Current Scenario of Antibiotic Susceptibility Pattern of Bacteria causing Urinary Tract Infection at B & B Hospital, Nepal: A Retrospective Cross-Sectional Study

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Urinary tract infections (UTIs) are the most common bacterial infections affecting people from all age groups, including neonates and the geriatric age group. The increasing burden of UTIs worldwide is due to the irrational use of antibiotics, including both self-administration and inappropriate prescribing. Therefore, the present study was conducted with the objectives of studying the antibiotic profile of antibiotic resistance trends among the bacterial isolates and MDR patterns. This study was a retrospective cross-sectional study conducted in the Microbiology Laboratory of B & B Hospital, Gwarko, Nepal, from January to December 2024. A total of 7500 urine samples requested for culture and sensitivity were collected from both inpatients and outpatients aseptically and without contaminating skin, and vaginal commensals were processed. Urine samples were inoculated on Cystine Lactose Electrolyte Deficient (CLED) agar and incubated aerobically at 37°C for 24-48 hours. A total of 1205 bacterial isolates were recovered from urine. *Escherichia coli* was the predominant pathogen, followed by *Klebsiella pneumoniae*, *Klebsiella oxytoca*, *Enterococcus faecalis*, and *Pseudomonas aeruginosa*. The highest growth rate was seen in the age category of 31-40 years, 185(15.35 %). Bacterial isolates were sensitive to colistin (98.47% to 100%), tigecycline (96.93% to 100%), and piperacillin-tazobactam (75% to 92%). Resistance to third-generation cephalosporins between 46% and 96% was observed. Since the increasing trends of multidrug-resistant (MDR) isolates, every health authority concerned must formulate a proper antibiotic

policy and antibiotic stewardship program that will help in the management of UTIs.

Keywords: escherichia coli, multidrug resistant, urinary tract infection.

Urinary tract infections (UTIs) are the most common bacterial infections both in the community and hospital, affecting 150 million people per year worldwide, and are increasing day by day.[1] UTIs affect people from all age groups, including neonates and the geriatric age group. The occurrences of UTIs are higher in women, which is likely due to the anatomical differences, pregnancy, and hormonal effects.[2] The most common microorganism responsible for causing UTIs is coliform bacteria, which accounts for 80% of the infection, since the acquisition of UTIs occurs through ascending routes.[3] *Escherichia coli* is the most common organism causing UTI, which accounts for up to 90% of cases, followed by *Klebsiella pneumonia*, *Klebsiella oxytoca*, *Proteus mirabilis*, *Proteus vulgaris*, *Pseudomonas aeruginosa, Enterobacter* species, *Citrobacter* species, and *Acinetobacter* species. Gram-positive organisms are less common, including Group B Streptococcus, *Staphylococcus aureus*, *Staphylococcus saprophyticus*, and *Staphylococcus epidermidis*.[4]

The most significant predisposing factors for UTIs are malnutrition, low socioeconomic level, and inadequate cleanliness.[5]

The increasing burden of UTIs worldwide leads to the misuse of antibiotics, including both self-administration and inappropriate prescribing.[6] This inappropriate empirical therapy can lead to higher mortality, prolonged treatments, increased hospital stays, and increased costs. According to the WHO, Drug resistance, which has been among the top 10 global health threats, is also a rapidly emerging problem in Nepal. Urinary pathogens are among the most frequently resistant organisms. There is an urgent need to understand the resistance pattern for commonly used antibiotics, both in inpatient and outpatient settings, in tertiary care centers.[7] UTI prevalence among Nepalese patients attending general hospitals ranges from 23% to 37%.[8]

Therefore, the present study was conducted to study the antibiotic profile of antibiotic resistance trends among the bacterial isolates and MDR patterns, which helps to formulate antibiotic policy and antibiotic stewardship program for clinical decision-making on the empirical treatment of UTIs, and to reduce the incidence of antibiotic resistance is greatly aided by urine antibiogram patterns.

Materials & Methods

This study was a retrospective cross-sectional study conducted in the Microbiology Laboratory of B & B Hospital, Gwarko, Nepal, from January

2024 to December 2024. A total of 7500 urine samples requested for culture and sensitivity were collected from both inpatients and outpatients aseptically and without contaminating skin, and vaginal commensals were processed. Urine samples were inoculated on CLED agar and incubated aerobically at 37°C for 24-48 hours. Significant bacterial count (10^5CFU/ml) was recorded from urine culture isolates. The identification of bacterial isolates was carried out by cultural, morphological characters, Gram stain, and appropriate biochemical tests (triple sugar iron, indole, citrate, urease, and motility) following standard procedures.

Antibiotic Susceptibility Tests

Modified Kirby-Bauer disc diffusion method was applied to perform an Antibiotic susceptibility test (AST) recommended by Clinical and Laboratory Standards Institute (CLSI).[9] The inoculum was prepared in nutrient broth by taking 3-5 identical colonies of bacterial isolates that matched to 0.5 McFarland standard turbidity. A sterile cotton swab was dipped into the inoculum after 15 minutes and streaked over the dried surface of Muller-Hinton agar (MHA) plate. The following commercially available antibiotic discs used for urine culture were amikacin (30μg), ciprofloxacin (30μg), ceftriaxone (30μg), cefotaxime (30μg), ceftazidime (30μg), nitrofurantoin (300μg), cotrimoxazole (25μg), cefixime (5μg), piperacillin-tazobactam (100/10μg), tigecycline (15μg), imipenem (10μg), meropenem (10μg), colistin (10μg), linezolid (30μg), ampicillin (10μg), amoxicillin-clavulanic acid (30μg), teicoplanin (30μg), and vancomycin (30μg). Plates were incubated aerobically at 37°C for 24 hours. Zone diameter in millimeters was measured, and organisms were identified as sensitive, resistant, and intermediate as per CLSI 2013 guidelines. *Escherichia coli* strain ATCC 25922 was used as the control strain. The data was entered, and the percentage calculations were analyzed by using Statistical Package for Social Sciences (SPSS) version 22 software.

Results

A total of 7500 samples were collected, in which 1205 bacterial isolates were recovered from urine samples of inpatients and outpatients of the hospital. Amongst them, *Escherichia coli* was the predominant pathogen, followed by *Klebsiella pneumoniae*, *Klebsiella oxytoca*, *Enterococcus faecalis*, and *Pseudomonas aeruginosa*. **Table 1** shows the distribution of bacterial isolates by gender, patient type, and age.

Table 1. Distribution of bacterial isolates based on demographic characteristics (n=1205)

Characteristics	**n(%)**
Gender	
Male	420(34.85)
Female	785(65.15)
Patient Type	
Inpatient	227(18.84)
Outpatient	978(81.16)
Age groups (In years)	
1-10	86(7.14)
11-20	64 (5.31)
21-30	167 (13.86)
31-40	185(15.35)
41-50	134(11.12)
51-60	143(11.87)
61-70	149(12.37)
71-80	156(12.95)
>80	121(10.04)

Among the 1205 isolates, the highest growth rate was seen in the age category of 31-40 years, 185(15.35%). It was observed that the percentage of outpatients (81.16%) was higher than that of inpatients (18.84%). The distribution of bacterial isolates in inpatients was found to be highest in the surgery ward (n=38), followed by the orthopedic ward (n=30), hemodialysis unit (n=28), ICU (n=25), and neurosurgery ward (n=23), as shown in **Figure 1**.

The highest number of *Escherichia coli* was isolated from urine (n=587), followed by *Klebsiella* species (n=420), *Enterococcus* faecalis (n=55), and *Pseudomonas aeruginosa* (n=51) shown in **Figure 2**. Antimicrobial susceptibility test of bacterial isolates from urine culture is shown in **Figure 3 and Table 2**.

The heatmap in **Figure 3** illustrates the percentage of antibiotic resistance among common Gram-negative bacterial isolates, including *Escherichia coli*, *Klebsiella pneumoniae*, *Pseudomonas aeruginosa*, and other species, against a panel of 14 antibiotics. The color gradient from light to dark red reflects increasing resistance rates. Overall, the pattern shows higher resistance among *K. pneumoniae* and *P. aeruginosa* compared to *E. coli* and other species. For *K. pneumoniae,* high resistance was observed for Cefixime (70.6%) and Nitrofurantoin (70.2%). More than half of isolates were resistant to several β-lactams, such as Cefotaxime (58%) and Ceftazidime (55.4%). *P. aeruginosa* exhibits very high resistance to Cefixime (96.1%), Nitrofurantoin (96.1%), Cefotaxime (94.12%), and Cotrimoxazole (90.2%), indicating multidrug resistance patterns.

In contrast, Colistin and Tigecycline remain highly effective across all bacterial species, with resistance rates below 5%.

E. coli shows moderate resistance from 35% to 56% against β-lactams and fluoroquinolones but retains low resistance to carbapenems (Imipenem 16.7%,

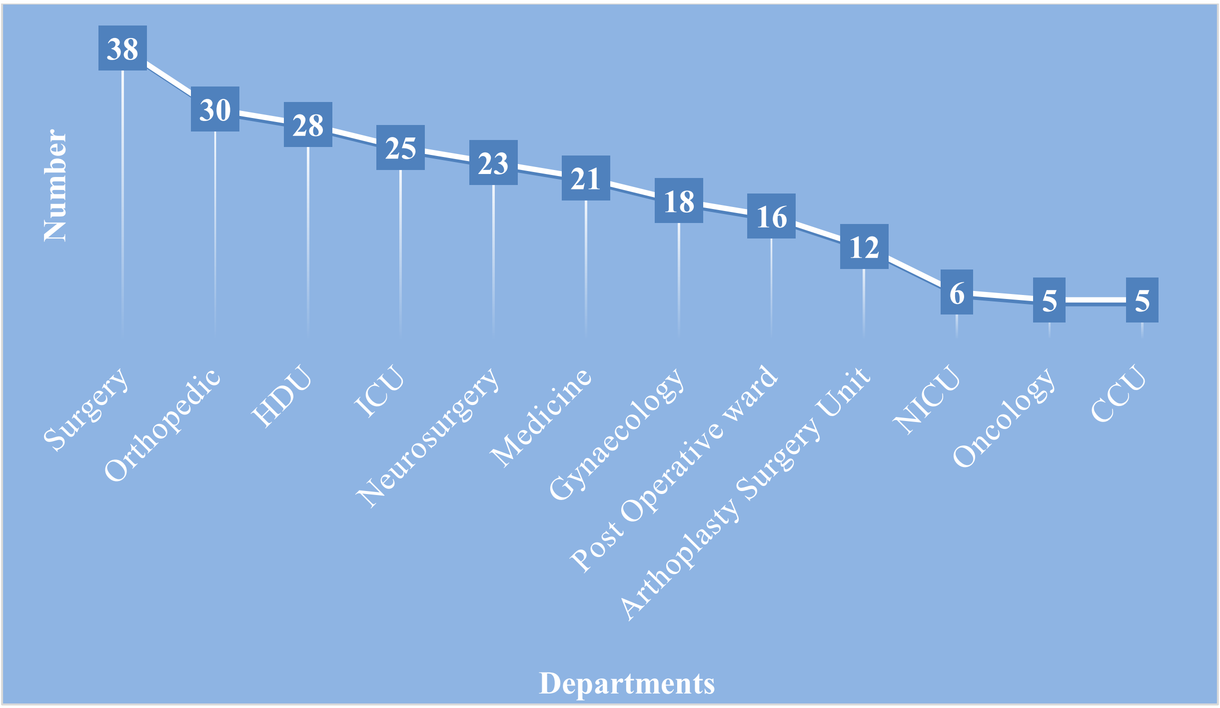

Figure 1: Distribution of bacterial isolates from different wards (n=277)

Table 2: Antibiotic susceptibility pattern of Enterococcus faecalis (n=55)

Antibiotics	***Enterococcus faecalis***	
	Sensitive n (%)	**Resistant n (%)**
Amoxycillin-Clavulanic acid	34(61.82)	21(38.18)
Amikacin	52(94.55)	3(5.45)
Ampicillin	29(52.73)	26(47.27)
Ciprofloxacin	33(60.00)	22(40.00)
Cotrimoxazole	21(38.19)	34(61.81)
Gentamycin	34(61.82)	21(38.18)
Linezolid	55(100)	-
Nitrofurantoin	36(65.45)	19(34.55)
Teicoplanin	50(90.91)	5(9.09)
Vancomycin	53(96.36)	2(3.64)

Meropenem 6.5%). Carbapenems (Imipenem, Meropenem) generally retain good activity, especially against *E. coli* and other Gram-negative bacteria.

Acinetobacter species shows high resistance to Nitrofurantoin (83.3%), Amoxiclav (66.7%), Cefotaxime (66.7%), and Ceftazidime (66.7%). Colistin (0%),

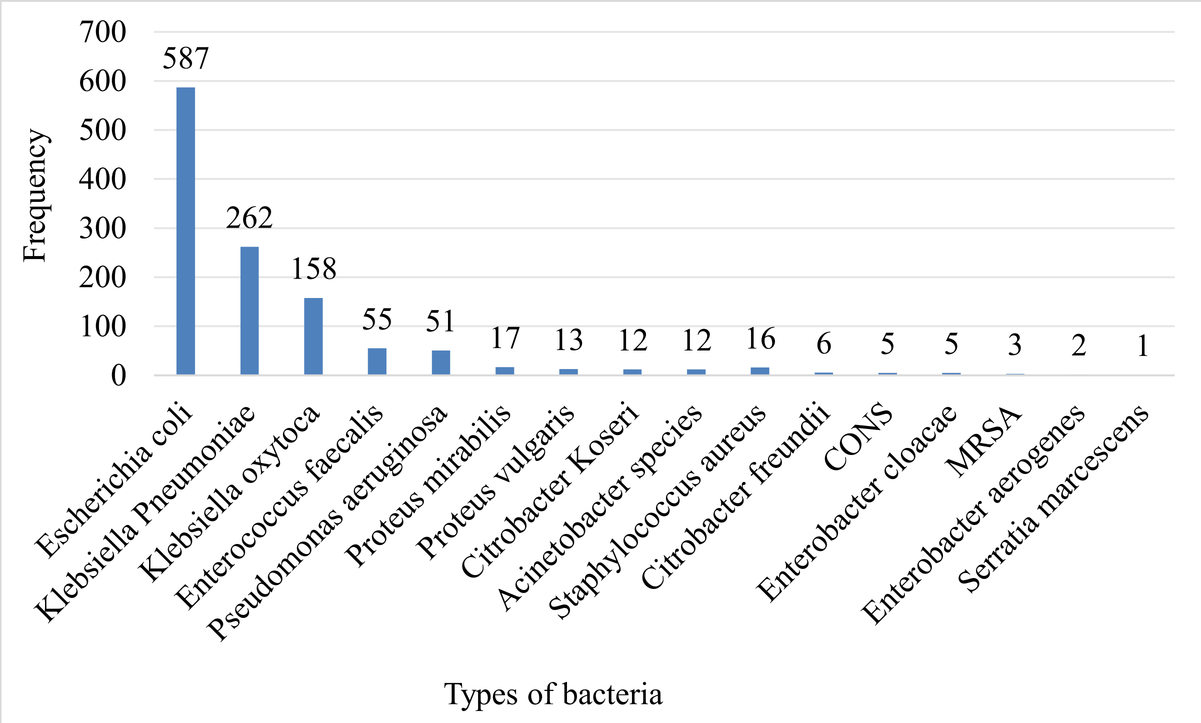

Figure 2. Number of bacteria in urinary isolates

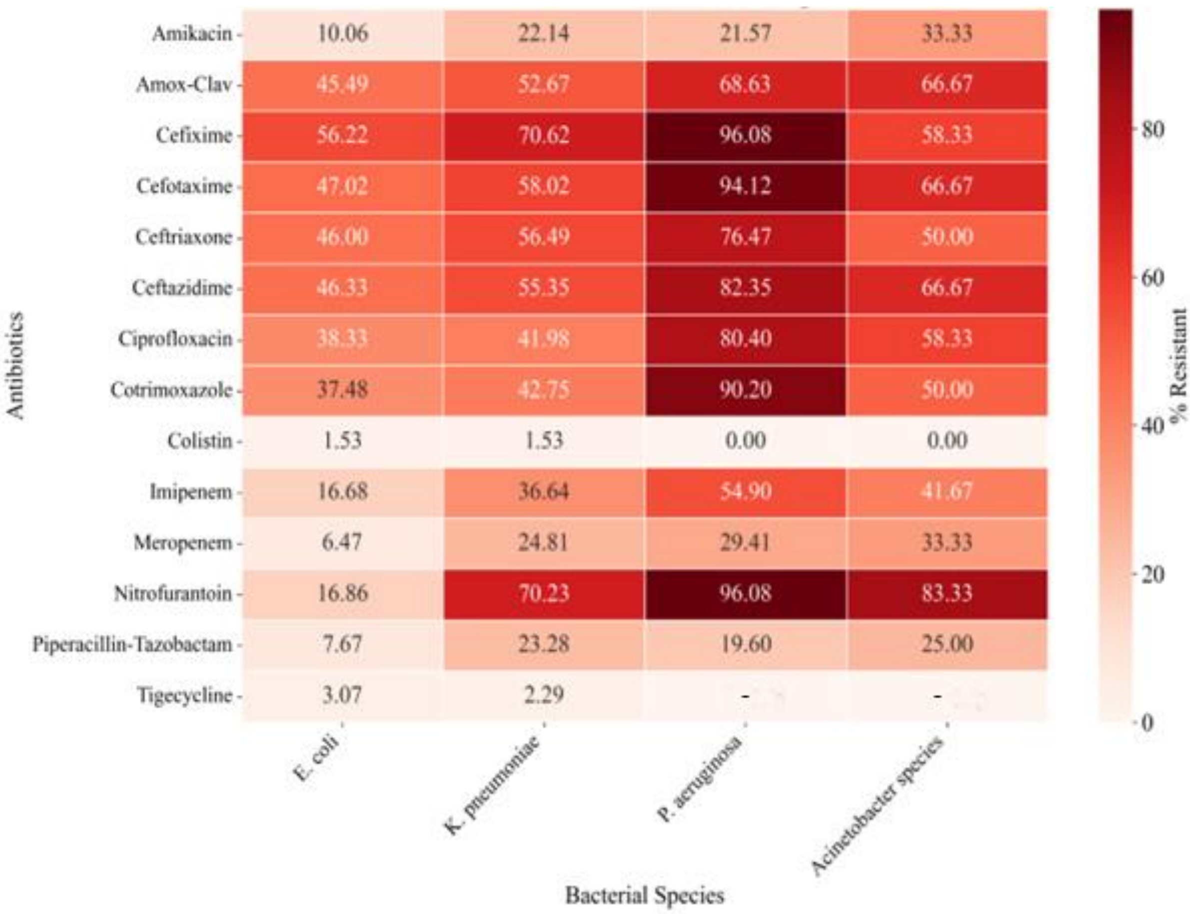

Figure 3: Antibiotic resistance pattern of Gram-negative isolates

Tigecycline (0%) were found to be highly effective against *Acinetobacter* species.

Table 2 shows the antibiotic susceptibility pattern of *Enterococcus faecalis*, with a maximum sensitivity to linezolid (100%), followed by vancomycin (96.36%), amikacin (94.55%), and teicoplanin (90.91%).

Out of 1205 bacterial isolates, a high incidence of UTIs caused by MDR (20.99%), MRSA (18.75%), and VRE (3.64%) was observed.

Discussion

Urinary Tract Infections (UTIs) are the most common bacterial infections in all age groups. Females are more prone to acquiring infection than males. UTIs are also a major cause of morbidity, leading to long-term complications such as renal failure. The present study provides the current spectrum of the antibiotic resistance pattern of bacterial pathogens isolated from the UTI patients from B and B Hospital, Nepal, during the period of January to December 2024.

The present study documented that the highest number of *Escherichia coli* (48.71%) isolates were recovered from urine. Concerning urinary tract infection, *E. coli*, *Klebsiella* species, *P. aeruginosa*, and *Acinetobacter* species showed a greater extent of resistance to amoxicillin-clavulanic acid, co-trimoxazole, and third-generation cephalosporins. A similar pattern of resistance in urinary isolates was shown in a previous study in Nepal.[6,10] This may be due to the irrational use of third-generation cephalosporins. However, a significant degree of susceptibility was found to 98.47% to colistin, followed by tigecycline (96.93%) and nitrofurantoin (83.13%). Similar findings have been reported in various studies.[11,12] This may be due to the rational use of these drugs in UTI cases, since it is a reserved drug for UTIs.

In this study, analysis of antibiotic susceptibility of *Escherichia coli* is 98.47% to colistin, followed by tigecycline (96.93%) and nitrofurantoin (83.13%). Similarly, *Klebsiella pneumoniae*, *Pseudomonas aeruginosa* and *Acinetobacter* species were found to be 98.47% to 100% sensitive to colistin, followed by tigecycline and piperacillin-tazobactam. The increased level of drug resistance is a major concern worldwide, since these are the first-line drugs recommended internationally[13,14], and are irrationally used in public and private sectors.[15,16]

Conclusion

No resistance was documented to tigecycline and colistin, suggesting the suitable drugs of choice for treating MDR and ESBL-producing isolates causing life-threatening infections. Of particular concern, the proper formulation of antibiotic policy and antibiotic stewardship program is absolutely required in every health sector by all concerned authorities.

Conflict of Interest: None.

References

1. Adhikari S, Khadka S, Sapkota S, Rana JC, Khanal S, Neupane A, et al. Prevalence and Antibiograms of Uropathogens from the Suspected Cases of Urinary Tract Infections in Bharatpur Hospital, Nepal. J Coll Med Sci [Internet]. 2019 Dec 31;15(4 SE-Original Articles):260–6. Available from: https://nepjol.info/index.php/JCMSN/article/view/20856
2. Ganesh R, Shrestha D, Bhattachan B, Rai G. Epidemiology of urinary tract infection and antimicrobial resistance in a pediatric hospital in Nepal. BMC Infect Dis [Internet]. 2019;19(1):420. Available from: https://doi.org/10.1186/s12879-019-3997-0
3. Paudel L, Manandhar N, Sah S, Khadka S, Neupane S, Joshi SK. Prevalence of urinary tract infection and associated risk factors among women in Sindhupalchowk district, Nepal. Int J Community Med Public Heal [Internet]. 2018 Jun 22;5(7 SE-Original Research Articles):2714–9. Available from: https://www.ijcmph.com/index.php/ijcmph/article/view/3015
4. Pardeshi P. Prevalence of urinary tract infections and current scenario of antibiotic susceptibility pattern of bacteria causing UTI. 2018;5(3):334–8. https://doi.org/10.18231/2394-5478.2018.0070
5. Sarkar A, Mukherjee S, Sau B. Antimicrobial resistance trends in bacterial isolates from urinary tract infections at a medical college in Eastern India - A retrospective observational study. 2024;14(06). https://www.njppp.com/fulltext/28-1696609421.pdf?1765427796
6. Shakya S, Edwards J, Gupte HA, Shrestha S, Shakya BM, Parajuli K, et al. High multidrug resistance in urinary tract infections in a tertiary hospital, Kathmandu, Nepal. Public Heal action. 2021 Nov;11(Suppl 1):24–31. https://doi.org/10.5588/pha.21.0035
7. World Health Organization. Global action plan on antimicrobial resistance. 2017. https://www.who.int/publications/i/item/9789241509763
8. Rai GK, Upreti HC, Rai SK, Shah KP, Shrestha RM. Causative agents of urinary tract infections in children and their antibiotic sensitivity

pattern: a hospital based study. Nepal Med Coll J. 2008 Jun;10(2):86–90. https://pubmed.ncbi.nlm.nih.gov/18828428/

9. Clinical And Laboratory Standards Institute [CLSI]. Performance Standards for Antimicrobial Susceptibility Testing; Twenty-Third Informational Supplement. 2013. https://link.springer.com/article/10.1186/s12941-016-0135-3#:~:text=https%3A//rdcu.be/eT8UY
10. Sedhain A, Sapkota A, Shrestha B. Antibiotic sensitivity pattern in urinary tract infection among adults in central part of Nepal. J Chitwan Med Coll [Internet]. 2019 Dec 27;9(4 SE-Original Research Articles):18–23. Available from: https://nepjol.info/index.php/JCMC/article/view/26894
11. Baral P, Neupane S, Marasini BP, Ghimire KR, Lekhak B, Shrestha B. High prevalence of multidrug resistance in bacterial uropathogens from Kathmandu, Nepal. BMC Res Notes [Internet]. 2012;5(1):38. Available from: https://doi.org/10.1186/1756-0500-5-38
12. Baral R, Shrestha LB, Ortuño-Gutiérrez N, Pyakure P, Rai B, Rimal SP, et al. Low yield but high levels of multidrug resistance in urinary tract infections in a tertiary hospital, Nepal. Public Heal action. 2021 Nov;11(Suppl 1):70–6. https://doi.org/10.5588/pha.21.0044
13. Gupta K, Hooton TM, Naber KG, Wullt B, Colgan R, Miller LG, et al. International clinical practice guidelines for the treatment of acute uncomplicated cystitis and pyelonephritis in women: A 2010 update by the Infectious Diseases Society of America and the European Society for Microbiology and Infectious Diseases. Clin Infect Dis an Off Publ Infect Dis Soc Am. 2011 Mar;52(5):e103-20.
14. Hooton TM, Scholes D, Gupta K, Stapleton AE, Roberts PL, Stamm WE. Amoxicillin-clavulanate vs ciprofloxacin for the treatment of uncomplicated cystitis in women: a randomized trial. JAMA. 2005 Feb;293(8):949–55. https://doi.org/10.1001/jama.293.8.949
15. Bosch FJ, van Vuuren C, Joubert G. Antimicrobial resistance patterns in outpatient urinary tract infections--the constant need to revise prescribing habits. S Afr Med J. 2011 May;101(5):328–31.

https://doi.org/10.7196/samj.4346

16. Lewis DA, Gumede LYE, van der Hoven LA, de Gita GN, de Kock EJE, de Lange T, et al. Antimicrobial susceptibility of organisms causing community-acquired urinary tract infections in Gauteng Province, South Africa. S Afr Med J. 2013 Mar;103(6):377–81. https://scielo.org.za/scielo.php?script=sci_arttext&pid=S0256-95742013000600018