Section: Microbiology

Original Research Article

A STUDY ON EMERGENCE OF FOSFOMYCIN AND NITROFURANTOIN RESISTANCE AMONG URINARY E. COLI ISOLATES IN TERTIARY CARE HOSPITAL OF SOUTH GUJARAT

Pramod Kumar Verma[1], Geeta Vaghela[2], Summaiya Mullan[3]

[1]2nd Year PG Resident, Department of Microbiology Government Medical College Surat, Gujarat, India.
[2]Associate Professor, Department of Microbiology, Government Medical College Surat, Gujarat, India.
[3]Professor and Head, Department of Microbiology, Government Medical College Surat, Gujarat, India.

Received *: 05/07/2025*
Received in revised form *: 12/08/2025*
Accepted *: 02/09/2025*

Corresponding Author:
Dr. Pramod Kumar Verma,
2nd Year PG Resident, Department of Microbiology, Government Medical College Surat, Gujarat India.
Email: pramodmbbs2k15@gmail.com

DOI: 10.70034/ijmedph.2025.3.544

Source of Support: Nil,
Conflict of Interest: None declared

Int J Med Pub Health
2025; 15 (3); 2960-2963

ABSTRACT

Background: Urinary tract infections (UTIs) are among the most common bacterial infections worldwide, with an estimated 150 million cases annually. Empirical treatment often leads to antibiotic misuse and resistance, making continuous surveillance of uropathogens essential. With rising multidrug resistance, older agents such as nitrofurantoin and fosfomycin, which achieve high urinary concentrations and minimal systemic effects, have regained importance. **Objective:** To evaluate the emergence of fosfomycin and nitrofurantoin resistance and its susceptibility pattern among urinary E. coli isolates in a tertiary care hospital.

Materials and Methods: A retrospective analytic study was conducted on urine samples received in the Department of Microbiology between June and November 2024. Samples were processed using standard laboratory protocols. Antimicrobial susceptibility was determined by Kirby-Bauer disc diffusion on Mueller-Hinton agar. Data were analyzed using Microsoft Excel.

Results: Out of 2,998 urine samples, 2,682 were mid-stream collections and 316 were catheterized specimens. A total of 150 Escherichia coli isolates were obtained. Susceptibility testing revealed that 78% were sensitive to nitrofurantoin and 92% to fosfomycin, with resistance rates of 12% and 7%, respectively.

Conclusion: Fosfomycin demonstrated higher in vitro susceptibility against E. coli compared to nitrofurantoin, supporting its role as an effective option for empirical management of UTIs in the era of rising resistance.

Keywords: Urinary Tract Infections; Escherichia coli; Drug Resistance, Bacterial; Nitrofurantoin; Fosfomycin; Anti-Bacterial Agents.

INTRODUCTION

UTIs are among the most common bacterial infections, affecting individuals across all age groups and populations. They account for nearly 25% of all reported infections,[1] with an estimated 150 million cases diagnosed annually worldwide.[2] Uropathogenic Escherichia coli (UPEC), characterized by diverse phylogenetic backgrounds and virulence profiles, are often multidrug-resistant (MDR), posing a significant global health challenge.[3] The high prevalence of UTIs, coupled with their generally mild clinical course, has led to frequent empirical antibiotic use. However, increasing antimicrobial resistance complicates treatment. Factors such as population aging, antibiotic allergies, adverse drug reactions, rising numbers of immunocompromised patients, and, most importantly, the emergence of MDR, contribute to therapeutic failures.

Owing to these challenges, older antibiotics such as fosfomycin and nitrofurantoin are being reconsidered as valuable alternatives.[4] Both agents demonstrate favourable pharmacokinetics, including rapid oral absorption, high urinary concentrations, and broad-spectrum bactericidal activity against Gram-negative

and Gram-positive pathogens.[5] These features make them suitable options for managing uncomplicated community-acquired UTIs. The present study was undertaken to evaluate the emergence of fosfomycin and nitrofurantoin resistance and its susceptibility pattern among urinary E. coli isolates in a tertiary care hospital of South Gujarat.

MATERIALS AND METHODS

This retrospective analytical study was conducted in the Department of Microbiology, a tertiary care hospital in South Gujarat, from June 2024 to November 2024.

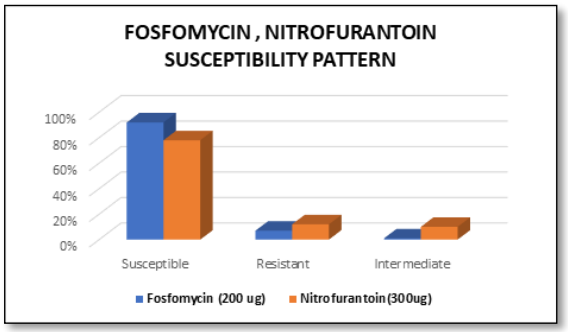
Microbiological methods: All urine samples received for culture and sensitivity testing during the study period were processed according to standard laboratory protocols. A total of 150 E. coli isolates were included in the study. Microscopy and culture were performed as per routine procedures, and a colony count of $\geq 10^5$ CFU/ml of a single organism (or of each of two potential pathogens), along with the presence of pus cells, was considered significant.

Culture and isolate identification: Organism identification was carried out based on colony characteristics on nutrient agar and MacConkey agar, wet mount microscopy, motility testing, and standard biochemical reactions, including indole production, citrate utilization, triple sugar iron test, urease test, methyl red test (MR), and Voges-Proskauer (VP) test.

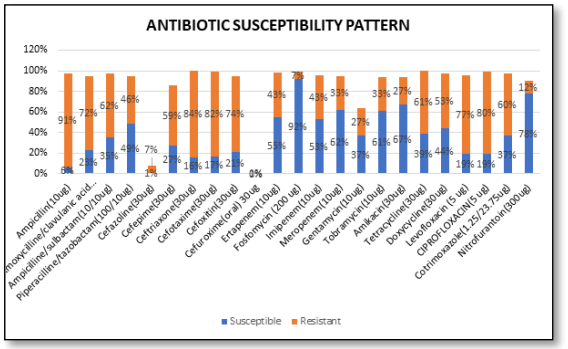
Antimicrobial susceptibility tests (AST): It was performed on Mueller–Hinton agar using the Kirby–Bauer disc diffusion method, following the Clinical and Laboratory Standards Institute (CLSI) guidelines, 33rd edition (2024).

Statistical Analysis: Data were analyzed using SPSS software, version 23.0. Categorical variables were summarized and expressed as frequencies and percentages.

RESULTS



Graph-1: Susceptibility Pattern



Graph-2: Antibiotic Susceptibility Pattern

Table 1: Susceptibility Pattern

Susceptibility Pattern	Susceptible	Resistant	Intermediate
FOSFOMYCIN (200ug)	92.00%	7.00%	1.00%
NITROFURANTOIN (300ug)	78.00%	12.00%	10.00%

A total of 2,998 urine samples were received, of which 2,682 were obtained through mid-stream collection and 316 from catheterized patients. Among the isolated E. coli strains, 78% were susceptible to nitrofurantoin and 92% to fosfomycin. Resistance was observed in 12% of isolates against nitrofurantoin and 7% against fosfomycin (As shown in Table 1).

Table 2: Antibiotic Susceptibility Pattern

Antibiotic (Disc Potency)	Susceptible (%)	Resistant (%)
Ampicillin (10 µg)	6.00%	91.00%
Amoxicillin/Clavulanic acid (20/10 µg)	23.00%	72.00%
Ampicillin/Sulbactam (10/10 µg)	35.00%	62.00%
Piperacillin/Tazobactam (100/10 µg)	49.00%	46.00%
Cefazoline (30 µg)	1.00%	7.00%
Cefepime (30 µg)	27.00%	59.00%
Ceftriaxone (30 µg)	16.00%	84.00%
Cefotaxime (30 µg)	17.00%	82.00%
Cefuroxime (30 µg)	21.00%	74.00%
Cefuroxime (30 µg)	0.00%	0.00%
Ertapenem (10 µg)	55.00%	43.00%
Fosfomycin (200 µg)	92.00%	7.00%
Imipenem (10 µg)	53.00%	43.00%
Meropenem (10 µg)	62.00%	33.00%
Gentamycin (10 µg)	37.00%	27.00%
Tobramycin (10 µg)	61.00%	33.00%

Amikacin (30 µg)	67.00%	27.00%
Tetracycline (30 µg)	39.00%	61.00%
Doxycycline (30 µg)	44.00%	53.00%
Levofloxacin (5 µg)	19.00%	77.00%
Ciprofloxacin (5 µg)	19.00%	80.00%
Cotrimoxazole (1.25/23.75 µg)	37.00%	60.00%
Nitrofurantoin (300 µg)	78.00%	12.00%

The antibiotic susceptibility pattern of urinary E. coli isolates revealed high resistance to ampicillin, cephalosporins, and fluoroquinolones, while moderate sensitivity was observed with aminoglycosides and carbapenems. Fosfomycin (92%) and nitrofurantoin (78%) remained the most effective agents, indicating their reliability for treating urinary tract infections (Depicted in table 1, Graph 2).

DISCUSSION

UTIs remain one of the most frequently encountered bacterial infections in both community and hospital settings, with E. coli being the predominant causative pathogen.[6] The increasing prevalence of MDR uropathogens has significantly limited the effectiveness of commonly prescribed antibiotics, creating major challenges in clinical management. In light of these concerns, there is renewed interest in older antimicrobials such as nitrofurantoin and fosfomycin, which have re-emerged as valuable treatment options for UTIs.

The findings of the present study demonstrated that E. coli isolates showed 78% susceptibility to nitrofurantoin and 92% to fosfomycin. These results are consistent with earlier studies showing the effectiveness of these agents against resistant strains. Sharmin S. et al.[10] reported that E. coli (65.84%) was the most frequently isolated uropathogen, followed by Klebsiella pneumoniae (16.49%). Similarly, Sharlee R. et al.[13] also identified E. coli as the predominant isolate (29.1%) among gram-negative bacilli.

Kaur J et al.[9] reported high resistance to third-generation cephalosporins, with ceftriaxone resistance observed in 60% of E. coli and 64% of K. pneumoniae. Ciprofloxacin resistance was also significant, and the highest resistance rate (62%) observed in Acinetobacter baumannii. In contrast, fosfomycin demonstrated strong activity, with ≥93% susceptibility across gram-negative isolates, compared with 72% susceptibility to nitrofurantoin.

In comparison, the present study found slightly lower susceptibility to nitrofurantoin (78%), when compared with findings by Kanaujia et al.[10] who reported 92% susceptibility. This difference may be attributed to the excessive use of nitrofurantoin in certain regions, contributing to increased resistance. Interestingly, fosfomycin susceptibility in our study (92%) was notably higher than that reported by Kanaujia et al. (65%).[10]

The prevalence of MDR isolates has been shown to vary across regions, ranging from 28.03% to 51.50% in different studies.[11-13] Dalai et al.[14] reported a comparatively lower prevalence of 14.80% in Pune. These variations likely reflect differences in antibiotic prescribing practices, regional antimicrobial stewardship, and infection control measures.

Overall, nitrofurantoin remains a suitable option for uncomplicated lower urinary tract infections, as bacterial resistance to it is still relatively uncommon. Fosfomycin, on the other hand, continues to be a safe and effective treatment option, especially for community-acquired infections caused by resistant organisms. However, its use should be carefully regulated to prevent the emergence of resistance. Together, these agents represent valuable therapeutic options for the management of UTIs in the era of rising multidrug resistance.

CONCLUSION

Fosfomycin demonstrated higher in vitro susceptibility against E. coli compared to nitrofurantoin, making it a more reliable agent for urinary tract infections. Its single-dose oral formulation also offers greater patient convenience and compliance. Nitrofurantoin, however, remains a valuable treatment for uncomplicated lower UTIs due to its long-standing clinical use and relatively low resistance rates. Both drugs can serve as effective empirical options in the management, particularly in settings where resistance to commonly prescribed antibiotics such as cephalosporins and fluoroquinolones is high. Ongoing antimicrobial surveillance and further large-scale studies are required to assess evolving resistance patterns and to ensure their sustained effectiveness in clinical practice.

REFERENCES

1. Ahmed MA, Shukla GS, Bajaj HK. Incidence of Urinary Tract Infections and determination of their susceptibility to antibiotics among Pregnant Women. Int J Cell Sci Biotechnol. 2016; 5:12-6.
2. Kothari A, Sagar V. Antibiotic resistance in pathogens causing community-acquired urinary tract infections in India: a multicenter study. J Infect Dev. 2008;2(5):354-8.
3. Abdelraheem WM, Mahdi WK, Abuelela IS, Hassuna NA. High incidence of fosfomycin-resistant uropathogenic E. coli among children. BMC Infectious Diseases. 2023 Jul 17;23(1):475.
4. Sorlozano, A.; Jimenez-Pacheco, A.; de Dios Luna Del Castillo, J.; Sampedro, A.; Martinez-Brocal, A.; Miranda-Casas, C.; Navarro-Marí, J.M.; Gutiérrez-Fernández, J. Evolution of the resistance to antibiotics of bacteria involved in urinary tract infections: A 7-year surveillance study. Am. J. Infect. Control 2014, 42,1033–1038.

5. Park KS, Kim DR, Baek JY, Shin A, Kim KR, Park H, Son S, Cho H, Kim YJ. Susceptibility to fosfomycin and nitrofurantoin of ESBL-positive Escherichia coli and Klebsiella pneumoniae isolated from urine of pediatric patients. Journal of Korean Medical Science. 2023 Dec 11;38(48).
6. Mancuso G, Midiri A, Gerace E, Marra M, Zummo S, Biondo C. Urinary Tract Infections: The Current Scenario and Future Prospects. Pathogens. 2023;12(4):623.
7. Sharmin S, Mostofa Kamal SM, Reza M, Ashik Elahi KM, Mostofa Elma SM, Habib B. Fosfomycin-A promising oral antibiotic for the treatment of Urinary Tract Infection (UTI) Open J Urol. 2022;12:257–70.
8. Sharlee R, Sumangala B. Fosfomycin susceptibility on uropathogens in a tertiary care hospital, Mandya institute of medical sciences, Mandya. Indian J Microbiol Res. 2019; 6:15–7.
9. Kaur J, Bhat P, Bhumbla U. Fosfomycin susceptibility in multidrug resistant uropathogens: A retrospective study in the era of antimicrobial resistance. J Family Med Prim Care. 2025;14(4):1346-1351.
10. Kanaujia R, Kumar A, Bajpai M. Determination of nitrofurantoin and fosfomycin susceptibility among urinary Escherichia coli isolates. Int J Res Med Sci 2020;8:3274-6.
11. Bakshi R, Sehgal VK, Kansal P, Kaur S. Detection of Extended spectrum beta lactamases and AmpC beta lactamases producing uropathogenic Escherichia coli in a tertiary care hospital. Int J Med Dent Sci. 2019; 8:1783–92.
12. Pai KB, Rajagopalan B. Susceptibility of urinary Escherichia coli to fosfomycin and nitrofurantoin-reexploration of old andforgotten oral antibiotics. J Evol Med Dent Sci. 2020; 9:928–31.
13. Jain R, Pal N, Hooja S. Fosfomycin susceptibility among multidrug resistant and extended spectrum? -lactamase producing uropathogenic Escherichia coli isolates at a tertiary care hospital of Western India. CHRISMED J Health Res. 2022; 9:125–9.
14. Dalai S, Modak M, Lahiri K. Fosfomycin susceptibility among uropathogenic E. coli and K. pneumoniae. Intern J Sci Res. 2019;8:282–4..