Original Article

Bacterial Profile in Urine Culture and Amikacin Sensitivity and Emergence of Carbapenem-Resistant Pathogens in Tertiary Medical College Hospital, Bangladesh

Syed Minhaj Uddin Ahmed[1], Kazi Shihab Uddin[2], Kamrunnahar Alo[3], Quazi Manjurul Haque[4], Marufa Rehnuma Azad[5], Mahaboba Rahman[6].

Abstract

Background: *Urinary tract infection (UTI) is one of the most common encounters both in the outpatient department and inpatient department. It is important to know the bacteriological etiology according to urine culture and to know the antibiotic sensitivity.*

Objective:*Our study was carried out to observe the urine culture and sensitivity pattern to commonly used injectable antibiotics such as amikacin and to look for the emergence of carbapenem-resistant uropathogens.*

Materials and methods: *A total of 150 patients of UTI being culture positive were isolated and identified by random selection. Samples were collected throughout January 2022 to March 2022. Standard microbiological techniques were used to identify the bacteria and test for susceptibility to various antibiotics. Data were entered into MS Office Excel 2016 for analysis and visualization.*

Results: *The most common urine culture positive was E. coli, 108 (72%) followed by Pseudomonas sp., 16 (11%) and staphylococcus saprophyticus, 15 (10%). The rest of 7% urine culture was positive were other bacterial species. Around 90% of the total cultured E. coli was sensitive to amikacin. Staphylococcus saprophyticus 8 cases (53%), E. coli 15 cases (14%) and Pseudomonas sp. single cases (6%) were resistant to carbapenem. Resistance to vancomycin was common among most of the pathogens, with 88 cases (81%) of E. coli and 12 cases (75%) of Pseudomonas sp. being resistant. In contrast, Staphylococcus saprophyticus had a higher sensitivity to vancomycin, with only 3 cases (20%) being resistant and 12 cases (80%) being sensitive.*

Conclusion: *The study focused on the commonest uropathogens causing UTI and antibiotic resistance in urine isolates may be useful guidelines for clinicians initiating empirical antibiotic therapy as well as help in the formulation of antibiotic therapy strategy.*

Key words: *Urinary Tract Infections (UTI), Uropathogen, Amikacin Sensitivity, Carbapenem-resistant.*

Date of received: *27.03.2023*

Date of acceptance: *25.02.2024*

DOI: https://doi.org/10.3329/kyamcj.v15i01.69779

KYAMC Journal. 2024; 15(01): 16-19.

Introduction

Infection of the urinary tract is one of the most common health concerns worldwide and is estimated to affect around 405 million people globally.[1] UTI may occur in any age and sex groups, especially female children, women in their reproductive age, and older women who are more vulnerable to infections.[2] In our country most of these patients are female, diabetic, and patient with a history of instrumentation of urinary tract. Thus, recurrent or chronic UTI is a concern for increased morbidity and health care cost of the patient.[3,4] These UTI patients are sometimes complicated with septicemia that is urosepsis which causes profound mortality. Studies reported that E. coli is the predominant organism causing both complicated and uncomplicated UTI followed by *Klebsiella pneumoniae, Enterococcus faecalis, Proteus mirabilis,* and *group B Streptococcus*.[5] infection caused by a bacteria's resistance to commonly used antibiotics and broad-spectrum antibiotics makes the situation even worse.[6] In developing countries, the scenario is debilitating due to the inappropriate use of antibiotics in UTI management and as a remarkable proportion of patients purchase antibi

1. Assistant Professor of Biochemistry, Khwaja Yunus Ali Medical College and Hospital, Enayetpur, Sirajganj, Bangladesh.
2. Associate Professor of Medicine, Khwaja Yunus Ali Medical College and Hospital, Enayetpur, Sirajganj, Bangladesh.
3. Associate Professor of Physiology, Khwaja Yunus Ali Medical College and Hospital, Enayetpur, Sirajganj, Bangladesh.
4. Professor of Microbiology, Khwaja Yunus Ali Medical College and Hospital, Enayetpur, Sirajganj, Bangladesh.
5. Anesthesiologist, Department of Anesthesia, Mymensingh Medical College and Hospital, Mymensingh, Bangladesh.
6. Assistant Professor of Physiology and Biochemistry, University Dental College and Hospital, Dhaka, Bangladesh.

Corresponding author: Syed Minhaj Uddin Ahmed, Assistant Professor, Department of Biochemistry, Khwaja Yunus Ali Medical College and Hospital, Enayetpur, Sirajganj, Bangladesh. **Cell**: +8801711978360, **E-mail:** drminhajtopu@gmail.com

otics directly from community pharmacies without prescription or any expert consultation.[6,7] Therefore, it is very important to find out the common pathogen causing UTI in a specific area of the population served by a tertiary medical college hospital. It is also crucial to find a cheaper but cost-effective antibiotic with a very good sensitivity profile to serve a large group of patients. In this study, we find out the bacterial etiology of UTI, the most common bacteria and percentages of other bacteria causing UTI. Based on the culture and sensitivity reports, we examined their sensitivity to injectable antibiotics that are widely used and affordable, such as amikacin. We also paid close attention to finding bacterial resistance to higher antibiotics, for example, carbapenem (Imipenem, meropenem), and aminoglycosides. Besides, we have sought antibiotics that are deemed to be sensitive to the resistant cases of infection that were mentioned before. We have also explored the carbapenem-resistant infection in depth because carbapenem resistance isolates in urine culture and sensitivity is on the rise worldwide.

Materials and Methods

In this observational study, a total of 150 urinary tract infection patients were selected randomly irrespective of age, sex and associated comorbidity like Diabetes mellitus (DM), Chronic kidney disease (CKD) and Benign Enlargement of Prostate (BEP) etc. in Khwaja Yunus Ali Medical College and Hospital in the northern part of Bangladesh throughout January 2022 to March 2022. Both outpatients and inpatients were included in this study. Patients having a clinical history and examination findings suggestive of UTI originating from the kidney, ureter and urinary bladder etc. were selected in an unbiased manner. Any patient having a valid culture report within last six weeks, a history of specific antibiotics resistance UTI, indwelling of catheterization and patients who have already started empirical antibiotics for UTI were excluded from this study. A proper clean catch method of urine sample collection was ensured in this study. Contamination was strictly managed by giving proper instructions on how to handle the specimen correctly.

The recommended culture procedures were used to isolate bacteria. Well-mixed urine samples were placed on MacConkey agar and 5% sheep blood agar. The BD Phoenix TM M50 Automated Microbiology System determined the gram-negative bacterial species. For the identification of organisms, a total of 45 substrates including carbohydrates, amino acids, proteins and its derivatives were used for the observation of reactions to them. All the procedures were done according to the manufacturer's instructions.[8] A sealed and self-inoculating molded polystyrene tray with 136 micro-wells which contain dried reagents, serves as the BD Phoenix disposable device. The combined panel contain an identification (ID) side with dried substrates for bacterial identification and an antimicrobial susceptibility test (AST) side with various concentrations of antimicrobial agents, growth and fluorescent controls at appropriate well locations. The BD Phoenix system utilizes various colorimetric and fluorometric indicators for ID and optimized colorimetric redox indicators for AST.

BD Phoenix M50 system AST was based upon minimal inhibitory concentration (MIC) of selected different antimicrobial agents.[9] A colorimetric oxidation-reduction indicator used to mark microbial metabolism in the BD Phoenix panels. While initial reduction occurs the indicator changes from blue to pink. Further reduction causes the indicator to change from pink to colorless. These microbial metabolisms inhibition indicate the susceptibility to respective antimicrobial agents. Conventional and anti-pseudomonal antibiotics were used in the AST panel.

Data analysis

Statistical analyses and data visualization were done in MS Office Excel 2016 (Microsoft, Washington, USA).

Results

At first, we titrated all the cases according to bacteriological etiology. *E. coli* was the highest bacterial yield in urine culture and it was around 72% (108 out of 150)) to be precised. Secondly Pseudomonas Sp. came up with 11% (16 cases) of urine culture. *Staphylococcus Saprophyticus* claimed the third spot by 10% (15 cases) in bacterial culture and the rest of 7% urine culture positive were *Staphylococcus* group (such as *Staphylococcus hemolyticus*, *Staphylococcus epidermis, Staphylococcus lentus, Staphylococcus aureus), Klebsiella and corynebacterium* (Table I). These bacteria mentioned above were grouped all together as others (Figure: 1).

Table I: Frequency and types of bacterial isolates in urine (total 150 urine samples)

Pathogens	Number of cases
E. coli	108
Pseudomonas sp.	16
Staphylococcus saprophyticus	15
Staphylococcus hemolyticus	2
Staphylococcus epidermis	2
Staphylococcus lentus	2
Staphylococcus aureus	2
Klebsiella	2
Corynebacterium	1

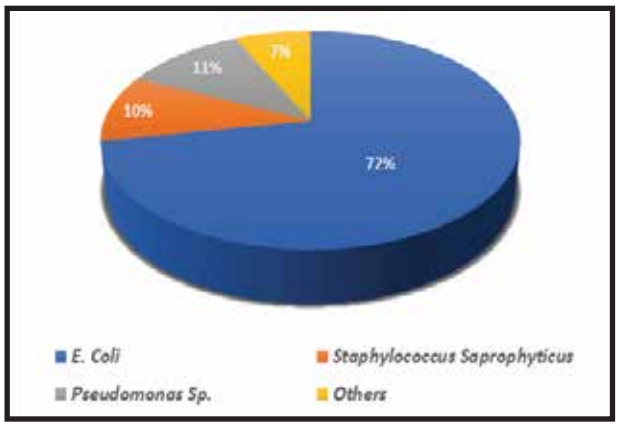

Figure 1: Percentages of bacterial organisms causing UTI

During the study of antibiotic sensitivity surprisingly we found that amikacin was the most sensitive antibiotic followed by carbapenem. About 90% of the total cultured E. coli and 10% of bacteria other than *E. coli* were sensitive to amikacin (Figure: 2).

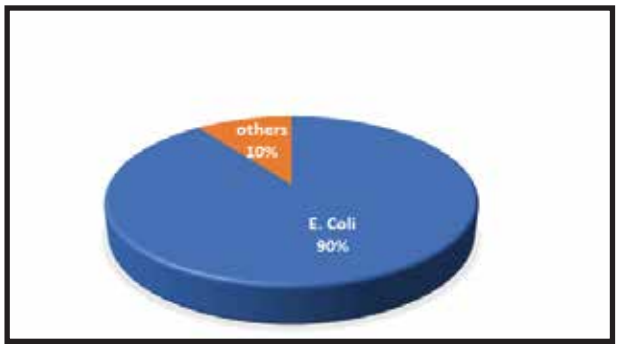

Figure 2: Amikacin sensitivity to Uropathogens

When we studied carbapenem sensitivity pattern 53% Staphylococcus saprophyticus (8 out of 15 cases) were resistance to carbapenem (both imipenem and meropenem). Approximately 14% of E. Coli culture resistance to carbapenem. However, as the E. coli was highest in count, 15 cases among 108 positive cases were resistance to carbapenem. Pseudomonas sp. resistance to carbapenem only 6%, a solitary case was resistance among total 16 cases. Other 9% resistance to carbapenem i.e., only 1 case out of 11. Whereas carbapenem sensitivity to E. coli, Staphylococcus saprophyticus, Pseudomonas sp. was observed 86%, 47% and 94% respectively (Figure: 3).

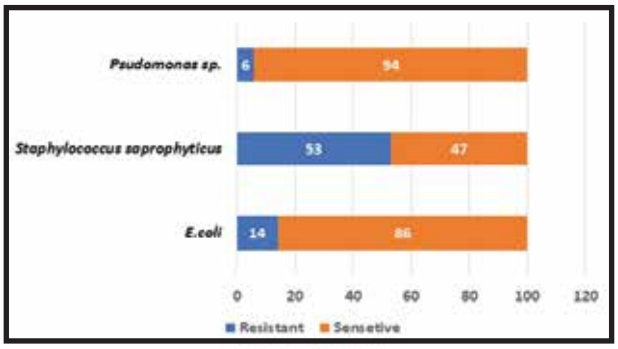

Figure 3: Graphical presentation of carbapenem sensitivity to uropathogens

In this study, most of the pathogens were resistant to vancomycin. Around 81% (88 cases) of E. coli infection were resistant to vancomycin. However, vancomycin resistance to Pseudomonas sp. was 75% (12 cases) as expected. Vancomycin has superior sensitivity to Staphylococcus saprophyticus by 80% (12 cases) being sensitive and 20% (3 cases) being resistant. (Figure: 4).

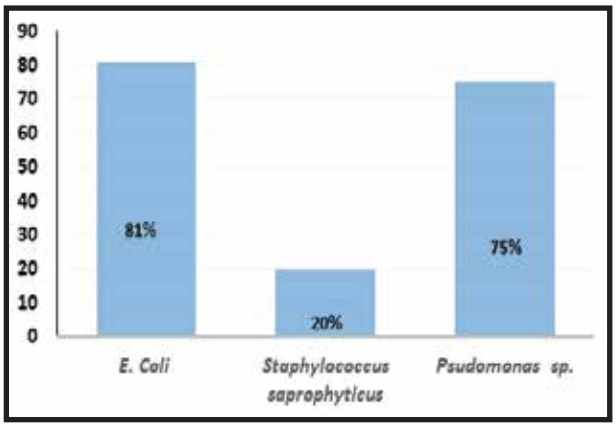

Figure 4: Graphical presentation of vancomycin-resistant to Uropathogens.

Discussion

We demonstrated that in the bacterial isolate without any surprise E. coli happened to be the highest number of pathogens in the urine culture. Pseudomonas got the second spot followed by staphylococcus saprophyticus at 3rd position. Nevertheless, if we include other staphylococcal species, they comprise 15% of the total cases and rank 2nd. Other studies have also reported that E. coli was the predominant isolate from patients with UTIs, which is consistent with this finding.[10] The Staphylococcal group rarely causes UTI. However, female patients are more likely to get it. Klebsiella, Corynebacterium, Proteus, Streptococcus acidominimus, Kocuria kristinae were some of the uncommon pathogens that were identified.[11]

During sensitivity study, E. coli was mostly sensitive to the injectable antibiotics. Amikacin is the most effective antibiotic against many Gram-negative bacteria.[12] Our study showed that amikacin sensitivity was present in more than 90% of E. coli isolates, which agrees with the findings of R. Shyamala et al.[13] Additionally, 86% of these isolates exhibited carbapenem sensitivity. Carbapenems are considered to be the drugs of choice for the treatment of severe infections caused by Enterobacteriaceae particularly E. coli, and other Gram-negative bacteria.[14] Unfortunately, the increased dependence on such antimicrobial agents has led to the emergence and spread of carbapenem resistance, especially among Enterobacteriaceae.[15] Carbapenem got resistant mostly to staphylococcus saprophyticus followed by E. coli and Pseudomonas. We found 13 cases where carbapenem was resistant but amikacin was sensitive. In these cases, amikacin happen to be the only alternative antibiotic. There were 5 cases where all the antibiotics were resistant. Out of these 5 cases 4 had E. coli and 1 had Staphylococcus saprophyticus.

Vancomycin has never been drug of choice in UTI. According to the result it showed very poor sensitivity to E. coli and Pseudomonas. However, vancomycin sensitivity was found to be better against staphylococcal species of pathogen, which is expected. We also found 5 cases where vancomycin was sensitive, although carbapenem and amikacin were resistant.
Our study revealed well well-documented emergence of carbapenem-resistant uropathogens which is alarming. Howev er, we still found other antibiotics which (amikacin and vancomycin) were sensitive to carbapenem-resistant cases. So still we have some option to choose in carbapenem-resistant cases. However, the fact that 5 cases of carbapenem-resistant were resistant to all antibiotics is frightening and may become perilous in the future. Therefore, the injudicious use of antibiotics has to be stopped. Regional and institute-based urine culture and sensitivity pattern guided protocol must be administered and followed strictly.

Conclusion

UTI is one of the commonest causes of inpatient admission throughout the world. In our study E. coli, is the commonest uropathogen causing UTI followed by Pseudomonas and Staphylococcal group. Empirical antibiotics are given awaiting urine culture report. A good methodical culture will take at least 48 hours to give proper results. It is important to make a good choice of antibiotic which is cheaper and has a good sensitivity profile to uropathogen. Our study result showed amikacin which is a very cheap and easily available antibiotic in our country can serve the purpose accurately and respectfully. Our study also showed the emergence of carbapenem-resistant uropathogens in a notable number of cases. Therefore, carbapenem and other antibiotics like these should be reserved until the culture and sensitivity report comes. They should only be used when other alternatives are resistant.

Acknowledegment

The authors extend their heartfelt appreciation to the dedicated staff of the Laboratory Services Department at Khwaja Yonus Ali Medical College Hospital for their invaluable assistance in conducting this study. Additionally, we express sincere gratitude to all research participants who generously contributed to our work.

References

1. Zeng Z, Zhan J, Zhang K, Chen H, Cheng S. Global, regional, and national burden of urinary tract infections from 1990 to 2019: an analysis of the global burden of disease study 2019. World J Urol. 2022; 40 (3):755–763.

2. Minardi D, d'Anzeo G, Cantoro D, Conti A, Muzzonigro G. Urinary tract infections in women: etiology and treatment options. Int J Gen Med. 2011; 4:333.

3. Noor R, Munna MS. Emerging diseases in Bangladesh: Current Microbiological Research Perspective. Ci Ji Yi Xue Za Zhi. 2015; 27(2):49–53.

4. Rahman MM, Zhang C, Swe KT, Rahman MS, Islam MR, Kamrujjaman M, et al. Disease-specific outof-pocket healthcare expenditure in urban Bangladesh: A Bayesian analysis. PLoS One. 2020; 15(1): e0227565.

5. Flores-Mireles AL, Walker JN, Caparon M, Hultgren SJ. Urinary tract infections: epidemiology, mechanisms of infection and treatment options. Nat Rev Microbiol. 2015; 13(5):269–268.

6. Auta A, Hadi MA, Oga E, Adewuyi EO, Abdu-Aguye SN, Adeloye D, et al. Global access to antibiotics without prescription in community pharmacies: A systematic review and meta-analysis. J Infect. 2019; 78(1):8–18.

7. Leski TA, Taitt CR, Bangura U, Stockelman MG, Ansumana R, Cooper WH 3rd, et al. High prevalence of multidrug resistant Enterobacteriaceae isolated from outpatient urine samples but not the hospital environment in Bo, Sierra Leone. BMC Infect Dis. 2016; 16:167.

8. Hong JS, Kim D, Kang DY, Park BY, Yang S, Yoon EJ, Lee H, Jeong SH. Evaluation of the BD Phoenix M50 Automated Microbiology System for Antimicrobial Susceptibility Testing with Clinical Isolates in Korea. Microb Drug Resist. 2019 Oct;25(8):1142-1148.

9. Auta A, Hadi MA, Oga E, Adewuyi EO, Abdu-Aguye SN, Adeloye D, et al. Global access to antibiotics without prescription in community pharmacies: A systematic review and meta-analysis. J Infect. 2019; 78(1):8–18.

10. Lei G, Yonghong X. 2006–2007 Mohnarin report:Bacterial distribution and resistance in urinary tract infections. Chinese J Antibiotics 2008; 33:586–634.

11. Qiao LD, Chen S, Yang Y, Zhang K, Zheng B, Guo HF, Yang B, Niu YJ, Wang Y, Shi BK, Yang WM, Zhao XK, Gao XF, Chen M, Tian Y. Characteristics of urinary tract infection pathogens and their in vitro susceptibility to antimicrobial agents in China: data from a multicenter study. BMJ Open. 2013 Dec 13;3(12): e004152.

12. R. Cruickshank; Medical microbiology: The practice of medical microbiology, Churchill Livingstone, U. K., 1989, 3, 374

13. R. Shyamala , M. V. Rama Rao, Janardhan Rao R. The Sensitivity pattern of Escherichia coli to Amikacin in a tertiary care hospital. Der Pharmacia Lettre, 2012, 4 (3):1010-1012

14. Pitout JD, Laupland KB. Extended-spectrum β-lactamase-producing Enterobacteriaceae: an emerging public health concern. Lancet Infect Dis. 2008; 8: 159-166.

15. Schwaber MJ, Carmeli Y. Carbapenem Resistant Enterobacteriaceae: A Potential Threat. JAMA. 2008; 300: 2911-2913.