ECRONICON OPEN ACCESS

EC MICROBIOLOGY
Research Article

Antibiotic Susceptibility of *Enterobacterales* and *Cocci* Uropathogens in Patients Attending Regional Hospital of Dedougou, Western Region (Burkina Faso)

René Dembélé[1,2]*, Roger Sanou[1], Oumar Traoré[1,2], Nafissatou Ouédraogo[1,2], Hiliassa Coulibaly[1], Alix Bénédicte Kagambega[1], Alassane Halawen Mohamed[1], Frédéric François Bado[1], Wendpoulomdé AD Kaboré[1], Dramane Sanou[3], Georgette Djiguemde-Nikiéma[3], Issiaka Soulama[4,5], Alfred S Traoré[1] and Nicolas Barro[1]

[1]Laboratory of Molecular Biology, Epidemiology and Surveillance of Bacteria and Viruses Transmitted by Food/ 03 BP 7021 Ouagadougou 03, Burkina Faso

[2]University of Dedougou, BP 176 Dedougou, Burkina Faso

[3]Regional Hospital of Dedougou, Burkina Faso

[4]National Centre for Research and Training on Malaria (INSP/CNRFP), 01 BP 2208 Ouagadougou 01, Burkina Faso

[5]Research Institute for Health Sciences (CNRST/IRSS), 03 BP 7192 Ouagadougou 03, Burkina Faso

***Corresponding Author:** René Dembélé, Laboratory of Molecular Biology, Epidemiology and Surveillance of Bacteria and Viruses Transmitted by Food/ 03 BP 7021 Ouagadougou 03, Burkina Faso.

Received: April 22, 2022; **Published:** May 24, 2022

Abstract

Making the diagnosis of urinary tract infection (UTI) and deciding when to initiate antimicrobial therapy remains a challenge to healthcare providers. This study was focused on the identification of bacterial pathogens causing UTI as well the evaluation of related antibiogram. A cross-sectional study was carried out over a period of one year (March 2018 to February 2019) in the Western part of Burkina Faso. In total, 388 urines samples were collected from individuals with suspected UTIs attending the Regional Hospital of Dedougou. Samples were inoculated on recommended media and isolation-identification of the bacterial strains were performed using standard microbiological protocols. Antibiotic susceptibility was carried out following European committee on antimicrobial susceptibility testing (EUCAST) recommended guidelines. The overall hospital prevalence of UTIs was 66% with 78.1% for males and 21.9% for females. In addition, half of the patients were under antibiotic treatment. Out of the 388 tested specimens, 132 (34.02%) had significant bacterial growth. *Escherichia coli* (44.7%) was the most frequently isolated specie and 56.8% of the strains were isolated from male patients. *Enterobacterales* were mainly resistant to amoxicillin-clavulanate, amoxicillin, ceftriaxone, ciprofloxacin and trimethoprim-sulfamethoxazole. *Cocci* isolates were resistance to oxacillin, norfloxacin and trimethoprim-sulfamethoxazole. At least, 17 of the *Enterobacterales* and 9 of the *Cocci* were multidrug resistant. The majority of isolates were resistant to commonly prescribed antibiotics. Therefore, the physician should strictly follow the culture report before starting therapy to prevent the emergence of multidrug resistance.

Keywords: *Urinary Tract Infections; Uropathogens; Antibiotic Susceptibility; Multi-Drug Resistance; Burkina Faso*

Introduction

Urinary tract infections (UTIs) which are frequently recurrent and highly prevalent worldwide [1,2] represents a health issue in community and hospital areas [3]. According to Nosseir., *et al*. recurrent UTIs are two documented UTI episodes (with fully eradicated bacterial infection after antibiotic treatment between each episode) within 6 months or three within 12 months, excluding relapses of previous UTIs [4]. Urinary tract infections are among the most common bacterial infections encountered in primary health care [5]. It has also

become the most common hospital-acquired infections, accounting for up to 35% of nosocomial infections and second cause of bacteremia in hospitalized patients [6]. There are two types of UTIs: uncomplicated UTIs occurring in a normal genitourinary tract with no prior instrumentation whereas complicated UTIs are associated with structural or functional abnormalities of the genitourinary tract or an underlying disease that interferes with host defense [7]. Complicated urinary tract infections impose a high burden on healthcare systems and are a frequent cause of hospitalization [2]. *Enterobacteriaceae* are the most common pathogens causing UTIs [8]. Indeed, some previous studies reported *Escherichia coli* as the main causative agent of UTIs in both infants and adults [3,9,10]. Moreover, pathogens such as *Enterococcus* sp., *Staphylococcus saprophyticus*, *Klebsiella* spp., *Enterobacter* sp., *Citrobacter* sp., *Proteus mirabilis, Morganella, Providencia* sp., other Gram-negative enteric bacilli, and enterococci may also occur [11,12]. The emergence and spread of antibiotic-resistant pathogens is a major public health threat [6] and UTIs are among the most common infections with an increasing resistance to antimicrobial agents [5].

Therefore, the management of UTI requiring antimicrobial therapy must be made conventionally based on antibiotic susceptibility tests to avoid any aggravation, partial healing or recurrence [3]. However, making the diagnosis of UTI and deciding when to initiate treatment with antimicrobial therapy is a challenge to all long-term care providers [13]. In many developing countries like Burkina Faso, the lack of medical bacteriology laboratories or their non-functionality often leads the nursing staff to prescribe broad-spectrum antibiotics to overcome this deficit [3,13]. In previous studies conducted in Burkina Faso, *E. coli* showed resistance rates with 76.64, 74.01, 25 and 74.34% to ampicillin, amoxicillin, amoxicillin/clavulanic acid and trimethoprim-sulfamethoxazole, respectively [14] whereas most of *K. pneumoniae* strains (94.4%) or *E. coli* strains (86%) were resistant to amoxicillin [3]. In this context, this study was conducted to assess the susceptibility of *Enterobacterales* and *Cocci* uropathogens to antibiotics in patients attending the regional hospital of Dedougou, Western region (Burkina Faso), in order to evaluate possible options for empirical antibiotic therapy. This information will also assist the clinicians in optimizing antibiotic management and ensure good antibiotic stewardship.

Materials and Methods

Study design and setting

This was a cross-sectional study conducted at the bacteriology laboratory of a regional hospital of western area, Burkina Faso over a period of one year (March 2018 to February 2019).

Study population

The study population were patients of all ages and sex coming for the Cytobacteriological Examination of the Urine (CBEU) at the bacteriology laboratory during the study period. A total of 388 (282 males and 106 females) urine samples were collected from patients attending this hospital. Only patients with well-informed reports and urine samples collected with recommended conditions for ECBUs were included in this study. Participants with incorrectly filled questionary were excluded from the study data analysis.

Collection and analysis of urine samples

The morning urine or urine remaining for at least four hours in the patient's bladder were collected in a clean, sterile jar. In the laboratory, analyzes were performed after assigning a code to each specimen. A structured questionnaire was administered to collect clinical, laboratory and patient information.

Macroscopic examination in a fresh state was carried out to appreciate the appearance of urine. The count was done using a Malassez cell with total homogenized urine and results expressed in leukocytes/mm^3 and/or red blood cells/mm^3 relating to the counting cell used.

Gram staining was done according to method described by Cheesbrough [15]. For culture, 10 µL of the urine were homogenized and stretched on agar with bromocresol purple using a sterile and calibrated loop close to the flame. Petri dishes were incubated at 37°C for 18 to 24 hours. The identification was based on the bacteria characteristics (crop, morphology) and biochemistry through macroscopic

examination, the oxidase test and the API 20E. The Chapman medium was used for the isolation of *Staphylococcus aureus* and confirmed through the catalase test and clumping factor, and, or protein A (latex agglutination test kits), if the catalase test was positive. Catalase test is used to differentiate bacteria producing the enzyme catalase, such as staphylococci, from non-catalase producing bacteria such as streptococci. Coagulase test is used to identify *S. aureus* that produces the enzyme coagulase. *S. aureus* is Coagulase positive, DNA-ase positive, Catalase positive.

The bacteria isolates were subjected to antibiotic susceptibility testing using the agar diffusion method as described by [16]. Mueller Hinton agar (Liofilchem, Italia) plates were inoculated with overnight culture of each isolate by streak plating. The standard antibiotic sensitivity discs were then aseptically placed at equidistance on the plates and allowed to stand for 1 hour. The plates were then incubated at 37°C for 24 hours. Sensitivity patterns of the isolates to Amoxicillin (30 µg), Amoxicillin-Clavulanic acid (30 µg), Oxacillin (5 µg), Ceftriaxone (30 µg), Imipenem (10 µg), Gentamicin (10 µg), Trimethoprim-sulfamethoxazole (25 µg), Ciprofloxacin (5 µg), Norfloxacin (10 µg), and Erythromycin (15 µg) were determined (Table 1). Based on the zone of inhibition produced by the antibiotic disc, isolates were categorized into susceptible, intermediate susceptible and resistant according to the European committee on antimicrobial susceptibility testing (EUCAST) breakpoint for interpretation of MICs and zone diameters [17].

Antibiotics families	Antibiotics	Diameters	
		Sensible	Resistant
Bêta-lactamins	Amoxicillin (30 µg)	≥ 21	< 14
	Amoxicillin-Clavulanic Acid (30 µg)	≥ 21	< 14
	Oxacillin (5 µg)	≥ 20	< 20
	Ceftriaxone (30 µg)	≥ 21	< 15
	Imipenem (10 µg)	≥ 22	< 17
Aminoside	Gentamicin (10 µg)	≥ 16	< 14
Sulfamide	Trimethoprime-sulfamethoxazole (25 µg)	≥ 16	< 10
Quinolones	Ciprofloxacin (5 µg)	≥ 22	< 19
	Norfloxacin (10 µg)	≥ 22	< 19
Macrolide	Erythromycin (15 µg)	≥ 22	< 19

Table 1: *Antibiotics sensitivity testing.*

Data analysis

The data were entered in MS Excel and analyzed using the software package Epi Info 7.2.2.6 (Centers for Disease Control and Prevention [CDC], Atlanta). The frequencies were calculated and the cross tables were used with the associated odds ratios (ORs) and 95% confidence intervals (95% CI). The statistical significance was evaluated using the Fischer exact 2- tailed p value, and a $p \leq 0.05$ was considered significant.

Ethics statement

The National Ethical Committee (s) of Burkina Faso (N° 2009-39) and the hospital authorities of the "Centre Hospitalier Régional de Dédougou" approved this study. Before participating, informed verbal consent was obtained from all study participants, parents, or legal guardian of participants under the age of 18 years. The study complied with the Declaration of Helsinki.

Results

This section may be divided by subheadings. It should provide a concise and precise description of the experimental results, their interpretation, as well as the experimental conclusions that can be drawn.

Prevalence of urinary infection

The overall prevalence of urinary infection was 66% with 78.1% for males and 21.9% for females (OR: 0.36, 95%CI (0.23-0.58); p = 0.000008). Among the age groups, the most representative of UTI was the 15 - < 65 years (60.5%) followed by ≥ 65 years (18%), 5 - < 15 years (12.9%) and less than 5 years (8.6%).

Demographic distribution of the study subjects

The male participants were predominant with 70.9% versus 29.1% for female with a female-to-male ratio of 0.4. The most represented age was 15 - 64 years (58.5%). In addition, half of the patients (CI 95% [45.8 - 55.7]) were under antibiotic treatment and 88.1% (CI 95% [84.5 - 90.9]) were outpatients. The distribution of study participants against demographic characteristics is shown in the table 2.

Parameters		Number	Prevalence (%)	CI 95% Limits
Age (years)	Less than 5	29	7.5	5.2-10.5
	5 - < 15	40	10.3	7.6-13.7
	15 - < 65	227	58.5	53.5-63.3
	≥ 65	92	23.7	19.7-28.2
Sex	Male	275	70.9	66.2-75.2
	Female	113	29.1	24.8-33.8
Patients status	Inpatients	46	11.9	9.01-15.4
	Outpatients	342	88.1	84.5-90.9
Patients' medical history	On antibiotic treatment	197	50.8	45.8-55.7
	Without antibiotic treatment	191	49.2	44.3-54.2

Table 2: *Demographic distribution of the subjects with percentage prevalence.*

CI: Confidence Interval.

Distribution of isolates

Out of the 388 tested specimens, 132 (34.02%) (CI95% [29.5 - 38.9]) presented significant bacterial growth. *Escherichia coli* was the most frequently specie isolated and accounted for 44.7% of the uropathogens (CI95% [36.04 - 53.6]). Moreover, organism such *Staphylococcus aureus* (6.8%) (CI95% [3.2 - 12.5]), *Streptococcus* spp. (12.9%) (CI95% [7.7 - 19.8]), *Klebsiella pneumoniae* (6.8%) (CI95% [3.2 - 12.5]), *Staphylococcus* spp. (6.8%) (CI95% [3.2 - 12.5]), *Hafnia alvei* (4.5%) (CI95% [1.7 - 9.6]), *Citrobacter koseri* (2.3%) (CI95% [0.5 - 6.5]), *Enterobacter cloacae* (3.03%) (CI95% [0.8 - 7.6]), *Salmonella* spp. (3.03%) (CI95% [0.8 - 7.6]) and *Providencia rettgeri* (2.3%) (CI95% [0.5 - 6.5]) were also identified as shown in table 3. The results show that uropathogens bacteria were more isolated in male patients compared to females: 75 (56.8%) of the strains were isolated from male patients. No significant difference in bacteria isolated was observed among age groups despite the highest susceptible age group of patients was 15 - < 65 years (54.5%) followed by ≥ 65 years (34.9%), 5 - < 15 years (5.3%) and less than 5 years (5.3%) (Table 3).

Variables (Number)		Bacterial isolates n (%)									
		E. coli	*K. pneumoniae*	*Hafnia alvei*	*Salmonella* spp.	*Enterobacter cloacae*	*Citrobacter koseri*	*Providencia rettgeri*	*S. aureus*	*Staphylococcus* spp.	*Streptococcus* spp.
Sex	Male (75)	30 (40)	9 (12)	6 (8)	4 (5.3)	0 (0)	0 (0)	3 (4)	4 (5.3)	9 (12)	10 (13.3)
	Female (57)	29 (50.8)	0 (0)	0 (0)	0 (0)	4 (7.01)	3 (5.3)	0 (0)	14 (24.5)	0 (0)	7 (12.3)
Age group	< 5 (7)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	7 (100)
	5 - < 15 (7)	3 (42.9)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	4 (57.1)	0 (0)	0 (0)
	15 - < 65 (72)	42 (58.3)	3 (4.2)	0 (0)	0 (0)	4 (5.5)	0 (0)	0 (0)	14 (18.4)	3 (4.2)	6 (8.3)
	≥ 65 (46)	14 (30.4)	6 (13.04)	6 (13.04)	4 (8.7)	0 (0)	3 (6.5)	3 (6.5)	0 (0)	6 (13.04)	4 (8.7)
Total n (%)		59 (44.6)	9 (6.8)	6 (4.5)	4 (3.03)	4 (3.03)	3 (2.3)	3 (2.3)	18 (13.6)	9 (6.8)	17 (12.9)

Table 3: *Bacterial isolates collected from urine samples of individuals with urinary tract infections attending "Centre Régional Hospitalier de Dédougou" from March 2018 to February 2019.*

n: number, E.: Escherichia, K.: Klebsiella, S.: Staphylococcus.

Antibiotics susceptibility

Sensitivity testing showed that the *Enterobacterales* and *Cocci* isolated had different levels of resistance to the antibiotics tested. *Enterobacterales* were mainly resistant to amoxicillin-clavulanate (96.1%), amoxicillin (100%), ceftriaxone (53.8%), ciprofloxacin (67.5%) and trimethoprim-sulfamethoxazole (73.08%) (Figure 1).

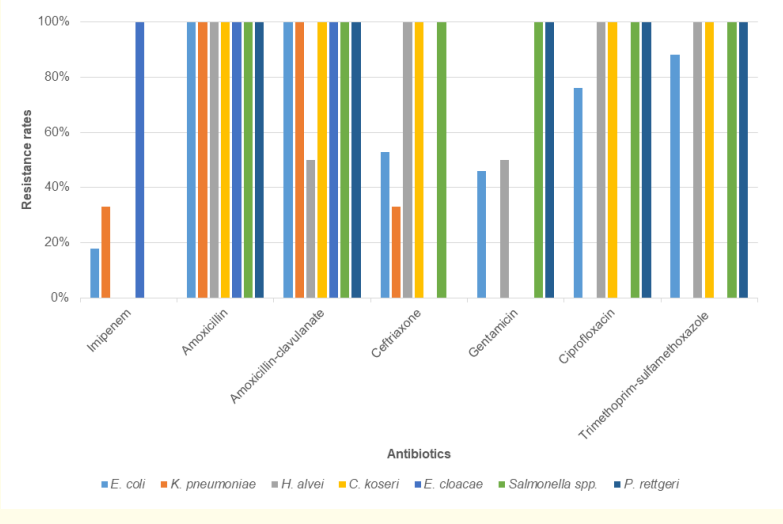

Figure 1: *Resistance to individual antimicrobial among Enterobacteria isolates.*

E. Escherichia, K. Klebsiella, H. Hafnia, C. Citrobacter, E. Enterobacter, P. Providencia.

Out of the *Cocci* isolates, we also noted high resistance to oxacillin (75% *Staphylococcus* spp. and 60% *Streptococcus* spp.), to norfloxacin (63% *Staphylococcus* spp. and 80% *Streptococcus* spp.) and to trimethoprim-sulfamethoxazole (75% *Staphylococcus* spp. and 80% *Streptococcus* spp.) (Figure 2). Moderate resistances were observed to the other antibiotics. At least, 17 of the *Enterobacterales* isolated (62.9%) and nine of the *cocci* isolated (69.2%) were multidrug resistant (MDR).

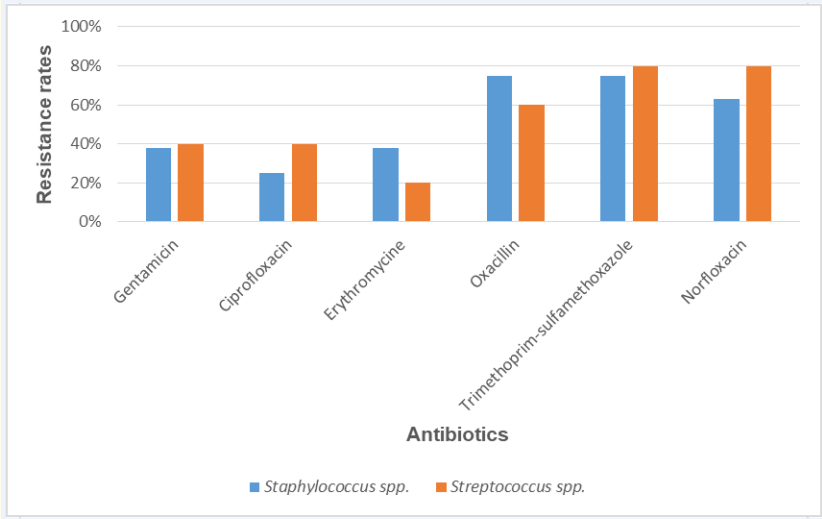

Figure 2: *Resistance to individual antimicrobial among cocci isolates.*

Discussion

This study was conducted to generate some insight on antibiotic susceptibility in UTI isolates collected from patients attending Regional Hospital of Dedougou-Burkina Faso. According to the results, most of the uropathogens were recovered from male patients (78.1%) which is consistent with a previous report in Burkina Faso [3]. By cons, according to some other previous studies, female patients were more exposed to urinary tract infections [18-20]. The present study showed that half of the patients were under antibiotic treatment and 88.1% were outpatients. Interestingly, a study reported that people in Burkina Faso do not consult a health care agent in the case of many diseases and use self-medication instead [21]. In another study, urinary tract infections (UTIs) were the most common infections diagnosed from outpatients as well as hospitalized patients (in patients) [6]. Of course, risk factors for UTIs may be behavioral, anatomical, or genetic in nature, and will vary depending on both the population being considered and the form of UTI [19]. In all cases, understanding individual and population-specific risk factors associated with recurrent urinary tract infections (UTIs) could help physicians tailor prophylactic strategies [19].

Out of the tested specimens, 34.02% had significant bacterial growth that is high than the 24.07% previously reported in Burkina Faso [3]. In addition, a prevalence of 18.4% of cases of urinary tract infections has been reported in Mauritania [22]. Otherwise, a prevalence of 36.1% has been reported in Pakistan where 50.7% of the strains were isolated from female patients [20]. These differences in UTI rates regarding areas could be explained by the disparities in location and health facilities in addition to patients' status (acute UTI or post-antibiotic treatment) [23,24].

With regard to uropthogens isolates, *E. coli* was the most abundant (44.73%), and *Citrobacter koseri* and *Providencia rettgeri* were the rarest (2.3%) (Table 3). The prevalence of *E. coli* was consistent with a previous report in Burkina Faso [14] and comparatively lower than in recent published reports in Burkina Faso and in Pakistan [3,20]. Indeed, uropathogenic *Escherichia coli* (*E. coli*) (UPEC) is the dominant infectious agent in both uncomplicated and complicated UTIs [25]. Likewise, the prevalence's of *Klebsiella pneumoniae* were consistent with previous reports in Burkina Faso and in Pakistan [14,20]. Our findings confirm the major place of Gram-negative organisms in UTI cases [26,27]. Indeed, variation in the spectrum of bacterial uropathogens has been reported across different geographical locations and by categorization of the patients' UTIs [28,29].

For antibiotic sensitivity test, our data also show that both the *Enterobacterales* and *Cocci* isolates were highly resistant to amoxicillin-clavulanate, amoxicillin, ceftriaxone, ciprofloxacin and trimethoprim-sulfamethoxazole. Moreover, the *Cocci* isolates (*Staphylococcus* spp. and *Streptococcus* spp.) showed high resistance to: oxacillin, norfloxacin and trimethoprim-sulfamethoxazole. Based on this, the present study provides valuable data for assessing drugs' pressure and monitoring the antimicrobial resistance among uropathogenic *Enterobacterales* and *Cocci* to improve patients' treatment. Indeed, treating patients, including UTI ones, suffering from infections caused by MDR bacteria is a challenging task, due to those targeted efforts to deal with this issue are crucial to provide a better health care service [30-32].

It has been shown that 62.9% of the *Enterobacterales* and 69.2% of the *Cocci* were multidrug resistant in this study. This is worrisome because the emergence of MDR organisms threatens the management of patients with UTIs. Multidrug resistance was observed in both Gram-negative and Gram-positive bacteria [20,33], in *E. coli* [6] according to studies carried out in Ethiopia, Pakistan and Uganda.

Conclusion

In our study, the predominant isolated organisms responsible for UTI in the "Centre Hospitalier Régional de Dédougou" were successively *E. coli*, *Streptococcus* spp., *K. pneumoniae*, *S. aureus* and *Staphylococcus* spp. The majority of isolates were resistant to commonly prescribed antibiotics in the study area. Therefore, it appears that the physician should strictly follow the culture report before starting therapy to prevent the emergence of multidrug resistance.

Author Contributions

RD, RS, GDN and NB participated in the conceptualization of this manuscript and co-wrote the section on methodology. HC, ABK, AHM, FFB, WADK, IS, OT, NO and AST reviewed various drafts of the manuscript. All authors contributed to the conceptualization of the article and reviewed the final draft of the manuscript. All authors have read and approved the manuscript. We thank the "Centre Hospitalier Régional de Dédougou", Burkina Faso.

Funding Support

This research received no external funding.

Data Availability Statement

Not applicable.

Acknowledgments

We thank the authorities of the "Centre Hospitalier Régional de Dédougou", Burkina Faso.

Conflicts of Interest

The authors declare no conflict of interest.

Bibliography

1. Wagenlehner F., *et al*. "Social and economic burden of recurrent urinary tract infections and quality of life: a patient web-based study (GESPRIT)". *Expert Review of Pharmacoeconomics and Outcomes Research* 18.1 (2017): 107-117.
2. Vallejo-Torres L., *et al*. "Cost of hospitalized patients due to complicated urinary tract infections: a retrospective observational study in countries with high prevalence of multidrug-resistant Gram-negative bacteria: the COMBACTE-MAGNET, RESCUING study". *BMJ Open* 8.4 (2018): e020251.
3. Sagna T., *et al*. "Antibiotic Susceptibility of *Escherichia coli* and *Klebsiella pneumoniae* Strains, Urinary Tract Infections Cases in Bobo-Dioulasso, Burkina Faso". *EC Microbiology* 15.3 (2019): 172-178.
4. Nosseir SB., *et al*. "Recurrent uncomplicated urinary tract infections in women: a review". *Journal of Women's Health (Larchmt)* 21.3 (2012): 347-354.
5. Bryce A., *et al*. "Global prevalence of antibiotic resistance in paediatric urinary tract infections caused by *Escherichia coli* and association with routine use of antibiotics in primary care: systematic review and meta-analysis". *BMJ* 352 (2016): i939.
6. Odongo I., *et al*. "Prevalence of *Escherichia coli* and Its Antimicrobial Susceptibility Profiles among Patients with UTI at Mulago Hospital, Kampala, Uganda". *Interdisciplinary Perspectives on Infectious Diseases* (2020): 8042540.
7. Lichtenberger P and Hooton TM. "Complicated urinary tract infections". *Current Infectious Disease Reports* 10.6 (2008): 499-504.
8. Flores-Mireles AL., *et al*. "Urinary tract infections: epidemiology, mechanisms of infection and treatment options". *Nature Reviews Microbiology* 13.5 (2015): 269-284.
9. Sorlózano-Puerto A., *et al*. "Etiological and Resistance Profile of Bacteria Involved in Urinary Tract Infections in Young Children". *BioMed Research International* (2017): 4909452.
10. Gajdacs M., *et al*. "Comparative epidemiology and resistance trends of common urinary pathogens in a tertiary-care hospital: a 10-year surveillance study". *Medicine* 55.7 (2019): 356.
11. Eiros-Bouza M., *et al*. "Etiological profile of urinary tract infections and antimicrobial susceptibility of urinary pathogens". *Anales de Pediatria (Barcelona)* 67.5 (2007): 461-468.
12. Gajdacs M and Urban E. "Resistance trends and epidemiology of *Citrobacter-Enterobacter-Serratia* in urinary tract infections of inpatients and outpatients (RECESUTI): a 10- year survey". *Medicine* 55.6 (2019): 285.
13. Nace DA., *et al*. "Clinical Uncertainties in the Approach to Long Term Care Residents with Possible Urinary Tract Infection". *Journal of the American Medical Directors Associations* 15.2 (2014): 133-139.
14. Karou SD., *et al*. "Antibiotic Resistance in Urinary Tract Bacteria in Ouagadougou". *Pakistan Journal of Biological Sciences* 12.9 (2009): 712-716.
15. Cheesbrough M. "District laboratory practice in tropical countries". Chapter 7, second edition in New York in USA (2009): 132-304.

16. Bauer AW., *et al*. "Antibiotic susceptibility testing by a standardized single disk method". *American Journal of Clinical Pathology* 45.4 (1996): 493-496.

17. EUCAST, European committee on antimicrobial susceptibility testing. Breakpoint for interpretation of MICs and zone diameters (2015).

18. Yang B., *et al*. "Analysis of the spectrum and antibiotic resistance of uropathogens in outpatients at a tertiary hospital". *Journal of Chemotherapy* 30.3 (2018): 145-149.

19. Storme O., *et al*. "Risk factors and predisposing conditions for urinary tract infection". *Therapeutic Advances in Urology* 11 (2019): 19-28.

20. Muhammad A., *et al*. "Prevalence and antibiotic susceptibility pattern of uropathogens in outpatients at a tertiary care hospital". *New Microbe and New Infections* 36 (2020): 100716.

21. Dembélé R., *et al*. "Burden of acute gastrointestinal infections in Ouagadougou, Burkina Faso". *Journal of Microbiology and Infectious Diseases* 6 (2016): 45-52.

22. Hailaji NSM., *et al*. "Sensitivity to antibiotics uropathogens bacteria in Nouakchott-Mauritania". *Progrès en Urology* 26.6 (2016): 346-352.

23. Shatalov A. "Prevalence and Antibiotic Resistance Pattern of *Escherichia coli* and *Klebsiella pneumoniae* in Urine Tract Infections at the La Paz Medical Center, Malabo, Equatorial Guinea". *Open Journal of Medical Microbiology* 5.4 (2015): 177-183.

24. Abe IA., *et al*. "Assessment of drugs pressure on *Escherichia coli* and *Klebsiella* spp. uropathogens in patients attending Abobo-Avocatier Hospital, North of Abidjan (Côte d'Ivoire)". *African Journal of Microbiology Research* 13.29 (2019): 658-666.

25. Medina M and Castillo-Pino E. "An introduction to the epidemiology and burden of urinary tract infections". *Therapeutic Advances in Urology* 11 (2019): 1756287219832172.

26. Mirzarazi M., *et al*. "Antibiotic resistance of isolated Gram-negative bacteria from urinary tract infections (UTIs) in Isfahan". *Jundishapur Journal of Microbiology* 6.8 (2013): 653-660.

27. Seifu WD and Gebissa AD. "Prevalence and antibiotic susceptibility of uropathogens from cases of urinary tract infections (UTI) in Shashemene referral hospital, Ethiopia". *BMC Infectious Diseases* 18.1 (2018): 30.

28. Yamamichi F., *et al*. "Relationship between urinary tract infection categorization and pathogens' antimicrobial susceptibilities". *Urologia Internationalis* 88.2 (2012): 198-208.

29. Yoon BI., *et al*. "Changes in bacterial species and antibiotic sensitivity in intensive care unit: acquired urinary tract infection during 10 years interval (2001-2011)". *Urology Journal* 11.2 (2014): 1478-1484.

30. Medina E and Pieper DH. "Tackling threats and future problems of multidrug-resistant bacteria". In: Stadler M, Dersch P, editors. How to overcome the antibiotic crisis: facts, challenges, technologies and future perspectives. Cham: Springer International Publishing (2016): 21.

31. Amraei S., *et al*. "Serotyping and Antibiotic susceptibility pattern of common bacterial uropathogens in urinary tract infections in Koohdasht, Lorestan Province". *International Journal of Enteric Pathogens* 4 (2016): e34824.

32. Hawkey PM., *et al*. "Treatment of infections caused by multidrug-resistant Gram-negative bacteria: report of the British Society for Antimicrobial Chemotherapy/Healthcare Infection Society/British Infection Association Joint Working Party". *Journal of Antimicrobial Chemother*apy 73.2 (2018): iii2-iii78.

33. Woldemariam HK., *et al*. "Common uropathogens and their antibiotic susceptibility pattern among diabetic patients". *BMC Infectious Diseases* 19.1 (2019): 43.

Volume 18 Issue 6 June 2022