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Identification of Bacteria Strains Isolated in Urinary Tract Infections and Their Antibiotic Susceptibility at the National Public Health Laboratory, Ouagadougou

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Abstract

Background: Urinary tract infections are still a real public health concern. The aim of this study was to identify the bacteria strains involved in urinary tract infections and to determine their antibiotic resistance profiles. **Methods:** Two kinds of studies were performed. The retrospective study was carried out for 2 years (from January 2018 to December 2019), and the prospective study was extended over a period of 6 months (from January to June 2020). Isolation and identification of bacteria strains were performed using conventional microbiology techniques. The strains' resistance profiles were determined by the diffusion method on Mueller-Hinton according to the criteria of EUCAST-2015. Fourteen (14) antibiotic discs were used depending on the isolated germ. **Results:** A total of 187 bacterial strains were isolated from 82 men and 105 women. Among the germs identified, 77.54% were Enterobacteriaceae and 13.36% were cocci strains. Non-fermentative gram-negative bacilli accounted for 9.08% of the isolated bacteria. The results showed that the majority of Enterobacteriaceae strains were resistant to beta-lactams: 100% to amoxicillin, 98.75% to amoxicillin + clavulanic acid, 41.76% to ceftriaxone, and 43.14% to ceftazidime. These findings were obtained with fluoroquinolones and aminoglycosides: 50.09% with ciprofloxacin, 54.04% with norfloxacin, and 22.58% with amikacin. 8.75% of the Enterobacteriaceae strains tested were resistant to imipenem. The same trends were observed with non-fermentative bacteria. As for the gram-positive bacteria isolated during our study, 13.33% were resistant to vancomycin, 21.05% to gentamicin, 94.12% to penicillin G, 88.89% to ampicillin, 77.78% to cefotaxime, 63.63% to kanamycin, and 52.63% to erythromycin. **Conclusion:** This study revealed, as in other studies, that Enterobacteriaceae strains remain the most incriminated bacteria strains in urinary tract infections, with a strong resistance to antibiotics. It is important that actions be taken to reduce the incidence of urinary tract infections and mitigate the spread of resistant bacteria.

Keywords

Urinary Tract Infections, Enterobacteriaceae, Antibiotic Resistance, Ouagadougou

1. Introduction

Urinary tract infections (UI) are due to the presence of a pathogenic bacterium within the patient's urinary tract [1]. They are the most common bacterial infections that pose a significant burden on public health, due to their very high frequency, their peak cost of treatment, and multiple treatment failures due to multi-resistance [2]. The bacteria in question are generally Enterobacteriaceae, with *Escherichia coli* as the main bacterium [3]. UIs are common in both hospital and community settings and affect all age groups (children, adults, and the elderly), with women as the predominant group. They occupy an important place among the reasons for consultation and prescription of antibiotics, second only to respiratory infections [4]. In Mali, Sissoko, during his study on urinary tract infections, obtained a prevalence of 27.6% [5]. In Burkina Faso in 2002, according to a study carried out, using 330 samples at the maternal and child health service of the Saint Camille Hospital, the prevalence of urinary tract infections was 18.5% [6]. In other studies in Burkina Faso, the respective prevalences of 27.5% and 30% have been reported [7] [8]. All these studies show the extent of urinary tract infections. Nowadays, the emergence and dissemination of bacterial resistance pose a public health problem to which Burkina Faso is not immune. The consequence of this phenomenon is an increase in morbidity and mortality. It is therefore necessary to know the bacteria strains frequently isolated in urinary tract infections and their susceptibility to antibiotics. It is with this in mind that this work was initiated in Ouagadougou, precisely at the National Public Health Laboratory (LNSP).

2. Materials and Methods

2.1. The Site, Period, and Type of Study

This was a retrospective and prospective study of the descriptive type carried out in the Bacteriology-Virology department of the National Public Health Laboratory (LNSP) in Ouagadougou, Burkina Faso. The retrospective study was extended over a period of 2 years (from January 2018 to December 2019), and the prospective study was extended over a period of 6 months (from January to June 2020). The study, therefore, covered the period from January 2018 to June 2020 (2 years and 6 months).

2.2. Inclusion and Non-Inclusion Criteria

The study population was patients who came to the LNSP for a cytobacteriological examination of urine (ECBU), without distinction of sex and age.

Any patient with a well-informed report and urine samples under the conditions indicated for an ECBU was taken into account, and any patient whose urine samples were not under the conditions indicated for the ECBU or who brought a sample of urine for a study other than the cytobacteriological study was excluded from the study.

2.3. Data Gathering

The information gathered for this study was primarily the patient's age, gender, and examination results. Data collection was done on sheets using the laboratory register.

2.4. Cytobacteriological Examination of Urine

On direct examination, the macroscopic appearance of the non-centrifuged urine was first assessed. Then the examination of the urine in the fresh state before and after centrifugation (microscopic examination) looked for figurative elements: leukocytes, red blood cells, bacteria, parasites, yeasts, epithelial cells, cylinders, and crystals. Gram staining was used and made it possible to account for the morphology of the bacteria and their tinctorial affinity.

On examination after culture, the urine was inoculated onto selective and non-selective agar media (Cystine-Lactose Electrolyte Deficient (Himedia, India) and Eosin Methylene Blue (Himedia, India) agar). Identification of gram-negative bacilli was made on suspect colonies using the API 20E gallery. For gram-positive cocci, we used the following characters: positive catalase, positive culture on Chapman (Himedia, India), DNAse and coagulase tests for the identification of *Staphylococci*, and when the bacteria strain was a *Streptococcus* or *Enterococcus*, a culture on esculin bile medium (Biomerieux Marcy Etoile, France) (specific for *Enterococci*) was performed, as well as a serology test.

The antibiotic susceptibility was carried out by the method of diffusion of discs on Muller-Hinton agar and interpretation was made using the EUCAST-2015 standard. Also, the reference *E. coli* strain ATCC 25922 was included during the antibiotic susceptibility testing in order to perform internal quality control.

2.5. Statistical Analysis

Statistical analysis was performed using the Excel 2013 spreadsheet. The different rates were compared using the Chi-squared statistical test. The significance level (α) is 0.05. Statistical differences with a probability value of less than 0.05 are considered significant. When the probability is greater than 0.05, the statistical differences are not significant.

2.6. Ethical Issues and Protection of the Participants

The study received ethical approval from the Ethics Committee for Health Research (CERS) of Burkina Faso. In addition to the consent for participation, individual consent was obtained for sample collection for further research.

3. Results

3.1. Sociodemographic Characteristics

A total of 187 urine samples taken from patients with urinary tract infections were analyzed during our study. These samples came from 82 men and 105 women, with respective proportions of 43.85% and 56.15% (a sex ratio of 0.78). Table 1 presents the distribution of urinary tract infections according to sex and age.

The patients were aged between zero and eighty-seven years [0; 87]. The average age of the patients was 45.64 years. In women, the most affected age groups were those of [30, 45] and 55 years old, and in men, the age group ≥55 was the most affected.

3.2. Bacteriological Considerations

3.2.1. Isolated Bacterial Diversity

The different bacteria isolated from the urine of the patients are shown in Table 2. A total of 187 bacteria were isolated, with a predominance of Enterobacteriaceae representing 77.54% of the isolates. *Escherichia coli* was the most frequent (48.66%), followed by *Klebsiella* (20.86%), *Enterobacter* (5.88%), *Citrobacter* and *Morganella* (1.07%). Gram-positive cocci accounted for 12.83% of isolates, of which 6.95% were *Staphylococci*, 5.88% were *Enterococci,* and *Neisseria*

Table 1. Distribution of urinary tract infections (UTI) according to age groups and sex.

Age	Sex				Total
	Women		Men		
	N	%	N	%	
[0; 15[	16	8.56	7	3.74	23
[15; 30[	21	11.23	4	2.14	25
[30; 45[	29	15.51	10	5.35	39
[45; 55[	13	6.95	9	4.81	22
[55; 87[	26	13.90	52	27,81	78
Total	105	**56.15**	82	**43.85**	187

Table 2. Distribution of isolated bacteria

Bacteria strains (N = 187)	Isolated bacteria	Number (N)	Percentage (%)
Enetrobacteriaceae (N = 145)	*E. coli*	91	48.66
	Klebsiella	39	20.86
	Enterobacter	11	5.88
	Citrobacter	2	1.07
	Morganella morganii	2	1.07
Non-fermentative GNB (N = 17)	*Pseudomonas aeruginosa*	2	1.07
	Acinetobacter baumanii	15	8.02
GPC (N = 24)	*Staphylocoques*	13	6.95
	Enterococci	11	5.88
Others (N = 1)	*Neisseria gonorrhoeae*	1	0.53

Legend: N: number, %: percentage, GNB: Gram-negative bacilli, GPC: Gram-positive cocci.

gonorrhea accounted for 0.53%. The frequency of non-fermentative gram-negative bacilli was 9.08%, including 1.06% of *Pseudomonas* and 8.02% of *Acinetobacter*.

3.2.2. The Resistance Profile of Isolated Enterobacteriaceae

The results of the Enterobacteriaceae strains' antibiotic susceptibility testing are presented in Table 3.

The results show that all Enterobacteriaceae strains isolated have low rates of resistance to antibiotics such as Colistin (5.85%), imipenem (8.75%), Amikacin (25.59%), and gentamicin (25%). In contrast, we noted a high level of resistance of Enterobacteriaceae strains to commonly used beta-lactam antibiotics (amoxicillin (100%), amoxicillin-clavulanic acid (98.75%), cefotaxime (65.77%), and aztreonam (57.53%)), quinolones (norfloxacin and ciprofloxacin, respectively, 54.05% and 58.98%), and sulfonamides (cotrimoxazole 75.67%).

3.2.3. Antibiotic Resistance Profile of Non-Fermentative Gram-Negative Bacilli

The resistance results of the non-fermentative gram-negative bacilli are recorded in Table 4.

- Resistance to amoxicillin (100%), amoxicillin + clavulanic acid (93.30%), ceftazidime (94.11%), and cotrimoxazole (66.66%) was obtained with *Pseudomonas aeruginosa* strains. However, these bacteria were less resistant to colistin, amikacin (0%), imipenem (11.77%), gentamicin (13.34%), norfloxacin (14.29%), and ciprofloxacin (18.79%).
- The strains of *Acinetobacter baumanii* strains isolated had a very high rate of resistance to most of the antibiotics tested. The resistance rate was 0% for colistin and amikacin. The strains were resistant to cotrimoxazole (14.29%), ciprofloxacin (21.43%), gentamicin (85.71%), and norfloxacin (83.33%).

Table 3. Resistance profile of Enterobacteriaceae strains isolated.

Antibiotic tested	S(n)	R + I(n)	% S(n)	% R + I(n)
AML	0	160	0	100
AUG	2	158	1.25	98.75
CTR	52	56	48.14	41.76
CAZ	87	66	34.64	43.14
CIP	75	78	49.01	50.09
CS	145	9	94.15	5.84
AK	72	21	77.41	22.58
IMP	146	14	91.25	8.75
GN	120	40	75	25.0
NOR	68	80	45.75	54.05
CTX	51	98	34.69	65.77
COT	19	56	12.75	75.67
ATM	62	84	42.46	57.53

Legend: N: number; %: percentage S: sensitivity; R: resistance; R + I; resistance + intermediate; AML: Amoxicillin, AUG: Amoxicillin + clavulanic acid, ATM: Aztreonam, CAZ: Ceftazidim, COT: Cotrimoxazole, CTX: Cefotaxime, CTR: Ceftriaxone, CIP: Ciprofloxacin, CS: Colistin Sulfate, AK: Amikacin, IMP: Imipenem, GN: Gentamicin, NOR: Norfloxacin.

Table 4. Profile of antibiotic susceptibility test of non-fermentative Gram-negative bacilli strains.

Antibiotiques	*Acinetobacter baumanii*		*Pseudomonas aeroginosea*	
	S	R + I	S	R + I
AML	0	100	0	100
AUG	0	100	7.69	93.3
CTR	7.14	92.85	6.25	93.75
CAZ	7.14	92.85	5.88	94.11
CIP	78.57	21.43	81.25	18.75
CS	100	0	100	0
AK	100	0	100	0
IMP	86.67	13.33	88.23	11.76
GN	85.71	14.29	86.66	13.33
NOR	83.33	16.67	85.71	14.28
TTC	30	70	27.27	72.72
COT	85.71	14.2 9	33.33	66.66

Legend: AML: Amoxicillin, AUG: Amoxicillin + clavulanic acid, CAZ: Ceftazidim, COT: Cotrimoxazole, CTR: Ceftriaxone, CIP: Ciprofloxacin, CS: Colistin Sulfate, AK: Amikacin, IMP: Imipenem, GN: Gentamicin, NOR: Norfloxacin, TTC: Ticarcillin + clavulanic acid

3.2.4. Cocci Resistance Pattern

In general, high cocci resistance rates were observed with penicillin G (94.12%), ampicillin (88.89%), cefotaxime (77.78%), kanamycin (63.63%), and erythromycin (52.63%).

The *Staphylococcus aureus* strains tested were resistant to penicillin, cotrimoxazole, oxacillin, and amoxicillin (100%), gentamycin (66.66%). However, they were resistant to clindamycin (00%) and erythromycin (27.28%) (**Figure 1**).

Enterococci ssp. strains showed 100% resistance to amoxicillin and erythromycin. On the other hand, 33.33% were resistant to vancomycin. Regarding aminoglycosides, we noticed that 28.57% were resistant to gentamicin and 0% to amikacin (**Figure 2**).

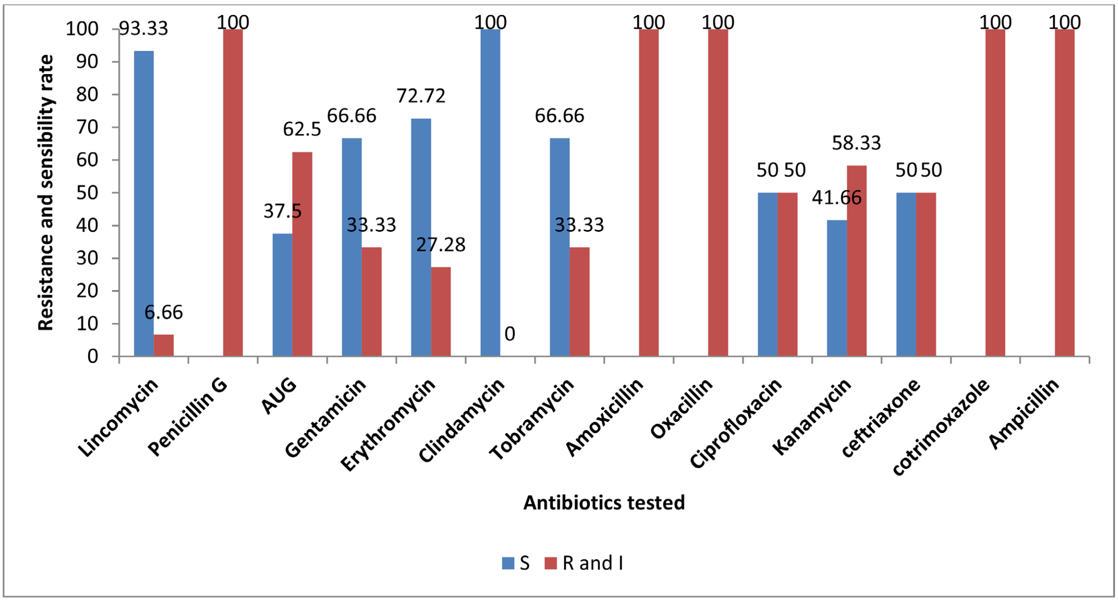

Figure 1. *Staphylococcus aureus* strains susceptibility profile.

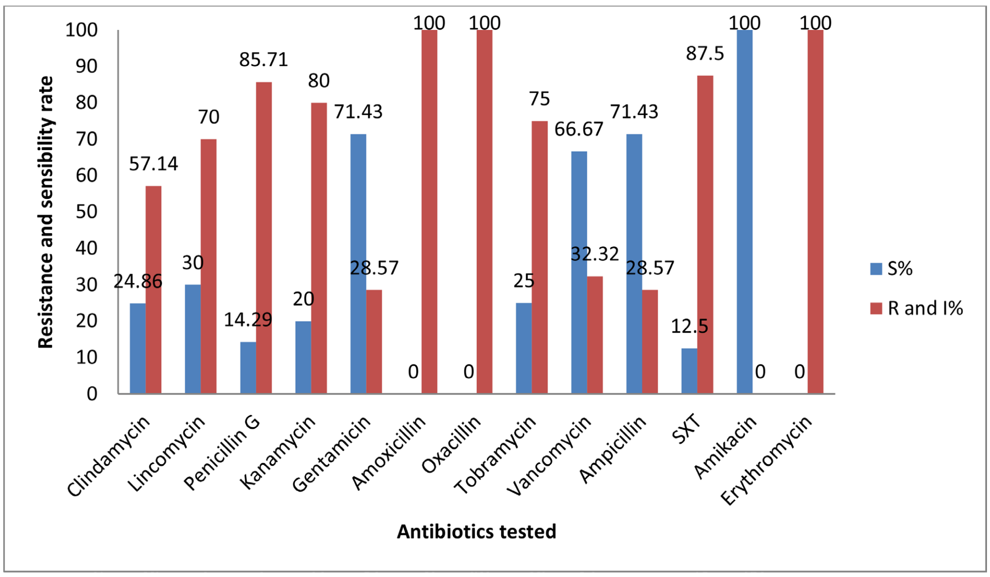

Figure 2. *Enterococcus* bacteria strains susceptibility profile.

4. Discussion

In our study, 56.15% of women had UI compared to 43.85% of men. Women were, therefore, more affected than men. Similar results were reported by Santos *et al.* in Brazil, who found 79.6% female versus 20.4% male during their study [9]. Also, Benhiba and collaborators in 2015, during their study on the epidemiology and antibiotic resistance of urinary tract infections in Marrakech, observed a sex ratio of F/M = 1.12 [3]. The proximity of the terminal digestive tract and the urogenital system associated with a short urethra could explain the predominance of UTIs in female individuals. In addition, the vagina has commensal flora that could be pathogenic to the urinary tract. Also, wiping the anus behind and forward after defecation promotes infection by germs found in the feces. In addition, not urinating after unprotected sex could be a favorable factor for urinary tract infections [10]. In his same study, Kj and collaborators reported proportions of 72.38% of women who had problems with urinary tract infections compared to 27.32% of men [10]. The same observation was made by Ouédraogo and collaborators in Burkina Faso in 2012, with 55% of women presenting with a urinary tract infection compared to 45% of men [11].

The average age of the patients was 45.64 years. In women, the most affected age groups were those of [30; 45[and ≥55 years old, and in men, the age group ≥55 was the most affected. Our results are similar to those of Sissoko in 2006 in Mali, who, during their study of urinary tract infections in Bamako, found that the age ranges of [16 - 35] and [36 - 65] in women and the age group of [36 - 60] in men were the most affected [5]. Our results could be explained by the fact that in women, the age groups of 30 and 45 are the most sexually active. There are also certain phenomena that could explain this result, such as pregnancy, the use of contraceptives, and the use of tampons during menstruation, which would increase the risk of urinary tract infection [12]. The high frequency of UI in the age group of 55 years would be linked to the phenomenon of menopause, which would lead to an imbalance of hormonal flow (lack of estrogen), and the loss of *lactobacilli* in the vaginal flora.

In men, the high frequency of UI in the age group of 55 years is thought to be due to benign prostatic hypertrophy or inflammation that prevents the bladder from emptying completely. During our study, the bacteria identified were Enterobacteriaceae strains (77.54%). *Escherichia coli* was the most common (48.66%).

Our findings are consistent with those of Sanou *et al.* from Burkina Faso, who found 66.67% Enterobacteriaceae, 65.38% *E. coli*, and 11.53% *Klebsiella* [13]. Also, our results corroborate those of Kj and collaborators in the DRC, who obtained a high number of Enterobacteriaceae (66.66%) with a predominance of *E. coli* (40.28%), followed by *Enterococcus* (15.28%), *Staphylococcus aureus* (12.04%), and *Pseudomonas aeruginosa* (6.02%).

The ascending physiopathology of UI as well as the strong colonization of the perineum by Enterobacteriaceae *strains* of digestive origin, associated with specific factors of uropathogenicity such as bacterial adhesins capable of binding to the urinary epithelium, could explain this predominance [14] [15].

The high frequency of *E. coli* could be explained by the pathophysiological mechanism of urinary tract infection, occurring essentially by the ascending route. *E. coli* is the most dominant species in the intestinal flora and can easily migrate to the urinary tract. In addition, *E. coli* is part of the fecal coliforms, so improper cleaning of the private parts can easily cause the bacteria to enter the urinary tract [10].

Regarding the resistance of Enterobacteriaceae strains to antibiotics, we observed that the isolated strains were in 100% of cases resistant to amoxicillin, to amoxicillin + clavulanic acid in 98.75% of cases, to cefotaxime in 65.77% of cases, and to aztreonam in 57.53% of cases. Our results are similar to those of Lahlou and collaborators [16] in Morocco, who noted a high frequency of resistance of community-acquired and nosocomial Enterobacteriaceae to beta-lactams with respectively 80% and 70% resistance to amoxicillin and amoxicillin + clavulanic acid for community strains and respectively 70% and 90% resistance to amoxicillin and ampicillin for nosocomial strains. Other studies, such as those by Zampaligré in 2012, Taale and collaborators in 2018 in Burkina Faso [7] [17], Touré and collaborators in 2012 in Mali [18], obtained resistance rates of 93.8%, 93.75%, 91%, and 66.67% respectively for *E. coli* to amoxicillin; and also resistance rates of 80%, 86.67%, 74%, and 23.53%, respectively, of *E. coli* to amoxicillin + clavulanic acid. These results reflect the extent of the resistance of this bacterium to beta-lactams. In the study by Taale *et al.*, a resistance rate to *Klebsiella pneumoniae* 100% was obtained for amoxicillin and amoxicillin + clavulanic acid. Regarding the resistance profile of Enterobacteriaceae to cefotaxime and aztreonam in our study, resistance rates of 65.77% and 57.53%, respectively, were obtained.

The high rate of resistance of Enterobacteriaceae strains to beta-lactams is mainly due to the production of beta-lactamases, which constitutes a very effective resistance mechanism. Indeed, beta-lactamases are produced by bacteria that inactivate beta-lactams by hydrolytic action, and this is the most widespread mechanism of bacterial resistance to antibiotics with a beta-lactam nucleus [19]. In addition, the abusive and inappropriate use (self-medication, incomplete treatment, and non-compliance with dosages) of certain antibiotics in developing countries and mainly in our country would contribute to the development of resistance [20] [21]. Indeed, in these countries, it is possible to obtain antibiotics without a medical or veterinary prescription, and patients under the effect of pain resort to self-medication for infections such as rum, cough, and diarrhea.

During our study, imipenem was the most active antibiotic against Enterobacteriaceae strains (91.25%). Resistance rates were 0% and 3.04% for *E. cloacae* and *K. pneumoniae*, respectively. In their study, Moutachakkir [22] in Morocco and Zampaligré in Burkina Faso, obtained a resistance rate of 0% and 33.4%, respectively, to imipenem. In Moutachakkir's study, no resistance (0%) to imipenem was observed with strains of *Enterobacter cloacae* while a resistance of 2.46%

was observed with strains of *Klebsiella pneumonia*e.

Compared to the behavior of Enterobacteriaceae strains toward aminoglycosides, most of the strains tested in our study were less resistant to aminoglycosides (Gentamicin: 25% and Amikacin: 22.59%). Our results are lower than those found by Moutachakkir and collaborators in Marrakech (gentamicin 17% and amikacin 1%) and those found by Zampaligré in Burkina Faso (gentamicin 24.6% and amikacin 95%).

In the present study, the resistance rates of Enterobacteriaceae strains to ciprofloxacin and norfloxacin were 58.98% and 54.05%, respectively. Specifically, a ciprofloxacin resistance rate of 67.05% was obtained with *E. coli* and 67.85% with norfloxacin. In other studies, low resistance rates to ciprofloxacin were obtained in *E. coli* [18] [22], *i.e.*, 43% and 12%, respectively. These high rates could be explained by the massive prescription of this molecule in our health facilities. Other authors, such as Vellinga *et al.*, reported in their study in Ireland that ciprofloxacin is the most prescribed molecule [23] in town.

Klebsiella oxytoca, Klebsiella ornithinolytica, and *Citrobacter frendii* strains showed resistance (100%) to ciprofloxacin. Thus, ciprofloxacin was ineffective against most Enterobacteriaceae. The best activity of this molecule was obtained on *Klebsiella pneumoniae* (66.67%), *Enterobacter cloacae* (77.77%), and *Morganella morganii* strains (50%).

In the present study, a high resistance rate of Enterobacteriaceae strains (75.67%) was obtained to cotrimoxazole.

In relation to these results, one could say that the high resistance rates of Enterobacteriaceae strains to sulfonamides would be due to the fact that this antibiotic is used in the treatment algorithm for opportunistic infections in HIV patients. This could therefore lead to antibiotic misuse [24].

Pseudomonas aeruginosa strains were found to be resistant to imipenem (11.77%), gentamicin (13.34%), norfloxacin (14.29%), ciprofloxacin (18.79%), ceftazidime (94.11%), and cotrimoxazole (66.66%).

As for *Acinetobacter baumanii*, the strains were resistant to cotrimoxazole (14.29%), ciprofloxacin (21.43%), gentamicin (14.29%), and norfloxacin (16.67%).

Bacterial resistance to antibiotics concerns both gram-negative and gram-positive bacteria. In our study, the gram-positive bacterial strains tested were resistant to penicillin (100%). According to Berger-Bachi, penicillinases are produced by 80% of *S. aureus* isolates and are the most widely distributed mechanism in the microbial world [25]. As for erythromycin and clindamycin, low resistance rates of 0% and 27.28% were obtained. These results give hope for the treatment of *S. aureus* infections. In addition, high rates of resistance were obtained during our study (66.66%) with aminoglycosides such as gentamicin and sulfonamides such as cotrimoxazole (100%). It is noted in the light of these results that, contrary to the work of these authors, the *Staphylococcus aureus* strain has developed resistance to many antibiotics. This could be explained by the anarchic use of antibiotics locally, the poor storage of antibiotics, and the under-dosage of certain antibiotics [10].

Regarding the resistance of *Enterococcus* (**Figure 2**), we obtained in our study similar results to those reported by Mebarkia and Daoudi in Algeria in 2016, where they noted high rates of resistance to amoxicillin and erythromycin (42.86% each) [26]. Similarly, these authors noted the good activity of antibiotics such as amikacin, clindamycin, and vancomycin.

At the end of this study, we can identify the limitations at two levels: 1) First, like any retrospective study, there are variables that were not taken into account, such as taking medication; 2) antibiotic resistance genes have not been studied to understand their circulation.

5. Conclusions

Through our study, we were able to identify the bacteria strains involved in urinary tract infections in patients at the LNSP in Ouagadougou and study their antibiotic susceptibilities. The data showed that the prevalence of urinary tract infections among the patients received at the LNSP was very high, with a predominance of the female sex (sex ratio F/M = 0.78). The most encountered bacteria strains were Enterobacteriaceae, with *E. coli* and *Klebsiella* in mind. This study also allowed us to measure the extent of the phenomenon of antibiotic resistance to bacteria isolated in urinary infections. Enterobacteriaceae strains showed strong resistance to beta-lactams, quinolones, and sulfonamides. Cocci also showed strong resistance to clindamycin, kanamycin, and erythromycin.

In view of the alarming problem of the resistance of uropathogens to antibiotics, awareness must be raised. The best ways to fight against urinary tract infections are prevention through population hygiene measures, carrying out antibiotic susceptibility testing before taking care of patients, respecting the prescription of antibiotics, and raising awareness to avoid self-medication at the health center level.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

[1] Isnard, C. (2015) Infections du tractus urinaire à pathogènes émergents. *Journal des Anti-Infectieux*, **17**, 152-161. https://doi.org/10.1016/j.antinf.2015.10.002

[2] Moukrad, N., Filali, F.R. and Makoudi, Y. (2012) Prévalence de la multi-résistance bactérienne aux antibiotiques des infections urinaires dans la ville de Meknès (Ma-

roc) et son évolution dans le temps. *Science Lib Editions Mersenne*, **4**, 1-17.

[3] Benhiba, I., Bouzekraoui, T., Zahidi, J., Noureddine, E., Said, L.A., Warda, K. and Zahlane, K. (2015) Epidémiologie et antibiorésistance des infections urinaires à entérobactéries chez l'adulte dans le CHU de Marrakech et implication thérapeutiques. *Uro'Andro*, **1**, 166-171.

[4] Akpabie, A. and Prieur, B. (2001) Germes urinaires et leur sensibilité aux antibiotiques en gériatrie. *Médecine et Maladies Infectieuses*, **31**, 461-467. https://doi.org/10.1016/S0399-077X(01)00247-5

[5] Sissoko, M.T. (2006) Infections Urinaires A Bamako: Aspects Épidémiologiques, Bactériologiques et Cliniques. Thèse de doctorat, Université de Bamako, Bamako, 103 p.

[6] Nikiema, A. (2002) Aspects épidémiologiques et bactériologiques des infections urinaires chez la femme enceinte au Service de Santé Maternelle et Infantile du Centre Médical Saint Camille de Ouagadougou. Thèse de doctorat, Université de Ouagadougou, Ouagadougou, 133 p.

[7] Taale, E., Sanou, S., Sangare, I., Abdelkerim, A.D., Mbatna, A., Sirima, C. and Savadogo, A. (2016) Urinary Tract Infection among Pregnant Women at Bobo-Dioulasso: Epidemiological and Bacteriological Aspects. *Journal of Fundamental and Applied Sciences*, **8**, 1132. https://doi.org/10.4314/jfas.v8i3.26

[8] Nana, W.F., Hervé, H., Ouili, S., Tall, I., Samia, L., Saizonou, J., Ouendo, E.M. and Drabo, K. (2018) Aspects épidémiologiques et thérapeutiques de l'examen. *Revue Bio-Africa*, **18**, 12-16.

[9] Santos, J.C., Weber, L.P. and Perez, L.R.R. (2007) Evaluation of Urinalysis Parameters to Predict Urinary-Tract Infection. *Brazilian Journal of Infectious Diseases*, **11**, 479-481. https://doi.org/10.1590/S1413-86702007000500008

[10] Kj, M., Ke, T. and Mv, N. (2020) Profil Bactériologique Des Infections Urinaires Diagnostiquées Aux Cliniques Universitaires De Lubumbashi-RDC. *Journal of Dental and Medical Sciences*, **19**, 1-8.

[11] Ouédraogo/Yugbaré, S.O., Kouéta, F., Dao, L., Minoungou, J., Ouédraogo/Traoré, R., Sanou, I. and Yé, D. (2012) Infection du tractus urinaire chez l'enfant: Aspects épidémiologiques et bactériologiques au Centre Hospitalier Universitaire pédiatrique Charles De Gaulle de Ouagadougou (Burkina Faso). *Mali Médical*, **4**, 11-17.

[12] Debré, B., Saighi, D. and Peyromaure, M. (2004) Urologie. Masson, Paris, 191 p.

[13] Sanou, R. (2019) Identification et profil de résistance aux antibiotiques de quelques souches d'entérobactéries et de cocci, responsables d'infections du tractus urinaire au Centre Hospitalier Régional de Dédougou, (Burkina Faso). Mémoire de master, Université de Ouagadougou, Ouagadougou, 64 p.

[14] Ferjani, A., Mkaddemi, H., Tilouche, S., Marzouk, M., Hannechi, N., Boughammoura, L. and Boukadida, J. (2011) Caractéristiques épidémiologiques et bactériologiques des bactéries uropathogènes isolées dans un milieu pédiatrique. *Archives de Pédiatrie*, **18**, 230-234. https://doi.org/10.1016/j.arcped.2010.09.024

[15] Larabi, K., Masmoudi, A. and Fendri, C. (2003) Étude bactériologique et phénotypes de résistance des germes responsables d'infections urinaires dans un CHU de Tunis: À propos de 1930 cas. *Médecine et Maladies Infectieuses*, **33**, 348-352. https://doi.org/10.1016/S0399-077X(03)00180-X

[16] Lahlou Amine, I., Chegri, M. and L'Kassmi, H. (2009) Épidémiologie et résistance aux antibiotiques des entérobactéries isolées d'infections urinaires à l'hôpital militaire Moulay-Ismail de Meknès. *The Journal of Antibiotics*, **11**, 90-96. https://doi.org/10.1016/j.antib.2008.10.004

[17] Zampaligré, I. (2012) Profil de sensibilité aux antibiotiques des souches de *Escherichia coli* isolées de 2007 à 2011 au Centre Hospitalier Universitaire Pédiatrique Charles De Gaulle (Ouagadougou, Burkina Faso). Thèse de doctorat, Université de Ouagadougou, Ouagadougou, 132 p.

[18] Touré, A. (2012) Infections Urinaires et grossesse au centre de santé de référence de la commune II (CSREFC II). Thèse de doctorat, Université de Bamako, Bamako, 68 p.

[19] Livermore, D.M. (1995) β-Lactamases in Laboratory and Clinical Resistance. *Clinical Microbiology Reviews*, **8**, 557-584. https://doi.org/10.1128/CMR.8.4.557

[20] Kaboré, W., Faye, B., Konaté, A., Boirasmé, S., Ouédraogo, D., Traoré, A.S., Barro, N. and Sangaré, L. (2018) Etude de la prévalence et de la sensibilité aux antibiotiques de *Streptococcus* et Staphylococcus isolés des parodontites apicales à Ouagadougou, Burkina Faso. *Revue Internationale du Collège d'Odonto-Stomatologie Africain et de Chirurgie Maxillo-Faciale*, **25**, 24-29. https://www.revues-ufhb-ci.org/fichiers/FICHIR_ARTICLE_2884.pdf

[21] Garba, A.-A., Doutchi, M., Maman, L., Hassan, D., Aboubacar, I., Alkassoum, I. and Adehossi, E.(2020) Étude Bactériologique des Infections Urinaires chez l'Adulte au Laboratoire de Microbiologie de l'Hôpital National de Zinder. *Health Sciences and Diseases*, **21**. https://www.hsd-fmsb.org

[22] Moutachakkir, M., Chinbo, M., Elkhoudri, N. and Soraa, N. (2015) La résistance aux antibiotiques chez les entérobactéries uropathogènes en milieu pédiatrique au CHU de Marrakech. *Journal de Pédiatrie et de Puériculture*, **28**, 16-22. https://doi.org/10.1016/j.jpp.2014.10.007

[23] Vellinga, A., Tansey, S., Hanahoe, B., Bennett, K., Murphy, A.W. and Cormican, M. (2012) Trimethoprim and Ciprofloxacin Resistance and Prescribing in Urinary Tract Infection Associated with *Escherichia coli*: A Multilevel Model. *Journal of Antimicrobial Chemotherapy*, **67**, 2523-2530. https://doi.org/10.1093/jac/dks222

[24] Diallo, I. (2003) Traitement antirétroviral à Ouagadougou chez 71 patients suivis pendant 1 an: Modalités-Résultats-Limites. Thèse de doctorat. Université de Ouagadougou, Ouagadougou, 135 p.

[25] Berger-Bachi, B. (1997) Résistance aux bétalactamines. *Médecine et Maladies Infectieuses*, **27**, 195-200. https://doi.org/10.1016/S0399-077X(97)80020-0

[26] Mebarkia, R. and Daoudi, H. (2016) Prévalence des infections urinaires dans la commune deTébessa. Université de Larbi Tébessi-Tébessa, Tébessa, 93 p.