (66.7%, each), *P. mirabilis* (60.0%), *P. aeruginosa* (55.6%), *E. aerogenes*, *K. pneumoniae* subspecies *pneumoniae* and *P. vulgaris* (50.0%, each), *E. coli* (33.7%), and *E. cloacae* and *K. oxytoca* (25.0%, each) (Table 2).

Table 2

Frequency distribution of isolated uropathogens among patients' gender [*n* (%)].

Isolated uropathogens	Total	Female	Male
Acinetobacter baumannii	2 (1.3)	2 (100.0)	–
Aeromonas caviae	1 (0.6)	1 (100.0)	–
Citrobacter freundii	1 (0.6)	1 (100.0)	–
Citrobacter koseri	3 (1.9)	1 (33.3)	2 (66.7)
Cronobacter sakazakii	1 (0.6)	1 (100.0)	–
Enterobacter aerogenes	2 (1.3)	1 (50.0)	1 (50.0)
Enterobacter amnigenus biogroup 2	1 (0.6)	–	1 (100.0)
Enterobacter cloacae	4 (2.5)	3 (75.0)	1 (25.0)
Escherichia coli	89 (55.6)	59 (66.3)	30 (33.7)
Klebsiella oxytoca	4 (2.5)	3 (75.0)	1 (25.0)
Klebsiella pneumoniae subspecies *pneumoniae*	26 (16.3)	13 (50.0)	13 (50.0)
Proteus mirabilis	10 (6.3)	4 (40.0)	6 (60.0)
Proteus vulgaris	2 (1.3)	1 (50.0)	1 (50.0)
Providencia rettgeri	3 (1.9)	1 (33.3)	2 (66.7)
Pseudomonas aeruginosa	9 (5.6)	4 (44.4)	5 (55.6)
Pseudomonas putida	1 (0.6)	–	1 (100.0)
Serratia marcescens	1 (0.6)	1 (100.0)	–
Total	160 (100.0)	96 (60.0)	64 (40.0)

3.2. Frequency of resistance among isolated uropathogens to tested antimicrobials

In this study, all isolated bacteria, except *C. koseri* and *C. sakazakii*, showed increased resistance to wide range of used antimicrobials including recently produced and expensive ones. Our results established that isolated *K. pneumoniae* subspecies *pneumoniae*, *E. coli*, *K. oxytoca*, *P. rettgeri* and *P. aeruginosa* were highly (33.0%, 22.4%, 64.5%, 63.2% and 52.1%, respectively) resistant and exhibit resistance to all tested antimicrobials except Amikacin and Imipenem; Amikacin, Imipenem and Meropenem; Amikacin, Gentamicin, Imipenem and Meropenem; Amikacin, Imipenem, Meropenem and Piperacillin–Tazobactam; Amikacin, Gentamicin, Cefepime and Piperacillin–

Table 3a

Distribution of resistance of isolated uropathogens to tested antimicrobials.

Tested antimicrobials	*Acinetobacter baumannii*	*Aeromonas caviae*	*Citrobacter freundii*	*Citrobacter koseri*	*Cronobacter sakazakii*	*Enterobacter aerogenes*	*Enterobacter amnigenus*	*Enterobacter cloacae*	*Escherichia coli*
Amikacin	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Gentamicin	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	11 (12.4)
Ertapenem	2 (100.0)	1 (100.0)	1 (100)	0 (0.0)	0 (0.0)	1 (50.0)	0 (0.0)	1 (25.0)	8 (9)
Imipenem	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Meropenem	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Cephalothin	2 (100.0)	1 (100.0)	1 (100.0)	1 (33.3)	0 (0.0)	2 (100.0)	1 (100.0)	4 (100.0)	78 (87.6)
Cefuroxime	2 (100.0)	1 (100.0)	1 (100)	1 (33.3)	0 (0.0)	2 (100.0)	0 (0.0)	4 (100.0)	18 (20.2)
Cefoxitin	2 (100.0)	1 (100.0)	1 (100)	0 (0.0)	0 (0.0)	2 (100.0)	1 (100.0)	4 (100.0)	8 (9.0)
Ceftazidime	1 (50.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (25.0)	9 (10.1)
Ceftriaxone	0 (0.0)	0 (0.0)	1 (100.0)	0 (0.0)	0 (0.0)	1 (50.0)	0 (0.0)	2 (50.0)	16 (18)
Cefepime	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (50.0)	0 (0.0)	2 (50.0)	17 (19.1)
Aztreonam	2 (100.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (25)	11 (12.4)
Ampicillin	2 (100.0)	1 (100.0)	1 (100.0)	3 (100.0)	1 (100.0)	2 (100.0)	1 (100.0)	4 (100.0)	76 (85.4)
Amoxicillin–Clavulanate	2 (100.0)	0 (0.0)	1 (100.0)	0 (0.0)	0 (0.0)	2 (100.0)	1 (100.0)	4 (100.0)	36 (40.4)
Piperacillin–Tazobactam	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (25.0)	7 (7.9)
Trimethoprim–Sulfamethoxazole	1 (50.0)	0 (0.0)	1 (100.0)	0 (0.0)	0 (0.0)	2 (100.0)	1 (100.0)	0 (0.0)	26 (29.2)
Nitrofurantoin	2 (100.0)	NA*	1 (100.0)	1 (33.3)	1 (100.0)	1 (50.0)	1 (100.0)	3 (75.0)	11 (12.4)
Ciprofloxacin	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (50.0)	1 (100.0)	0 (0.0)	23 (25.8)
Levofloxacin	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (50.0)	1 (100.0)	0 (0.0)	23 (25.8)
Total	18 (47.4)	5 (27.8)	9 (47.4)	6 (10.5)	2 (10.5)	18 (47.4)	8 (42.1)	31 (40.8)	378 (22.4)

Distribution of resistance of isolated uropathogens to tested antimicrobials. *N/A: not applied.

Table 3b
Distribution of resistance of isolated uropathogens to tested antimicrobials.

Tested antimicrobials	*Klebsiella oxytoca*	*Klebsiella pneumoniae* subspecies pneumoniae	*Proteus mirabilis*	*Proteus vulgaris*	*Providencia rettgeri*	*Pseudomonas aeruginosa*	*Pseudomonas putida*	*Serratia marcescens*	Total bacterial resistance
Amikacin	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Gentamicin	0 (0.0)	6 (23.1)	2 (20.0)	0 (0.0)	1 (33.3)	0 (0.0)	0 (0.0)	0 (0.0)	20 (12.5)
Ertapenem	2 (50.0)	7 (26.9)	2 (20.0)	0 (0.0)	3 (100.0)	8 (88.9)	0 (0.0)	0 (0.0)	36 (22.5)
Imipenem	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (11.1)	0 (0.0)	0 (0.0)	1 (0.6)
Meropenem	0 (0.0)	2 (7.7)	0 (0.0)	0 (0.0)	0 (0.0)	2 (22.2)	0 (0.0)	0 (0.0)	4 (2.5)
Cephalothin	4 (100.0)	15 (57.7)	4 (40.0)	2 (100.0)	3 (100.0)	9 (100.0)	1 (100.0)	1 (100.0)	129 (80.6)
Cefuroxime	4 (100.0)	12 (46.2)	3 (30.0)	2 (100.0)	3 (100.0)	9 (100.0)	1 (100.0)	1 (100.0)	64 (40.0)
Cefoxitin	4 (100.0)	5 (19.2)	0 (0.0)	0 (0.0)	2 (66.7)	9 (100.0)	1 (100.0)	1 (100.0)	41 (25.6)
Ceftazidime	1 (25.0)	9 (34.6)	0 (0.0)	0 (0.0)	1 (33.3)	1 (11.1)	0 (0.0)	0 (0.0)	23 (14.4)
Ceftriaxone	4 (100.0)	10 (38.5)	2 (20.0)	2 (100.0)	3 (100.0)	9 (100.0)	1 (100.0)	0 (0.0)	51 (31.9)
Cefepime	4 (100.0)	10 (38.5)	0 (0.0)	0 (0.0)	1 (33.3)	0 (0.0)	0 (0.0)	0 (0.0)	35 (21.9)
Aztreonam	4 (100.0)	10 (38.5)	0 (0.0)	0 (0.0)	1 (33.3)	3 (33.3)	0 (0.0)	0 (0.0)	32 (20.0)
Ampicillin	4 (100.0)	26 (100.0)	7 (70.0)	2 (100.0)	3 (100.0)	9 (100.0)	1 (100.0)	1 (100.0)	144 (90.0)
Amoxicillin–Clavulanate	4 (100.0)	10 (38.5)	2 (20.0)	0 (0.0)	3 (100.0)	9 (100.0)	1 (100.0)	1 (100.0)	76 (47.5)
Piperacillin–Tazobactam	4 (100.0)	6 (23.1)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	18 (11.3)
Trimethoprim–Sulfamethoxazole	2 (50.0)	7 (26.9)	3 (30.0)	0 (0.0)	3 (100.0)	9 (100.0)	0 (0.0)	0 (0.0)	55 (34.4)
Nitrofurantoin	4 (100.0)	14 (53.8)	10 (100.0)	2 (100.0)	3 (100.0)	9 (100.0)	1 (100.0)	1 (100.0)	65 (40.9)
Ciprofloxacin	2 (50.0)	8 (30.8)	4 (40.0)	1 (50.0)	3 (100.0)	1 (11.1)	0 (0.0)	0 (0.0)	44 (27.5)
Levofloxacin	2 (50.0)	6 (23.1)	3 (30.0)	1 (50.0)	3 (100.0)	1 (11.1)	0 (0.0)	0 (0.0)	41 (25.6)
Total	49 (64.5)	163 (33.0)	42 (22.1)	12 (31.6)	36 (63.2)	89 (52.1)	7 (36.8)	6 (31.6)	879 (28.9)

Tazobactam, consecutively. On contrary, *C. sakazakii* strain, isolated from urine sample of 3 years old female, was sensitive to all tested antimicrobials except Ampicillin and Nitrofurantoin. Considering our results, Amikacin was the most (0% resistance) powerful antimicrobial followed by Imipenem (0.6% resistance) and Meropenem (2.5% resistance) which affected 100.0%, 99.4% and 97.5% of tested uropathogens, respectively; on the other hand, Cephalothin and Ampicillin were the least (80.6% & 90.0% resistance, respectively) effective ones and affected only 19.4% and 10.0% of tested isolates, respectively. The effect (resistance% & sensitivity%) of remaining antimicrobials were ordered as follow; Piperacillin–Tazobactam (11.3% & 88.7%), Gentamicin (12.5% & 87.5%), Ceftazidime (14.4% & 85.6%), Aztreonam (20.0% & 80.0%), Cefepime (21.9% & 78.1%), Ertapenem (22.5% & 77.5%), Cefoxitin and Levofloxacin (25.6% & 74.4%, each), Ciprofloxacin (27.5% & 72.5%), Ceftriaxone (31.9% & 68.1%), Trimethoprim–Sulfamethoxazole (34.4% & 65.6%), Cefuroxime (40.0% & 60.0%), Nitrofurantoin (40.9% & 59.1%), Amoxicillin–Clavulanate (47.5% & 52.5%), Meropenem (2.5% & 97.5%), Imipenem (0.6% & 99.4%) and Amikacin (0.0% &100.0%).

The isolated uropathogens showed increased resistances ranged from 10.5% to 64.5%, with an overall resistance of 28.9%. *K. oxytoca* and *P. rettgeri* were the most resistant (64.5% & 63.2%, respectively) species, while *C. koseri* and *C. sakazakii* were the lowest (10.5%, each) resistant organisms. The remaining bacterial species showed resistance in the following order, *P. aeruginosa* (52.1%), *A. baumannii*, *C. freundii* and *E. aerogenes* (47.4%, each), *Enterobacter amnigenus* biogroup 2 (42.1%), *E. cloacae* (40.8%), *Pseudomonas putida* (36.8%), *K. pneumoniae* subspecies *pneumoniae* (33%), *P. vulgaris* and *S. marcescens* (31.6%, each), *A. caviae* (27.8%), *E. coli* (22.4%), and *P. mirabilis* (22.1%) (Tables 3a and b).

4. Discussion

This study aimed to determine the bacterial causative agent of urinary tract infection among different groups in Messalata central hospital. Bacterial pathogens were isolated from 13.9% of the requested urine culture. This result nearly similar to that previously reported [14] however, this rate of prevalence is lower than that previously (20.7%) documented in a recent study conducted at Zawiya city, Libya and 440/1 110 (39.6%) [15,16], but it is higher than that previously reported [17]. The prevalence of UTI in this study was considerably low due to peoples' traditions who feel ashamed of going for medical checkups, self-medications, in addition to widespread private clinics for which most of patients especially with clinical symptoms prefer to investigate themselves.

In relation to gender of patients majority of them were female 96 (60%). This result is correlates with previously reported by many other researchers [18,19]. This result was expected, as women are more prone to UTI than males because their urethra is much shorter and closer to the anus than in males, hence bacteria from the anus can pass easily into the urinary tract.

Regarding the causative uropathogens in this study, all of the isolates were belonged to Gram negative bacteria. *E. coli* were the most prevalent and *K. pneumoniae* subspecies *pneumoniae* were the second most. This finding was in agreement with the common knowledge about the causative agents of UTI such as that reported by Abunja *et al.* [15].

About the distribution of infection among patients' age groups, an evident of higher incidence of UTI was seen in adults, especially sexually actives, followed by elderly then among children. In contrast to the published data, UTIs among elderly, adults and children were 58.7%, 36.2%, and 5.1%, respectively

[20]. While, UTI was found in 16.55% of elderly women [21], in 24.48% of old age (61–70 years) males [22]. The similarities and differences in the type and distribution of uropathogens show a discrepancy from country to another due to many factors as environmental conditions, health practices, patient conditions, personal hygiene, number of patients examined, and laboratory procedures. Moreover, the possible causes of the higher incidence of UTI in elderly may be attributed to many factors including urinary tract anomalies, urinary and fecal incontinence, decline in the immune system, malnutrition, functional disability, diabetes, prostate enlargement in males and post-menopausal hormonal changes in females [21,23,24].

Majority of bacterial species were isolated from female patients while only 12 bacterial species, other than *A. baumannii*, *A. caviae*, *C. freundii*, *C. sakazakii* and *S. marcescens*, were isolated from male patients. Our results were in agreement with other studies which dictated that uropathogens are always predictable and *E. coli* are the leading causes, besides other common Gram negative organisms as *Klebsiella*, *Enterobacter*, *Proteus* and *Citrobacter* species [25]. All isolated bacteria in this study belonged to Enterobacteriaceae that can live in the digestive tract, rectum, vagina or around the urethra, from which infection occurs when these bacteria enter the normally sterile urinary system and multiply there [26]. Similarly, Enterobacteriaceae is the predominant (78.7%) isolates, of which *E. coli* was the most (64.0%) common organisms followed by *Klebsiella* species (17.9%) [8]. *K. pneumoniae*, *P. aeruginosa*, *A. baumannii* and *Proteus* species are very often isolated in hospitals [7].

Although, isolated uropathogens, in this study, were highly sensitive to Amikacin, Imipenem and Meropenem, the isolates exhibited extreme resistance to both Ampicillin and Cephalothin. Also, unexpected higher resistance was detected against Amoxicillin–Clavulanate and Nitrofurantoin followed by Trimethoprim–Sulfamethoxazole, Ceftriaxone, Ciprofloxacin and Levofloxacin, which are commonly used as empirical treatment in most of UTIs. Our results of antimicrobial resistance profile are consistent with many previously reported studies [15,27,28] which declared that Amikacin, Imipenem and Meropenem were highly effective against Gram negative bacteria which are highly resistance to Cephalosporins (first, second and somewhat third generations) and Penicillins, hence physicians advised to stop prescribing these agents as an empiric treatment for UTIs. Additionally, majority of Gram-negative bacteria isolated were sensitive to Gentamicin, Ceftazidime and Ciprofloxacin; however, most of these bacteria were resistant to Ampicillin, Chloramphenicol and Amoxycillin.

Moreover, the most effective antimicrobial agent reported was Amikacin and the least effective one was Ampicillin, whereas Ciprofloxacin, Cefoxitin, Levofloxacin, Nitrofurantoin, Nalidixic acid, Chloramphenicol, Amoxycillin and Gentamicin were effective at different levels. In a study investigated UTI during pregnancy at Al-khoms, Libya, *E. coli*, *Proteus* species and *Klebsiella* species. were highly sensitive to Nitrofurantoin, Ofloxacin, Cefotaxime, Ciprofloxacin, Norfloxacin and Amikacin; however, higher degree of resistance was observed against Ampicillin and Cotrimoxazole. Additionally, *P. aeruginosa* isolates were resistant to all tested antimicrobials except Amikacin and Nitrofurantoin [29].

The alarming finding in this study is the increased resistance of isolated uropathogens to most of commonly used antimicrobials including third- and fourth-generation Cephalosporins; Penicillins and Fluoroquinolones. The explanation behind this situation is that these drugs are in use for a long period. Moreover, in developing countries like Libya, the massive- and misuse of these antimicrobials, besides they are also purchased directly from the pharmacies without doctors' prescription as self medication is a common practice and finally the initial use of antimicrobial before the laboratories results of antimicrobial susceptibility. So restrictions should be put on antibiotic prescribing.

In conclusion, our study dictated the prevalence of UTI among tested patients. Additionally, large numbers of bacterial species, with *E. coli* are predominant, were isolated from patients especially females, which showed increased levels of resistance to most of tested antimicrobials. In view of our study findings we recommend Amikacin, Gentamicin, Imipenem and Meropenem as drug of choice, with restriction to some of their adverse effects, in treatment of urinary tract infections on the basis of its demonstrated high sensitivity. Moreover, further studies including different hospitals and private clinics are imperative to highlight the emergence of multi-drug resistance among clinical bacterial species.

Conflict of interest statement

No competing interests are declared.

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