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. Although several different microorganisms can cause UTIs, bacteria are the major causative organisms and are responsible for more than 95% of UTI cases.

Bacterial UTI is primarily caused by Gram-negative bacteria and Gram-positive pathogens are also involved. More than 95% of uncomplicated UTIs are monobacterial infection 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
urinary tract infections every year. There is a high increase in the prevalence of UTIs in Africa especially in sub-Saharan countries. 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%).

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.

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 pause 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. 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 form 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%), Coagulate Negative

| Variables         | Frequency (%) |
|-------------------|---------------|
| Females           | 180 (67.4)    |
| Males             | 87 (32.6)     |
| Mean age          | 43.7(±20.3)   |

| Age groups | Female | Males | Total |
|------------|--------|-------|-------|
| ≥15 Years  | 16 (8.0) | 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).

**Table 2: Antimicrobial resistance profile of bacterial isolates**

| Bacteria               | Cases | CN  | CIP | NOR | AMP | OX  | TE  | CTX | DXT | E   | NA |
|------------------------|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|----|
| E. coli                | 152   | 43  | 20  | 15  | 25  | 49  | 39  | 20  | 76  | 127 | 46 |
| S. aureus              | 76    | 20  | 20  | 0   | 2   | 4   | 9   | 8   | 12  | 21  | 60 |
| Proteus spp           | 12    | 3   | 2   | 2   | 2   | 2   | 3   | 2   | 3   | 3   | 3  |
| Klebsiella spp        | 3     | 1   | 4   | 0   | 0   | 0   | 0   | 0   | 2   | 3   | 4  |
| Enterobacter spp      | 2     | 3   | 2   | 2   | 2   | 2   | 2   | 2   | 2   | 2   | 2  |
| Proteus spp           | 1     | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1  |
| Morganella spp        | 5     | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1  |
| N. gonorrhoeae        | 3     | 2   | 2   | 2   | 2   | 2   | 2   | 2   | 2   | 2   | 2  |
| Other staphlococci    | 4     | 3   | 3   | 3   | 3   | 3   | 3   | 3   | 3   | 3   | 3  |
| Total                 | 267   | 77  | 44  | 87  | 87  | 77  | 77  | 77  | 77  | 77  | 77 |

Antimicrobial resistance profile of isolated bacteria: R=Resistant, S=Sensitive, spp.=species, CN=Gentamicin, CIP=Ciproflaxacin, 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

**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
**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. 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. 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. 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. Similarly, in the Kabugo et al study, the E. coli was isolated at a 50% rate and followed by S. aureus with 15.4%. 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.

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. 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 organisms 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 drugs. 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 Ampicillin. 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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