

Urinary tract infection and antimicrobial resistance profile in patients attending Nemba District Hospital in Rwanda



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ABSTRACT

Background: About 150 million people worldwide are diagnosed with urinary tract infection (UTI) every year and more than half of women get UTI at least once in their lifetimes. Overuse and misuse of antibiotics have contributed to the growing problem of resistance amongst uropathogenic bacteria making it hard to treat. **Aims and Objectives:** This study aimed to determine bacteria causing UTIs and their antibiotic resistance profile among patients attending Nemba District Hospital in Rwanda. **Materials and Methods:** A retrospective study design was used and 267 patient's data with positive urine culture were reviewed from microbiology laboratory logbooks. **Results:** In this study, UTI was more frequent in female 180(67.4%) than male 87(32.6%). The most frequently isolated bacteria to cause UTI were *Escherichia coli* (56.93%) followed by *Staphylococcus aureus* (28.46%), *Proteus* spp. (4.49%), *Klebsiella* spp. (3.75%), *Morganella morganii* (1.87%), *Coagulase Negative Staphylococcus* (1.50%), *Neisseria gonorrhoea* (1.12%), *Enterobacter* spp. (1.12%) and *Citrobacter* spp. (0.7%). There was a high antimicrobial resistance profile among bacterial isolates. The most commonly used antimicrobial agents including third-generation cephalosporin were resistant to bacterial isolates at a higher rate. **Conclusion:** These findings suggest continued antimicrobial resistance surveillance and special precautions should be taken for empirical treatment referring to local antimicrobial resistance.

Key words: Bacterial isolates; Antimicrobial resistance; Urinary tract infection

INTRODUCTION

Urinary tract infection (UTI) is among the common infections, nearly 10% of people experience it during their lifetime. UTI may be symptomatic or asymptomatic, community, or hospital acquired and can result in serious sequelae if left untreated.¹ Although several different microorganisms can cause UTIs, bacteria are the major causative organisms and are responsible for more than 95% of UTI cases.²

Bacterial UTI is primarily caused by Gram-negative bacteria³ even Gram-positive pathogens are also involved.⁴ More than 95% of uncomplicated UTIs are monobacteria infection⁵ and the most common pathogen responsible for it, are *Escherichia. Coli (E.coli)* (75%–95%), followed by *Klebsiella pneumoniae*, *Staphylococcus saprophyticus*, *Enterococcus faecalis*, group B streptococci, and *Proteus mirabilis*. *E. coli* can cause both uncomplicated and complicated UTIs while *P. mirabilis*, *Pseudomonas aeruginosa* and *Enterococcus*

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spp.primarily cause complicated infections and are more commonly isolated in hospitals and long-term care facilities.⁶

Millions of people worldwide are affected by urinary tract infections every year.⁷There is a high increase in the prevalence of UTIs in Africa especially in sub-Saharan countries.^{7,8}In Rwanda, the previous study conducted in patients attending Butare University Teaching Hospital (BUTH) and Kigali University Teaching Hospital (KUTH) found that *E. coli* was the most common uropathogenic accounting 60.7% of UTI cases and frequently occurred in outpatients (70.6%).⁹

The introduction of antibiotic therapy has played an important role in the management of UTIs. However, the major problem with current antimicrobial therapy is the rapid emergence of antibiotic resistance in both hospital and community acquired UTI cases. Antimicrobial sensitivity testing (AST) was found to be a solution and reliable guidance to antimicrobial therapy. Unfortunately, the low-income countries do not have a well-equipped and functioning microbiology laboratory to perform AST. In addition, turnaround time (TAT) of AST results is longer and cannot serve emergency cases. Thus, empirical treatment has become routine practice and the only solution especially in sub-Saharan countries. However, treatment failure associated to increased antimicrobial resistance is emerging.^{5,10}

Initial appropriate empirical treatment requires a good knowledge of local and global epidemiological data; unfortunately, most of Sub-Saharan countries lack continued surveillance. Moreover, emergency and continuing antibiotic resistance phenomenon pose great challenge on empirical treatment, and pathogen spectrum resistance rates vary according to the geographical setting, suggesting continued and regular antimicrobial resistance monitoring to improve and revise empirical treatment guidelines.^{2,7} It is in this regard, this study aimed to determine the most common bacteria causing UTIs and their antimicrobial resistance profile in patients attending Nemba District Hospital in Rwanda.

MATERIAL AND METHODS

Study setting and design

This study was conducted in the Northern Province of Rwanda, Gakenke District at Nemba District Hospital. It was a retrospective study design and data were collected from archived urine culture results logbook in the microbiology laboratory unit of Nemba District Hospital.

Data collection

Data were collected from 1st July 2017 up to 30th June 2019 and only positive urine culture cases were taken into consideration. Retrospectively, from microbiology logbooks, a total number of 267 cases suspected of having UTI with positive urine culture were included in the study.

Data analysis

Data were entered into Microsoft Excel and exported in SPSS version 22 for frequencies and percentages calculation. Data were presented in tables and figures.

Ethical considerations

The researcher handled all patients' data gathered in this study confidentially. Furthermore, laboratory anonymous coding was used to hide the identity of patients. Ethical clearance was obtained from the institutional review board of INES Ruhengeri and was presented to the administration of Nemba District Hospital for approval. Before starting data collection, an acceptance letter was given to the researcher from Nemba District Hospital administration.

RESULTS

Characteristics of the study participants

The current study has recruited 267 participants including 180(67.4%) female and 87(32.6%) male. The mean age of the participants was 43.7(±20.3) years of age. The age groups of ≥15 years were 23(8.6%), 15-35 years were 78(29.2%), 36-50 years were 81(30.3%), while the participants ≥50 years were 85(31.9%) (Table 1).

Frequency of bacterial isolates

E. coli was the most isolate 152 (57.0%) followed by *S. aureus* 76 (28.4%), *Proteus* spp. 12 (4.4%), *Klebsiella* spp. 10 (4.0%), *Morganella morganii* 5 (2.0%), *Coagulase Negative*

Table 1: Demographic characteristics of the study participants

Variables	Frequency (%)		
Females	180 (67.4)		
Males	87 (32.6)		
Mean age	43.7(±20.3)		
Age groups	Female	Males	Total
≥15 Years	16 (6.0)	7 (2.6)	23 (8.6)
15-35 years	60 (22.5)	18 (6.7)	78 (29.2)
36-50 years	52 (19.5)	29 (10.9)	81 (30.3)
≥50 years	52 (19.5)	33 (12.4)	85 (31.9)
Total	180 (67.4)	87 (32.6)	267 (100)

Demographic characteristics of study participants: Data are presented as frequency (%) unless otherwise indicated. N=267

Staphylococcus (CNS) 4 (1.50%), *Neisseria gonorrhoeae* 3 (1.1%), *Enterobacter* spp. 3 (1.1%) and *Citrobacter* spp. 2 (0.7%) (Figure 1). In addition, Gram Negative isolates accounted 187(70%) while Gram Positive isolates were 80(30%) (Figure 2).

Antimicrobial resistance profile of bacterial isolates

The main Gram negative isolates were *Escherichia coli* and *Klebsiella* spp and exhibited antimicrobial resistance as following: E.coli was resistant to Gentamicin 28.3%, Ciproflaxacin 13.1%, Norflaxacin 31.6%, Ampicillin 79.6%, Oxacillin (80.9%), Tetracycline (50%), Cefotaxime (20.4), Doxycycline (65.1%), Erythromycin (83.6%), Naladixic Acid (31.6). *Klebsiella* spp was resistant to Gentamicin (40%), Ciproflaxacin (20%), Norflaxacin (30%), Ampicillin (90%), Oxacillin (80%), Tetracycline (40%), Cefotaxime (40%), Doxycycline (70%), Erythromycin (100%), Naladixic Acid (10%). The main Gram Positive isolate were *S.aureus* and were resistant to: Gentamicin (26.3%), Ciproflaxacin (19.7%), Norflaxacin (32.9%), Ampicillin (78.9%), Oxacillin (64.5%), Tetracycline (65.8%), Cefotaxime (27.6%), Doxycycline (59.3%), Erythromycin (86.9%), Naladixic Acid (30.3%) (Table 2).

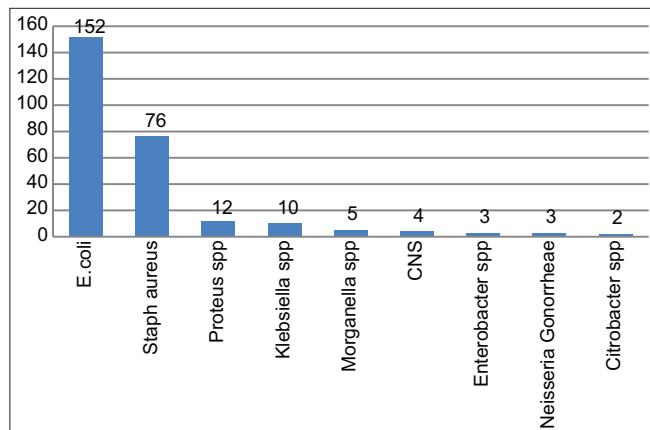


Figure 1: Frequency of bacteria species isolated from clinical specimen. Data are presented as frequency (%) unless otherwise indicated. N=267

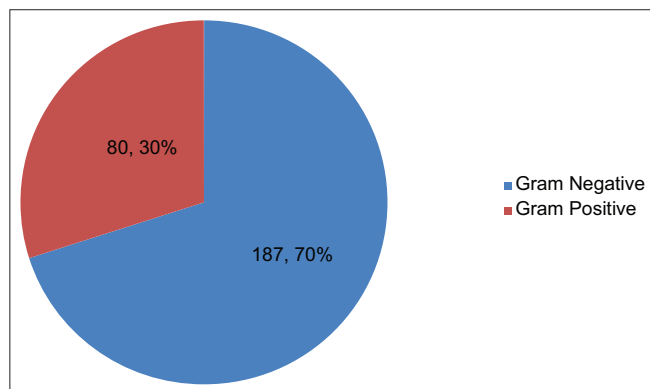


Figure 2: Frequency of Gram Negative and Gram Positive isolates. Data are presented as frequency (%) unless otherwise indicated. N=267

Table 2: Antimicrobial resistance profile of bacterial isolates

Bacteria	Cases	CN	CIP	NOR	AMP	OX	TE	CTX	DXT	E	NA
<i>E. coli</i>	152	43 (28.3)	20 (13.1)	48 (31.6)	121 (79.6)	123 (80.9)	76 (50.0)	31 (20.4)	99 (65.1)	127 (83.6)	48 (31.6)
<i>S. aureus</i>	76	20 (26.3)	15 (19.7)	25 (32.9)	60 (78.9)	49 (64.5)	50 (65.8)	21 (27.6)	45 (59.3)	66 (86.9)	23 (30.3)
<i>Klebsiella</i> spp	10	4 (40.0)	2 (20.0)	3 (30.0)	9 (90.0)	8 (80.0)	4 (40.0)	4 (40.0)	7 (70.0)	10 (100.0)	1 (10.0)
<i>Enterobacter</i> spp	3	0 (0.0)	0 (0.0)	2 (66.7)	3 (100.0)	2 (66.7)	2 (66.7)	1 (33.3)	1 (33.3)	3 (100.0)	0 (0.0)
<i>Citrobacter</i> spp	2	2 (100.0)	2 (100.0)	1 (50.0)	2 (100.0)	1 (50.0)	1 (50.0)	1 (50.0)	1 (50.0)	1 (50.0)	0 (0.0)
<i>Proteus</i> spp	12	3 (25.0)	2 (16.7)	5 (41.7)	12 (100.0)	8 (66.7)	6 (50.0)	3 (25.0)	5 (41.7)	12 (100.0)	7 (58.7)
<i>N. gonorrhoeae</i>	3	2 (66.7)	1 (33.3)	1 (33.3)	3 (100.0)	3 (100.0)	2 (66.7)	1 (33.3)	2 (66.7)	3 (100.0)	1 (33.3)
<i>M. morgani</i>	5	1 (20.0)	0 (0.0)	0 (0.0)	4 (80.0)	5 (100.0)	3 (60.0)	0 (0.0)	2 (40.0)	2 (40.0)	2 (40.0)
Other staphilococci	4	2 (50.0)	2 (50.0)	2 (50.0)	3 (66.7)	2 (50.0)	3 (66.7)	1 (33.3)	0 (0.0)	4 (100.0)	1 (33.3)
Total	267	77 (28.9)	44 (16.5)	87 (32.6)	217 (81.3)	201 (75.3)	123 (46.1)	63 (23.6)	167 (62.6)	228 (85.4)	83 (31.1)

Antimicrobial resistance profile of isolated bacteria: R=Resistant, S=Sensitive, spp. = species, CN=Norflaxacin, NOR=Norflaxacin, AMP=Ampicillin, OX=Oxacillin, TE=Tetracycline, CTX=Cefotaxime, DXT=Doxycycline, E=Erythromycin, NA=Naladixic Acid. The data are presented as frequency (%) unless otherwise indicated. N=267

DISCUSSION

The study included 267 participants with UTI. The infection was equally distributed in age groups above 15 years old and females were more affected than males. This is in agreement with the review of Mikolaj M *et al* where they highlight that UTIs are still a common clinical problem occurring more often in sexually active women, pregnancy, elderly, after catheterization of a urinary bladder and urological surgery as well as in the co-existence of diabetes or nephrolithiasis.¹¹ The female predisposition may be associated with the anatomical structure of their genital urinary organ and gut normal flora, which can easily be transferred to the genital organ. Besides, fecal contamination could be associated with female UTI who have a shorter ureteral canal.

Also, the current study has found that Gram-negative bacteria were more involved in UTI than Gram-positive pathogens. Previously, Gram-negative bacteria especially *Enterobacteriaceae* family were reported to cause UTI.¹² This could be due to the presence of a unique structure in Gram-negative bacteria, which facilitates attachment to the uroepithelial cell and their predominance in the gastrointestinal tract. Those unique characteristics prevent their elimination with urinary lavage and allow their multiplication, which may result in tissue invasion pyelonephritis. Another finding of the study is that, the main isolates were Gram-negative bacteria, mainly *E.coli* and *Klebsiella spp.* The finding is similar to that reported in the study conducted by Ntirenganya *et al*, where they found that *E.coli* was the main causative agent of UTI in Rwanda.¹³ Also, in our study, Gram-positive isolates were predominated by *Staphylococcus aureus*. Similar data were reported where *E. coli* was the main causative agent of UTI at a rate of 54.88%, followed by *S. aureus* and *Klebsiella spp.*⁸ Similarly, in the Kabugo *et al* study, the *E. coli* was isolated at a 50% rate and followed by *S. aureus* with 15.4%.¹⁴ All of those findings highlight that *E.coli* is the most UTI causative agent. This may be attributed to fecal contamination, as it is normal flora.¹¹

Antimicrobial agents are the only option to manage bacterial infections; however, the emergency of their resistance is handicapping the prognosis. Epidemiological surveillance is only remaining guidance for empirical treatment.^{15,16} Thus, the current study has evaluated the antimicrobial resistance profile of isolated UTI causative agents. The finding of this study highlight increased resistance of commonly used drugs including third generation cephalosporin. The finding is in accordance with that of the previous study conducted by Ntirenganya *et al*, which reported an alarming rate of drug resistance among both gram-negative and gram-positive organisms¹³ in Rwanda. It is also consistent

with the study of Kabugo *et al* conducted in Uganda where 50% of UTI isolated showed resistance to commonly used drugs¹⁴. These results are also in the same line with the results from Ayelign *et al* study conducted in Turkey, where the resistance of isolated bacteria towards Ciprofloxacin was 80.88%, Gentamicin was 79.41%, and Tetracycline 58% and resistance of 72.06% to Ampicillin⁸. Taken all together, these findings clearly show how resistant strains are expanding at an alarming rate in the area. With this trend, an antibiotic, which was previously effective, might not be effective in the future.

CONCLUSION

The most UTI causative isolates were *E. coli*, *S. aureus*, *Proteus spp.*, *Klebsiella spp.*, *Morganella morganii*. UTI was more frequent in females than males and there was high antimicrobial resistance among bacterial isolates. The most commonly used antimicrobial agents including third generation cephalosporin were not susceptible to bacterial isolates at a higher rate. These findings suggest continued antimicrobial resistance surveillance and special precautions should be taken for empirical treatment.

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Author's contribution:

MJB and BJ- have designed the project and carried out the study. All authors have contributed in manuscript writing and correction.

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