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Research Article

Isolation and Identification of Pathogenic Bacteria from Urinary Tract Infection in Patients Attending Rwanda Military Hospital

ISHIMWE Alain Prudence[1,2]*, MUTABAZI Donatien[2], GATEMBEZI Tharcisse[2], HAKIZIMANA Philippe[3], KANANURA Viateur[4], NSABIYAREMYE Lauben[5]

[1:] Ines-Ruhengeri, Faculty of Applied Fundamental Sciences, Department of Biomedical Laboratory Sciences, Rwanda.
[2:] University of Gitwe, Faculty of Education, Department of Sciences, Rwanda
[3:] University of Gitwe, Director of Research, Rwanda
[4:] University of Gitwe, Faculty of Nursing, Department of General Nursing
[5:] University of Gitwe, Director of quality assurance

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*Address for Correspondence:

ISHIMWE Alain Prudence, Ines-Ruhengeri, Faculty of Health Sciences, Department of Biomedical Laboratory Sciences, Rwanda.

Abstract

Background: About 150 million people worldwide are diagnosed with urinary tract infection every year and more than half of women will get at least one in their lifetimes. Overuse and misuse of antibiotics have contributed to the growing problem of resistance amongst uropathogenic bacteria making it hard to treat UTIs. There is an increasing prevalence of antibiotic resistance and that's why area-specific monitoring studies to document the microorganisms causing UTIs and their antimicrobial susceptibility is mandatory for helping the selection of an effective empirical treatment.

Aim: The present study aimed to determine bacteria causing UTIs and their antibiotic susceptibility patterns among patients attending Rwanda military hospital.

Methodology: The study was a cross-sectional study and a total number of 118 patient's urine samples were tested in microbiology Lab.

Results: Most frequently isolated bacteria to cause UTIs in this study was *E. coli* (59%) followed by *Klebsiella pneumonia* (16%), *S. aureus* (6%), *Citrobacter freundii* (5%), *Proteus* spp. (3%), *S. Saprophyticus* (3%), *Streptococcus* spp. (3%), *Pseudomonas aeruginosa* (2%), *Klebsiella oxytosa* (2%) and *Acinetobacter* baumanii (2%). Meropem, imipem, gentamicin and cefotaxime were the most effective antibiotics in susceptibility testing. Thus, ciprofloxacin, sulfamethoxazole and norfloxacin were mostly developed resistance to isolated bacteria.

Conclusion: The study recommended that the ministry of health in Rwanda should establish the commission or government body which will be in charge of controlling use of antibiotics properly and fighting against drugs resistance in Rwanda.

Keywords: Pathogenic bacteria, Urinary tract infections, *E.coli*, Antibiotics

INTRODUCTION

Urinary tract infections (UTIs) are the common bacterial infections that affect any part of urinary system and the occurrence is found in both males and females. Despite the fact, that both genders are susceptible to the infection, women are mostly vulnerable due to their anatomy and reproductive physiology compared to male[1]. 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 results 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[2].

Urinary tract infections (UTIs) are the most common infectious diseases diagnosed around the globe, particularly in developing countries[3]. It is one of the most common microbial diseases encountered in medical practice. School children, students in higher learning institutions, and any of the population, especially females living in communal camps/institutions from developing and middle-income countries, monotonously hear of the disease whenever they visit health facilities. Worldwide, UTIs' prevalence is estimated at around 150 million people per year resulting in more than 4 billion pounds (6 billion dollars) in direct health care expenditure. The disease spares no community provided dwells in risky areas[4].

There is a high increase in the prevalence of UTIs in Africa especially in sub-Saharan countries. The overall prevalence of UTI in sub-Saharan Africa is 32.12%. The highest prevalence (67.6%) was recorded in South Africa, followed by Nigeria (43.65%) and Zambia

(38.25%) In Ghana, the prevalence rate is 15.9%, in Senegal 4.5%, and 12.3% in Nigeria[5]. 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%)[6]. More than 95% of urinary tract infections are caused by a single bacterial species. E. coli is the most frequent infecting organism in acute infection followed by Enterobacter, Staphylococci, Klebsiella, Proteus, Pseudomonas, and Enterococci species[7].

Treatment of UTI cases are often started empirically. Therapy is based on information determined from the antimicrobial resistance pattern of the urinary pathogens. However, because of the evolving and continuing antibiotic resistance phenomenon, regular monitoring of resistance patterns is necessary to Improve guidelines for empirical antibiotic therapy[8]. The introduction of antibiotic therapy has played Important role in management of UTIs but, the major problem with current antimicrobial empirical therapy is the rapid emergence of antibiotic resistance in both hospitals and community[9].

METHODOLOGY

Study area

This study was conducted in Kigali city at Rwanda Military Hospital located in Kicukiro district in Kanombe sector in Microbiology lab department.

Study design

A cross-sectional study was conducted on patients attending Rwanda Military Hospital in a period of three months from March to June 2023.

Study population and sample size

The target population of this study were patients with positive urine culture cases in microbiology lab from 7th March to 2nd June 2023, and the sample size was given by time limit of the study.

Sample collection and analysis

Urine samples were obtained from a midstream into standardized, sterile container and delivered to the laboratory within 2 hours and guidelines for proper specimen collection were told to all patients. Identification was done based on culture characteristics, gram stain and routine standard biochemical tests where API 20 system was used for biochemical testing and identification of isolated bacteria.

Antibiotic susceptibility test was carried out on Mueller Hinton agar by Kirby-Bauer's disk diffusion method according interpretive criteria recommended by the clinical and laboratory standards institute (CLSI) guidelines. Appropriate antibiotic discs were tested depending upon whether the organism was gram positive or gram negative. Interpretation of results was done based on the diameter of the zone of inhibition.

Data collection and analysis

Data were entered into Microsoft excel spreadsheet and analyzed using statistical package for social sciences software (version 22.0). Study findings were presented in tables and figures.

RESULTS AND DISCUSSION

Socio-demographic characteristic of study participants

In the three months' 118 urine samples were tested, for both female and male patients. The majority of the study participants were ranging between 30 to 45 years old.

Table *1*: Distribution of participants according to age

Age group		Frequency	Percentage (%)
	0-15	10	8.5
	16-30	17	14.4
	31-45	40	33.9
	46-60	27	22.9
	61-75	13	11.0
	>75	11	9.3
	Total	118	100.0

The highest prevalence of UTI is seen in the age group of 31-45 years old with the frequency of 40(33.9%) and the lowest prevalence is seen in the age group of 0-15 years old with frequency of 10(8.5%) and this may be due to the fact Individuals in the 30-45 age group are more sexually active, leading to a higher likelihood of exposure to UTIs, they may also have underlying health conditions, such as diabetes or obesity, that can increase the risk of UTIs and these conditions can affect the body's immune response and create an environment conducive to bacterial growth[1]. And the findings are in same line with observation reported by another researcher who found it to be 38.1%[10].

Table *2*: Distribution of UTIs based on gender

GENDER	Frequency	Percentage %
Female	67	56.8%
Male	51	43.2%

The incidence of UTI was high in females 67 (56.8%) than in males 51 (43.2%). These findings are in line with the work done by a researcher where the higher incidence of UTI was 59.2 % in females and in male was 40.8%[11]. All authors attribute the higher incidence rate of urinary tract infection in female to the nature of the anatomical structure of their urogenital tract; the urethra of females is much shorter and closer to the anus than in males, and it also lacks the bacteriostatic properties of prostatic secretions. The higher incidence in females observed may also be a result of the unhygienic habits of not cleaning the vagina from front to the back after urination but rather from back to front, thus resulting in autoinfection[12].

Frequency of identified bacteria species

Figure 1 represents the frequency of all isolated bacteria from the attended patients.

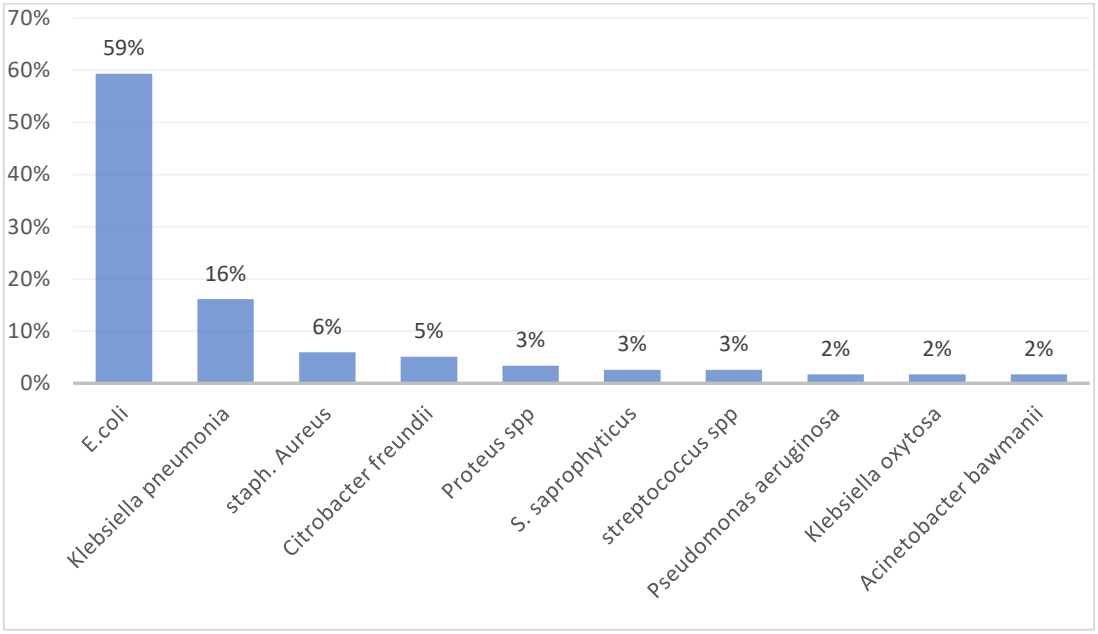

Figure 1**:** Frequency of identified bacteria

In this study as with previous studies illustrates *E. coli* as the predominant etiology of UTI counting for 59% followed by *Klebsiella pneumonia* with 16% and *S. aureus* with 6%. This higher prevalence of *E. coli* may be due to the fact that it is normal inhabitant of the gastrointestinal tract in humans, so it can easily travel from the rectal area to the urethra and eventually the bladder, leading to infection.

It also has certain characteristics that allow it to adhere to the urinary tract lining, colonize and multiply, causing the infection additionally, *E. coli* possesses various virulence factors that enhance its ability to evade the immune system and cause damage to the urinary tract tissues[13].

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 [14]. 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 where they found that *E. coli* was the main causative agent of UTI in Rwanda[15].

From the findings, *Acinetobacter baumannii* was found to be the least bacteria causing UTI, as it is considered an opportunistic pathogen, meaning it tends to infect individuals who are already vulnerable due to underlying health conditions, compromised immune systems, or invasive medical procedures. it is more commonly associated with respiratory infections, bloodstream infections, and wound infections, particularly in individuals who are already critically ill, immunocompromised, or hospitalized. Healthy individuals with normally functioning urinary tracts and immune systems are generally better equipped to fend off *Acinetobacter baumannii*, making them less prone to UTIs caused by this bacterium[16].

Susceptibility test of isolated bacteria

The study findings showed that ciprofloxacin and sulfamethoxazole were the common antibiotic to resist on the UTIs with total case of 45.5% both. Meropenem and Imipenem were the least antibiotic to resist on UTIs at percentage of 10% and 14.5% respectively. The most common sensitive antibiotic on UTIs identified were Meropenem, Imipenem and gentamicin at percentage of 90,85.5 and 58.7 respectively. The table 4 shows the total antibiotic results for sensitive and resistance of bacteria.

Table *3*: Susceptibility test of isolated bacteria

Isolates	Total	Patterns	CN	CIP	NOR	AMC	MEM	CTX	SXT	E	NIT	IPM
E. coli	70	S	27 (38.6)	15 (21.4)	32 (45.7)	29 (41.4)	45 (64.3)	25 (35.7)	14 (20)	22 (31.4)	14 (20)	50 (71.4)
		I	7 (10)	8 (11.4)	11 (15.7)	9 (12.8)	8 (11.4)	7 (10)	10 (14.3)	11 (15.7)	7 (10)	2 (2.8)
		R	36 (51.4)	47 (67.1)	27 (38.6)	32 (45.7)	17 (24.3)	38 (54.2)	46 (65.7)	37 (52.8)	49 (70)	18 (25.7)
S. aureus	7	S	4 (57)	2 (26.8)	2 (26.8)	2 (26.8)	4 (57)	2 (26.8)	1 (14.3)	4 (57)	3 (43)	4 (57)
		I	0	1 (14.3)	0	2 (26.8)	1 (14.3)	2 (26.8)	1 (14.3)	1 (14.3)	0	1 (14.3)
		R	3 (43)	4 (57)	5 (71.4)	3 (43)	2 (26.8)	3 (43)	5 (71.4)	2 (26.8)	4 (57)	2 (26.8)
Klebsiella spp.	21	S	16 (76.2)	10 (47.6)	10 (47.6)	8 (47.6)	17 (81)	14 (66.7)	7 (33.3)	12 (57.1)	7 (33.3)	16 (76.2)
		I	0	1 (4.7)	2 (9.5)	1 (4.7)	2 (9.5)	0	2 (9.5)	2 (9.5)	3 (14.3)	3 (14.3)
		R	5 (24.8)	10 (47.6)	9 (42.8)	12 (57)	2 (9.5)	7 (33.3)	12 (57)	7 (33.3)	11 (57)	2 (9.5)
Proteus spp	4	S	1 (25)	2 (50)	2 (50)	0	1 (25)	2 (50)	3 (75)	2 (50)	2 (50)	3 (75)
		I	0	1 (25)	0	2 (50)	2 (50)	0	0	1 (25)	0	0
		R	3 (75)	1 (25)	2 (50)	2 (50)	1 (25)	2 (50)	1 (25)	1 (25)	2 (50)	1 (25)
Citrobacter spp.	6	S	3 (50)	2 (33.4)	4 (66.6)	2 (33.4)	4 (66.6)	3 (50)	2 (33.4)	1 (16.6)	3 (50)	3 (50)
		I	1 (16.6)	1 (16.6)	0	0	1 (16.6)	0	1 (16.6)	2 (33.4)	0	1 (16.6)
		R	2 (33.4)	3 (50)	2 (33.4)	4 (66.6)	1 (16.6)	3 (50)	3 (50)	3 (50)	3 (50)	2 (33.4)
Acinetobacter spp	2	S	0	0	0	1 (50)	2 (100)	0	1 (50)	1 (50)	0	1 (50)
		I	1 (50)	0	0	0	0	1 (50)	0	1 (50)	0	0
		R	1 (50)	2 (100)	2 (100)	1 (50)	0	1 (50)	1 (50)	0	2 (100)	1 (50)
streptococcus spp	3	S	2 (66.7)	1 (33.3)	1 (33.3)	2 (66.7)	0	1 (33.3)	2 (66.7)	1 (33.3)	1 (33.3)	1 (33.3)
		I	0	0	1 (33.3)	0	1 (33.3)	0	0	1 (33.3)	1 (33.3)	1 (33.3)
		R	1 (33.3)	2 (66.7)	1 (33.3)	1 (33.3)	2 (66.7)	2 (66.7)	1 (33.3)	1 (33.3)	1 (33.3)	1 (33.3)
S.saprophyticus	3	S	2 (66.7)	1 (33.3)	1 (33.3)	1 (33.3)	3 (100)	1 (33.3)	2 (66.7)	1 (33.3)	1 (33.3)	3 (100)
		I	1 (33.3)	0	1 (33.3)	0	0	0	0	1 (33.3)	0	0
		R	0	2 (66.7)	1 (33.3)	2 (66.7)	0	2 (66.7)	1 (33.3)	1 (33.3)	2 (66.7)	0
Pseudomonas aeruginosa	2	S	1 (50)	1 (50)	0	1 (50)	0	1 (50)	0	1 (50)	0	0
		I	0	0	0	0	1(50)	0	0	0	1(50)	1 (50)
		R	1(50)	1 (50)	2 (100)	1(50)	1 (50)	1(50)	2 (100)	1(50)	1(50)	1 (50)
Total	118	S	56 (47.4)	36 (30.5)	52 (44)	46 (39)	76 (64.5)	48 (40.7)	32 (27.1)	45 (38)	31 (26.3)	80 (67.8)
		I	9 (7.6)	12 (10.1)	15 (12.7)	15 (12.7)	16 (13.5)	11 (9.3)	14 (11.9)	20 (17)	12 (10.2)	9 (7.6)
		R	53 (45)	70 (59.3)	51 (43.2)	57 (48.3)	26 (22)	59 (50)	72 (61)	53 (45)	75 (63.5)	29 (24.6)

R= Resistant, S= Sensitive, spp. = species, CN= Gentamicin, CIP= Ciprofloxacin, NOR= Norfloxacin, AMC= Amoxicillin and clavulanic acid, NIT=Nitrofurantoin, SXT= Sulfamethoxazole, E= Erythromycin, MEM= Meropenem, IPM=Imipenem Number in bracket indicates percentages (%).

The most common isolated pathogen *Escherichia coli* exhibited antimicrobial resistance as follows: *E. coli* was resistant to Gentamicin 51.4%, Ciprofloxacin 67.1%, Norfloxacin 38.6%, Amoxicillin and clavulanic acid 45.7%, Meropenem (24.3%), Sulfamethoxazole (54.2%), Erythromycin (52.8%) Nitrofurantoin (70%) Imipenem (25.7%).

Klebsiella spp was resistant to Gentamicin (24.8%), Ciprofloxacin (47.6%), Norfloxacin (42.8%), Amoxicillin and clavulanic acid (57%), Meropenem (9.5%), Erythromycin (33.3%), Sulfamethoxazole (57%), Nitrofurantoin (57%), Imipenem (9.5%).

The main Gram Positive isolated was *S. aureus* and was resistant to: Gentamicin (43%), Ciprofloxacin (57%), Norfloxacin (71.4%), Amoxicillin and clavulanic acid (43%), Meropenem (26.8%), Sulfamethoxazole (71.4%), Erythromycin (28.6%), Nitrofurantoin (57%), and imipem (26.8%). The findings of this present study were similar to the study conducted by different researchers where they found that the main Gram positive isolate were *S. aureus* and were resistant to: Gentamicin (26.3%), Ciprofloxacin (19.7%), Norfloxacin (32.9%), Ampicillin (78.9%), Oxacillin (64.5%), Tetracycline (65.8%), Cefotaxime (27.6%), Doxycycline (59.3%), Erythromycin (86.9%), Nalidixic Acid (30.3%)[17]

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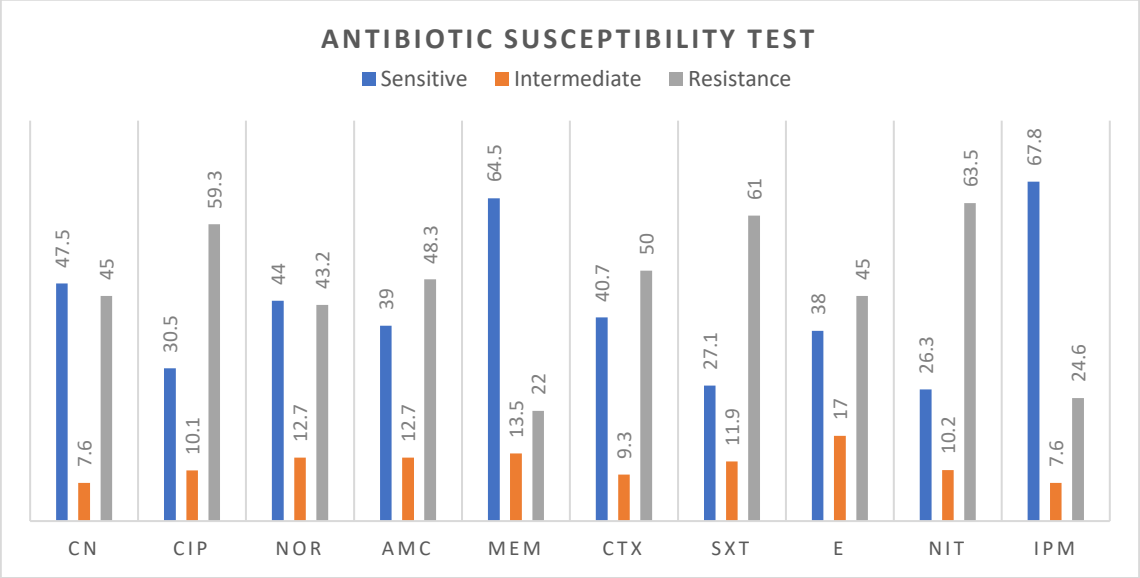

Figure *2*: Antibiotic susceptibility pattern of identified bacteria

Figure 2 represents the percentage to which an antibiotic was sensitive and resistant. The highest sensitive percentage was seen on meropem 90% followed by Imipem 83.6%, Gentamicin 62.7% and Amoxicillin-clavulanic acid 57.3% respectively. The high resistance percentage was seen on Ciprofloxacin 50.8% followed by Sulfamethoxazole 50.8% and Nitrofurantoin with 40.7%.

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REFERENCES

1. Vasudevan, R. Urinary tract infection: an overview of the infection and the associated risk factors. J Microbiol Exp, 2014;1(2). doi:00008. https://doi.org/10.15406/jmen.2014.01.00008

2. Audrey, S., & Procter, S. Employers' views of promoting walking to work: A qualitative study. International Journal of Behavioral Nutrition and Physical Activity, 2015;12(1):1-10. https://doi.org/10.1186/s12966-015-0174-8 PMid:25888840 PMCid:PMC4344752

3. Gupta, K., & Trautner, B. Urinary tract infection. Annals of Internal Medicine 2017'156(1):147-152.

4. Uçkay, I., Sax, H., Gayet-Ageron, A., Ruef, C., Mühlemann, K., Troillet, N.,& Pittet, D. High proportion of healthcare-associated urinary tract infection in the absence of prior exposure to urinary catheter a cross-sectional study. Antimicrobial Resistance and Infection Control, 2013;2(1):1-10. https://doi.org/10.1186/2047-2994-2-5 PMid:23391300 PMCid:PMC3598194

5. Jombo, G. T. A., Egah, D. Z., Banwat, E. B., & Ayeni, J. A. Nosocomial and community acquired urinary tract infections at a Teaching Hospital in North Central Nigeria: Findings from a Study of 12,458 Samples. Nigerian Journal of Medicine, 2016;15(3):230-236. https://doi.org/10.4314/njm.v15i3.37219 PMid:17111749

6. Muvunyi, C. M., Masaisa, F., Bayingana, C., Mutesa, L., Musemakweri, A., & Muhirwa, G. Decreased susceptibility to commonly used antimicrobial agents in bacterial pathogens isolated from urinary tract infections in Rwanda: need for new antimicrobial guidelines. The American Journal of Tropical Medecine and Hygiene,

2011;84(6):923. https://doi.org/10.4269/ajtmh.2011.11-0057 PMid:21633029 PMCid:PMC3110351

7. Lee, S. H. ,& Le, J. Infectious diseases. Washington DC: American College Of Clinical Pharmacy. 2018;7-22.

8. Farajnia, S., Alikhani, M. Y., Ghotaslou, R., Naghili, B., & Nakhlband, A. Causative agents and antimicrobial susceptibilities of urinary tract infections in the northwest of Iran. International Journal of Infectious Diseases, 2009;13(2):140-144. https://doi.org/10.1016/j.ijid.2008.04.014 PMid:18703368

9. Nyiramahirwe, F. Evaluation of antibacterial drug resistance among suspected patients with urinary tract infections at Nemba hospital (Unpublished memoire). INES Ruhengeri, Musanze, Rwanda. 2017.

10. Foxman, B. Urinary tract infection syndromes occurrence, recurrence, bacteriology, risk factors, and disease burden. Infectious Disease Clinics of North America, 2014;28(1):1-13. https://doi.org/10.1016/j.idc.2013.09.003 PMid:24484571

11. Nwachukwu, E., Onyebuchi, O., & Michael, O. Prevalence of urinary tract infections in pregnant women in Onitsha, Nigeria. Journal of Bacteriology & Mycology Open Access, 2018;6(5):284-285. https://doi.org/10.15406/jbmoa.2018.06.00219

12. Davis, N. F., & Flood, H. D. The pathogenesis of urinary tract infections. In Clinical management of complicated urinary tract infection, 2011; 1(1):978-953.

13. Foxman, B. The epidemiology of urinary tract infection. Nature Review of Urology, 2010;7(6):653-660. https://doi.org/10.1038/nrurol.2010.190 PMid:21139641

14. Byron, J. K. Urinary tract infection. Veterinary Clinics: Small Animal Practice, 2019;49(2):211-221. https://doi.org/10.1016/j.cvsm.2018.11.005 PMid:30591189

15. Ntirenganya, C., Manzi, O., Muvunyi, C. M., & Ogbuagu, O. High prevalence of antimicrobial resistance among common bacterial isolates in a tertiary healthcare facility in Rwanda. The American Journal of Tropical Medicine and Hygiene, 2015;92(4):865-870. https://doi.org/10.4269/ajtmh.14-0607 PMid:25646259 PMCid:PMC4385787

16. Whiteway, C., Breine, A., Philippe, C., & Van der Henst, C. Acinetobacter baumannii. Trends in Microbiology, 2022;30(2):199-200. https://doi.org/10.1016/j.tim.2021.11.008 PMid:34836792

17. Munyemana, B. J., Bikorimana, J., Kantarama, E., & Kabanyana, P. Urinary tract infection and antimicrobial resistance profile in patients attending Nemba District Hospital in Rwanda. Asian Journal of Medical Sciences, 2020;11(6):42-43. https://doi.org/10.3126/ajms.v11i6.29921