Microbiology Research Journal International

Volume 33, Issue 6, Page 40-50, 2023; Article no.MRJI.104409
ISSN: 2456-7043
(Past name: British Microbiology Research Journal, Past ISSN: 2231-0886, NLM ID: 101608140)

Epidemiology and Sensitivity to Antibiotics of Uropathogenic Bacteria in Patients at the CHU Ignace Deen National Hospital in Conakry, Guinea

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/MRJI/2023/v33i61389

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/104409

Original Research Article

Received: 10/06/2023
Accepted: 16/08/2023
Published: 22/08/2023

ABSTRACT

Introduction: Urinary tract infections are caused by the colonisation of the various organs of the urinary tract by microorganisms.
Objective: The aim of this study was to determine the antibiotic sensitivity of bacteria isolated from urinary tract infections and improve the health care of patients with urinary tract infections.
Methods: This is a prospective, cross-sectional descriptive study that took place over three months, from 2 February to 2 May 2022.

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Results: Bacterial identifications showed a predominance of *Escherichia coli* (*E. coli*) with 52%, followed by *Klebsiella pneumoniae* (*K. pneumoniae*) with 13%, *Enteroccus spp*., with 9%, *Enterobacter cloacae complex* (E. cloacae) and *Staphylococcus aureus* (*S. aureus*) with 8% each. and the other germs are weakly represented. The antibiogram showed that certain antibiotics were active on the majority of strains, including imipenem (75%), cefoxitin (65%) and ertapenem (64%), amikacin (61%). All age groups were affected by urinary tract infections with a predominance in the age group of 51 years and over (54%), and 25 to 50 years are the most represented in our study with respectively 54% and 28%. The Marital Status shows that Married people were mostly exposed to urinary tract infections with a prevalence of 78%. The distribution according to socio-professional characteristics showed that Housewives were the most represented (30%). The majority of infected patients came from the Commune of Ratoma (35%).
Conclusion: Urinary tract infections are a major public health problem whose health management necessarily involves an antibiogram and possibly the monitoring of hematological parameters.

Keywords: Urinary tract infections; epidemiology; antibiogram; Conakry.

1. INTRODUCTION

Urinary tract infections are diseases of the urinary tract caused by microorganisms. These infections can affect all parts of the urinary system (kidneys, ureter and bladder) [1]. They are much more common in women than in men and can affect young children [1-3]. These conditions are most often manifested by a burning sensation during urination, lower abdominal pain, leucorrhea [4,5]. Bacteria are the microorganisms most frequently associated with these infections. The majority of bacteria involved in bacterial infections belong to the *Enterobacteriaceae* family. Antibiotics are the molecules used in the treatment of bacterial infections. Some of these molecules are active on these bacterial germs, others on the other hand use different mechanisms to antibiotics. Among other mechanisms used by bacteria is the production of plasmid-mediated extended-spectrum beta-lactamases (ESBLs). These enzymes are the major cause of bacterial resistance to bêta -lactam antibiotics and have been the subject of extensive microbiological, biochemical, and genetic investigations [6].

ESBLs were first described in the 1980s in pathogenic bacteria isolated from hospitalized patients [7]. The frequency of UTIs depends on age and gender. Women are much more affected than men given the proximity of the anal tract and the urinary meatus [5]. There are an estimated 150 million urinary tract infections per year worldwide [5,7,8,9]. In the United States, urinary tract infections result in approximately 8 million physician visits per year [4,7].

A study conducted in 2006 by Roos et al., (2006), showed that UTIs affected more than ten million people in Western Europe [10]. Katongole et al. reported in Uganda that *E. coli* causes 80 to 90% of community urinary tract infections and 30 to 50% of those contracted in hospitals [11,12].

In France, 20 to 25% of infections occurring in hospitals are nosocomial urinary tract infections [13]. In Africa, the prevalence among women of childbearing age varies from country to country. In Guinea Bissau, it is 20%. In Mauritania, 10% according to a study carried out in 2008. In the Republic of Guinea, in 1996, urological emergencies represented 7.70% of medico-surgical emergencies at the Ignace-Deen National Hospital in Conakry and constituted 60% of admissions to the service. While the majority of patients came from Lower Guinea, i.e. 67.9%, Upper Guinea and Forest Guinea were poorly represented with 7.8 and 2.2% respectively [14].

2. MATERIALS AND METHODS

The study was carried out at the National Mycobacteria Reference Laboratory (LNRM) of the Pneumophtisiology department of the National Hospital CHU Ignace Deen and at the Microbiology Laboratory of the Gamal Abdel Nasser University of Conakry. The urine and blood taken from the patients constituted our Bio-material. This is a prospective, cross-sectional and descriptive study lasting three months, from February 2 to May 2, 2022. Our study population consisted of all patients with urinary tract infections seen at the LNRM during our survey period. Bacterial cultures were carried out on different agar media. Positive cultures were stained by Gram's method. Bacterial identifications were carried out in API galleries,

and antibiograms were carried out by the agar diffusion method.

The sampling was simple random and the sample size (N = 228) was calculated using the average hospital prevalence of the city of Conakry (8%) by the Schwartz formula Were included in our study, all patients received at the laboratory with a report card or an examination book on which a Cytobacteriological Examination of Urine (ECBU + ATB) and the NFS are requested.

2.1 Data Analysis

The data collected was stripped, entered, processed and analyzed by Word and Excel software under Windows 2010.

3. RESULTS AND DISCUSSION

3.1 Sociodemographic Characteristics

The distribution of patients by sex showed that the female sex was predominant with 62% (55/88) against 38% (33/88) for the male sex. The sex ratio (Male/Female) was 0.6 (Table 1). These rates are similar to those reported in Morocco by Ismaël in his doctoral thesis in medicine, with 56.51% of women and 43.49% of men [15]. Similarly in Guinea, Makanéra et al reported in 2021 a predominance of the female sex (70%) compared to the male sex (30%) [5]. Many other studies relating to uropathogenic *E. coli* maintain that the female sex generally remains predominant due to its anatomical structure, due to the proximity of the anus and the urinary meatus [5]. Another reason for the lower incidence of uropathogenic *E. coli* infections in men than in women is the antibacterial property of prostatic fluid [1].

The distribution of patients according to age showed that the age group 51 years and over was the most affected (53.40%) followed by that of 25-50 years (28.40%). The least represented age group is that between 0-10 with 1% (Table 1). This could be explained by the fact that the frequency of urogenital infections increases with age. These data are comparable to those reported in Guinea in 2021 [5].

Table 1. Distributionof patients with urinary tract infections according to socio-demographic characteristics

Parameters	Number	Percentage
Sex		
Male	33	37.5
Female	55	62.5
Age groups		
0 -10	1	1.13
11- 25	15	17.04
25- 50	25	28.40
51 years and plus	47	53.40
Marital status		
Married	69	78.40
Célibataires	19	21.59
Socioprofessional categories		
Household	26	29.54
Administrative officers	17	19.31
Pupils/Students	15	17.04
Commercial agents	14	15.90
Workers	14	15.90
Health workers	2	2.27
Residence		
Ratoma	30	34.09
Kaloum	20	22.72
Matoto	18	20.45
Matam	3	3.4
Dixinn	2	2.27
Out of Conakry	15	17.04

Sexe ratio (M/F)=0.6

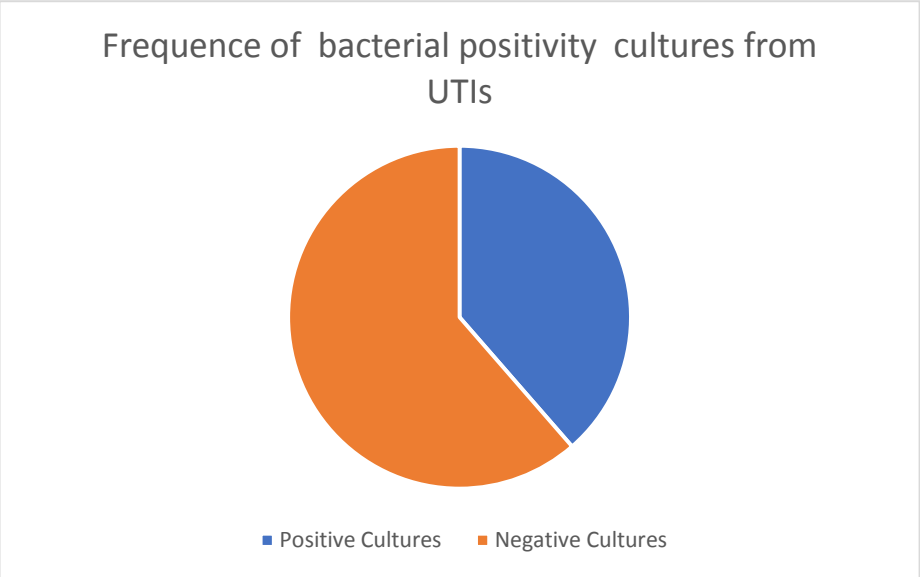

Fig. 1. Frequency of positive bacterial cultures from urines

As for civil status, we note that married couples are the most affected by urinary tract infections with 69 cases (78.40%). The Married/Single ratio was 3.63 (Table 1). This could be due to the frequency of sexual intercourse, to a pregnancy thus favoring the installation of germs [16]. In Guinea, culturally and religiously, sexual intercourse is rather authorized between married people.

From the socio-professional point of view, urinary tract infections were observed in all socio-professional strata. However, housewives were the most represented in this study with 29.54% (26/88) followed by administrative workers with 19.31% (17/88) and pupils/students with 17.04% (15/88) (Table 1).

Compared to the prevalence of urinary tract infections, the results show that 39% of patients actually suffer from urinary tract infections (88/228) compared to 61% of patients who had no urinary tract infections (140/228) (Table 2)

The distribution of infected urine according to Gram shows that of the 88 urines of patients suffering from urinary tract infections, 77.27% contained Gram-negative Bacilli (68/88) and 22.72% Gram-positive Cocci (20/88) (Table 1).

Distribution of bacterial germs isolated from infections according to species shows that *E. coli* was the main species isolated from urinary tract infections with 52.27% (46/88), followed by *Klebsiella pneumoniae* with 12.5% (11/88), *Enterococcus spp*., with 9.09% (8/88), Enterobacter cloacae complex and *Staphylococcus aureus* which each accounted for 8%. The other species were poorly represented (Table 2).

Table 2. Isolation frequency of the different bacterial species

N°	Bacterial species	Number	Percentage
1	*Escherichia coli*	46	52.27
2	*Klebsiella pneumoniae*	11	112.5
3	*Enterobacter cloacae complex*	7	7.95
4	*Pseudomonas aeruginosa*	3	3.40
5	*Acinetobacter baumanni*	1	1.13
6	*Staphyloccus aureus*	7	7.95
7	*Enteroccocus spp.*	8	9.09
8	*Staphyloccocus haemoliticus*	5	5.68
Total		88	100

The high prevalence of *E. coli* in this study could be explained by the fact that this bacterial species represents the majority species of coliforms of the digestive tract. However, the anal tract and the genital tract are close in women than in men. Thus, the lack of hygiene in the intimate part, especially in women, can be a factor favoring infection of the urinary tract [5].

3.2 Hematological Aspect of Patients Affected by Urinary Tract Infections

The distribution of patients with UI shows that out of 88 patients with urinary tract infections, 86 had a low hemoglobin level, i.e. 98%. Also, 13 patients had low lymphocyte counts, i.e. 15%, while 10 patients had low neutrophils, i.e. 11% and only one patient suffered from hypo-leukocytosis, i.e. 1%. On the other hand, 73 patients had high leukocyte levels, i.e. 83%. On the other hand, 76 patients had hyper-neutrophilia, i.e. 86% and 7 patients had high Mixed elements (Basophils, Eosinophils and Monocytes), i.e. 8%. This situation could be explained by the sepsis and the presence of other infections in the patients.

This shows that in patients with urinary tract infections, hematological parameters should be monitored.

Analysis of this table shows us that of the 88 patients with urinary tract infections, 86% had a low hemoglobin level with the following anemic typology: mild anemia in 27 patients (i.e. 31%), anemia moderate in 50 patients (i.e. 64%) and severe anemia in 9 patients (i.e. 10%).

These data show that in patients with urinary tract infections, the hemoglobin level should be monitored. In patients with severe and moderate anemia, this situation could be corrected by a good, rich and balanced diet, while in patients with severe anemia, it could be corrected by a blood transfusion before any antibiotic treatment.

3.3 Antibiotic Sensitivity of Uropathogens

The results showed bacterial sensitivity to amikacin (61%) and gentamicin (35%). This sensitivity of germs to certain aminoglycosides could be explained by the fact that aminoglycosides are broad-spectrum antibiotics (Table 3).

Table 3. Overall sensitivity to antibiotics of the different species isolated from urinary

Antibiotics	S N (%)	I N (%)	R N (%)	ND N (%)	Total
Ampicillin	2(2)	0(0)	63 (72)	23(26)	88(100)
Ticarcillin	2(2.27)	0(0)	62(71)	24(27)	88(100)
Piperacillin/Tazobactam	24(27)	3(3.4)	40(46)	21(24)	88(100)
Cefoxitin	19(22)	4(5)	27(30)	38(43)	88(100)
Cefotaxim	57(65)	1(1.13)	10(11)	20(23)	88(100)
Ceftazidime	13(15)	0(0)	54(61)	21(24)	88(100)
Ertapenem	56(64)	0(0)	54(61)	22(25)	88(100)
Imipenem	66(75)	1(1.13)	1(1)	20(23)	88(100)
Amikacin	54(61)	1(1.13)	12(14)	21(24)	88(100)
Gentamicin	31(35)	0(0)	35(40)	22(25)	88(100)
Tobramicin	24(27)	2(2.27)	22(25)	40(46)	88(100)
Nalidixic Acid	12(14)	0(0)	52(59)	24(27)	88(100)
Ciprofloxacin	27(31)	2(2.27)	43(49)	16(18)	88(100)
Ofloxacin	11(13)	6(7)	53(60)	18(20)	88(100)
Nitrofurantoine	49(56)	3(3)	30(34)	6(7)	88(100)
Trimethoprim/Sulfamethoxazole	9(10)	0(0)	62(71)	17(19)	88(100)
Clindamycin	5(6)	0(0)	5(6)	78(88)	88(100)
Erythromycin	3(3)	0(0)	8(9)	77(88)	88(100)
Quinupristin/dalfopristin	8(9)	0(0)	4(5)	76(86)	88(100)
Linezolid	11(13)	0(0)	9(10)	68(77)	88(100)
Vancomycin	9(10)	0(0)	12(14)	67(76)	88(100)

Legends: S: sensitivity; I: intermediate; R: resistance; N: Number

The sensitivity of the bacterial strains studied to quinolones was generally low with 31% for ciprofloxacin, 13% for ofloxacin and 12% for nalidixic acid (Table 3).

The class of nitrofurans represented by a single antibiotic, nitrofurantoin, to which 56% of the strains were sensitive, whereas 34% of these strains were resistant to this molecule (Table 3).

The resistance of the strains studied to the trimethoprim/sulfamethoxazole combination and to clindamycin was high, with 71% for trimethoprim/sulfamethoxazole and 78% for clindamycin, respectively (Table 3). Similarly, resistance to macrolides and quinupristin/dalfopristin were even higher with 88% and 86% respectively (Table 3). Very few germs are sensitive to linezoid antibiotics (Table 3). The family of glycopeptides is presented by a single antibiotic which is vancomycin. Thus 10% of the strains were sensitive to this molecule. (Table 3).

High sensitivity to imipenem (75%), Cefoxitin (65%) and ertapenem (64%).

In contrast, resistance to ampicillin (72%) and ticarcillin (71%) and ceftazidime (54%) (Table 3).

Our results are comparable to those of several authors who reported a high sensitivity of uropathogenic ESBL-producing *E. coli* to carbapenems (imipemem and ertapenem) of uropathogenic ESBL-producing strains [17]. The uropathogen *E. coli* strains sensitivity to carbapenems founded during this present work is comparable to those reported in Mexico by Ramirez-castillo et al, (2018) who founded total susceptibility of all strains of uropathogenic *E. coli* during their study [3]. Rezaï et al. (2015) reported that most strains of uropathogenic ESBL-producing *E. coli* were sensitive to carbapenems [17]. The susceptibility to beta-lactams of the majority of *E. coli* studied in this present work was globally comparable to that reported by some authors [17].

The strains studied in this present work were generally resistant to ampicillin, ticarcillin, ceftazidime is due, on the one hand, to the fact that these molecules (in particular ampicillin) are used in Guinea in an abusive way, and on the other apart from the fact that most of these strains are ESBL producers. Shahbazi et al. (2018) found that a higher number of isolates of uropathogenic ESBL-producing *E. coli* were resistant to aminoglycosides and quinolones compared to strains of uropathogenic *Escherichia coli* that was not producing ESBL [18]. Carbapenems (imipenem and meropenem) represent the best option for the treatment of urinary tract infections caused by ESBL-producing strains [19]. Cephalosporins, penicillins and monobactams could be used with β-lactamase inhibitors [20].

The frequency of isolates of ESBL-producing *E. coli* is different in different regions of the world and sometimes even in different hospitals in the same country. In addition to β-lactam resistance, isolates of ESBL-producing *E. coli* are also resistant to other antimicrobial agents, such as aminoglycosides, tetracycline and trimethoprim/sulfamethoxazole [17]. Shahbazi et al. (2018) found that a higher number of ESBL-producing UPEC isolates were resistant to aminoglycosides and quinolones compared to non-ESBL-producing UPEC strains [18]. Carbapenems (imipenem and meropenem) represent the best option for the treatment of urinary tract infections caused by ESBL-producing strains [19]. Cephalosporins, penicillins and monobactams should be used with β-lactamase inhibitors [20].

Table 4. Distribution of patients with urinary tract infections according to hematological parameters (N=86)

	Values					
	Low		Normales		High	
Paramters	Number	%	Number	%	Number	%
Hemoglobin	86	98	2	2	-	-
Leucocytes	1	1	14	16	73	83
Lymphocytes	13	15	74	84	1	1
Neutrophils	10	11	2	2	76	86
Mixed Elements	-	-	81	92	7	8

Table 5. Typology of anemias, physiopathological variations MCV and MCHC

Anemias					
Frustreted		**Moderated**		**Severe**	
Number	%	Number	%	Number	%
27	31	50	64	9	10
MCV					
Microcytic		**Normocytic**		**Macrocytic**	
Number	%	Number	%	Number	%
71	83	15	17	0	0
MCHC					
Hypochromic		**Normochromic**		**Hyperchromic**	
Number	%	Number	%	Number	%
29	34	57	66	0	0

High resistance to broad-spectrum antibiotics such as carbapenems, which contrasts with other studies done in different countries that reported lower resistance (around 34%) to imipenem and meropenem in India [21], in Malaysia [22], Colombia, Saudi Arabia [23] and Iran [21,22]. Although we found that carbapenems were more active in ESBL-producing bacteria, the high rate of resistance, compared to other studies, remains of great concern [24-26]. Recently, a study carried out in Iran showed a 75% sensitivity to carbapenems in pathogenic bacteria producing ESBL [27]. The main reason for the large difference in the resistance rate between different countries and different regions within the same country is due to the extensive use of broad-spectrum antibiotics, especially third-generation cephalosporins, and the persistence of resistant strains in health facilities. Extensive use of broad-spectrum antibiotics, particularly third-generation cephalosporins, has been reported by Salehifar et al. [28]. The rate of antibiotic consumption in our institution was significantly higher than in the other centers [28].

Table 3 shows that the aminoglycosides (amikacin, gentamycin and tobramycin) proved to be very active on the strains of *E. coli*. Indeed, these strains of *E. coli* were generally sensitive to amikacin (96.96%), gentamicin (69.23%) and tobramycin (60.60%). These results are different from those found in India by Shahid et al. (2008) in terms of frequency of susceptibility to aminoglycoside antibiotics [29]. Indeed, these authors reported that strains of *E. coli* analyzed in their study had a 57.1% sensitivity to amikacin, followed by tobramycin with 38.5% and gentamicin with 31.9%. This shows that these molecules were more active on strains of *E. coli* in this study than those of these authors. However, in our study, the susceptibility frequencies of strains of *E. coli* to aminoglycosides showed that amikacin was more active than gentamicin, and the latter more active than tobramycin. Thus, conversely, the resistance phenotype detected in strains of *E. coli* was generally lower and the phenotypic resistance detected is mainly as follows: Resistance GEN, TOB, NET and AMI.

The majority of strains of *E. coli* were quite resistant to quinolones. Indeed, this resistance of *E. coli* to quinolones was 82.75% for nalidixic acid, 56.0% for ciprofloxacin and ofloxacin. These results are similar to those of other work done elsewhere in the world. Indeed, Akya et al. (2015) reported metadata from 53 studies of strains of *E. coli* uropathogens, carried out between 2001 and 2011 on quinolones [30]. Compilation of these data showed high resistance strains of uropathogenic *E.coli* to these molecules. Indeed, the overall resistance of these strains to nalidixic acid, ciprofloxacin, norfloxacin and ofloxacin was respectively 42.3%, 28.2%, 48.5% and 24.1% [30].

Thus, the resistance observed in strains of uropathogenic *Escherichia coli* isolated at the Sino-Guinean Friendship Hospital in Kipé is much higher than the average resistance observed by these authors [5]. This situation would be favored by the excessive use of quinolones in Guinea, considered as broad-spectrum antibiotics. They are potent inhibitors of bacterial DNA gyrase and topoisomerase IV [31]. Quinolone resistance is on the rise in all bacterial species worldwide. Mechanisms of acquired resistance are mainly chromosomal (modification of targets, impermeability/active efflux) while plasmid resistance is frequently detected in *Enterobacteriaceae* such as *E. coli* [31].

Nitrofurantoin was the only antibiotic molecule representing the furan class. This molecule was

active on the majority of strains of *E. coli* analyzed. Indeed, 87.17% of these strains were sensitive to this molecule.

These results are similar to many others reported around the world. Indeed, in 2019, Kot reported that the resistance of uropathogenic *E. coli* to nitrofurantoin is very low, favoring its use as a first-line antibacterial agent. Studies by Sanchez et al. (2016) showed that in the United States, nitrofurantoin retains a high level of antibiotic activity against *E. coli* isolated from UTIs [32]. A comparison of reports from the period of 2003 to 2012 revealed that the resistance of isolates of *E. coli* from adults to nitrofurantoin increased only slightly (from 0.7% to 0.9%). Kresken et al, (2016) reported that studies from Germany, Belgium and Spain showed that *E. coli* is generally susceptible to nitrofurantoin. Indeed, the resistance rates of uropathogenic *E. coli* in these countries during the period 2013-2014 were less than 1.5% [33].

According to European Urological Association guidelines [34], nitrofurantoin is recommended for the treatment of uncomplicated cystitis as first-line empirical therapy.

In Argentina and Brasilia, isolates of uropathogenic *E. coli* are generally susceptible to nitrofurantoin. Indeed, a slightly higher percentage of uropathogenic *E. coli* resistant to nitrofurantoin was observed among isolates from elderly hospitalized patients in Argentina (2.3%) [35]. While in Brazil, the rate of isolates of uropathogenic *E. coli* resistant to nitrofurantoin was 6.6% [36].

The sulfonamide class was represented by the trimethoprim/sulfamethoxazole combination. This combination of sulfonamides was not very active on the majority of strains of *E. coli* studied. Indeed, 83.60% of these strains were resistant to the sulfonamides tested.

This observation has been made beforehand by many other authors. Indeed, in Mexico City, Ramifez-Castillo et al, (2018) reported in their study a high frequency of resistance of strains of *E. coli* to the trimethoprim/sulfamethoxazole combination which was 72.7% [3]. In Iran, Rezai et al. (2015) reported a resistance frequency of 65% of strains of uropathogenic *E. coli* to the trimethoprim/sulfamethoxazole combination [17]. A similar rate of resistance of isolates of uropathogenic *E. coli* against the trimethoprim/sulfamethoxazole combination (50.6%) has been observed in Brazil [36]. These resistance frequencies of *E. coli* in the combination of antibiotics are lower than those found in this work. The high frequency of *E. coli* uropathogenic to combined antibiotics (trimethoprim and sulfamethoxazole) would be due to the uncontrolled use of this molecule, often used in Guinea during respiratory infections and diarrhea.

4. CONCLUSION

The results of this present study showed that urogenital infections were mainly caused by strains of *Escherichia coli* with a high prevalence in men. Carbapenems (imipenem and ertapenem), nitrofurantoin and aminoglycosides as well as certain cephalosporins (piperacillin/tazobactam combination) have been shown to be more active on the bacterial strains studied. Despite these results, carbapenems must still remain the last choice of antibiotics used in the treatment of bacterial infections. Hence the need for the proper use of antibiotics according to the current recommendations of the World Health Organization in this area.

CONSENT

Before any administration of the questionnaire, the consent of each patient was requested. The validity of the work was explained beforehand, and anonymity in the restitution of the data was respected.

ETHICAL APPROVAL

As per international standard or university standard written ethical approval has been collected and preserved by the author(s).

ACKNOWLEDGEMENT

The authors would like to thank the managers and laboratory technicians of the National Mycobacteria Reference Laboratory (LNRM) of the University Hospital of Ignace Deen and those of the Microbiology laboratory of the Gamal Abdel Nasser University of Conakry for their support in carrying out this work.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:
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https://www.sdiarticle5.com/review-history/104409