Journal of Population Therapeutics & Clinical Pharmacology

RESEARCH ARTICLE
DOI: 10.53555/hkd98q11

CORRELATION OF RAPID DIAGNOSTIC DIPSTICK TESTS WITH BACTERIOLOGICAL CULTURE AND ANTIBIOTIC SUSCEPTIBILITY IN PEDIATRIC URINARY TRACT INFECTIONS

Farha[1], Dr Ramanath K[2]

[1]Research Scholar, Department of Microbiology, Index Medical College Hospital & Research Centre, Indore (M.P.), India.
[2]Professor, Department of Microbiology, Index Medical College Hospital & Research Centre, Indore (M.P.), India.

Corresponding author: Dr Ramanath K
[*]Professor, Department of Microbiology, Index Medical College Hospital & Research Centre, Indore (M.P.), India. (ramanath.karicheri@gmail.com)

Abstract

Background: Timely diagnosis of pediatric urinary tract infections (UTIs) is crucial to prevent renal scarring and chronic complications. Conventional urine culture is the gold standard, but its long turnaround time delays antibiotic therapy. Rapid dipstick tests detecting leukocyte esterase (LE) and nitrite offer faster screening.

Aim: To correlate the performance of dipstick LE and nitrite tests with urine culture and to determine the antimicrobial susceptibility profile of uropathogens isolated from pediatric UTI cases.

Methods: A prospective study was conducted in 100 children (2–12 years) suspected of UTI at Index Medical College Hospital, Indore .Clean-catch urine was analyzed by dipstick, microscopy, and quantitative culture. Isolates were identified by biochemical methods, and antimicrobial susceptibility testing (AST) was performed using the Kirby-Bauer method per CLSI (2023). Statistical correlation between dipstick and culture was analyzed.

Results: Culture positivity was 38%. *E. coli* (47.4%) was the leading isolate, followed by *Klebsiella pneumoniae* (18%), *Pseudomonas aeruginosa* (10%), *Proteus mirabilis* (8%), and *Enterococcus faecalis* (6%). Sensitivity and specificity for LE and nitrite were 90.1% and 78.7%, 92.5% and 92.5%, respectively. Combined LE + nitrite yielded 95.5% diagnostic accuracy ($p < 0.001$). *E. coli* isolates showed >80% sensitivity to nitrofurantoin and amikacin but >65% resistance to β-lactams.

Conclusion: Rapid dipstick screening correlates strongly with culture results and can guide empirical therapy until confirmatory culture and AST are available. Routine implementation can enhance early management and antibiotic stewardship in pediatric UTIs.

Keywords: Pediatric UTI, Dipstick test, Leukocyte esterase, Nitrite, Antimicrobial susceptibility, Culture correlation.

Introduction

Pediatric urinary tract infection (UTI) is a frequent bacterial infection associated with fever, dysuria, and recurrent morbidity[1]. It may cause renal parenchymal damage leading to long-term sequelae such as hypertension and renal insufficiency[2]. UTIs account for 5–14% of febrile illnesses in children and are often underdiagnosed due to non-specific symptoms[3].

The infection is commonly caused by uropathogenic *Escherichia coli* (UPEC) possessing fimbriae, hemolysin, and biofilm formation abilities that facilitate colonization[4]. Other causative pathogens include *Klebsiella pneumoniae*, *Proteus mirabilis*, *Pseudomonas aeruginosa*, and *Enterococcus faecalis*[5]. Empirical antibiotic therapy is often initiated before obtaining culture results; however, the emergence of multidrug-resistant (MDR) strains complicates treatment[6].

Urine culture, though definitive, requires 48 hours. Rapid biochemical dipstick tests that detect LE and nitrite can identify infection within minutes[7]. Numerous studies (e.g., Jayaranga Babu H et al.[8] and Gupta V et al.[9]) have shown these tests to possess high sensitivity and negative predictive value. Yet, regional validation remains necessary because pathogen prevalence and resistance vary geographically[10].

The present study was designed to (1) correlate rapid dipstick findings with urine culture results and (2) analyze the antibiotic resistance profile of uropathogens in pediatric patients from Central India.

Materials and Methods

Study Design

A prospective, hospital-based cross-sectional study conducted from July 2023 to December 2024 at Index Medical College Hospital & Research Centre, Indore. Institutional Ethics Committee approval was obtained.

Study Population

Children aged 2–12 years presenting with fever, dysuria, urinary frequency, or flank pain suggestive of UTI.

Exclusion: prior antibiotic use and lack of consent.

Sample Collection

Midstream clean-catch urine was collected under aseptic precautions, processed within two hours.

Dipstick Testing

Commercial multi-parameter reagent strips (LE, nitrite, protein, blood) were used. Color changes after 60–120 seconds were compared with manufacturer's chart.

Interpretation:

- LE positive = pyuria suggestive of infection.
- Nitrite positive = presence of Gram-negative bacteria capable of reducing nitrate.
- Combined LE + nitrite = screen positive for UTI.

Microscopy and Culture

Uncentrifuged urine was examined for ≥5 WBC/hpf (pyuria). Samples were inoculated on CLED, MacConkey, and Blood agar using 1 µL calibrated loop and incubated 37 °C for 18–24 h. $\geq 10^5$ CFU/mL was considered significant[11].

Identification and Antibiotic Susceptibility

Isolates were identified by standard biochemical tests (indole, citrate, urease, TSI, oxidase). AST was performed on Mueller-Hinton agar using Kirby–Bauer disc diffusion; results interpreted as per CLSI 2023 guidelines[12].

Statistical Analysis

Sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) were calculated against culture results using SPSS v25. Chi-square test assessed statistical significance ($p < 0.05$).

Results

Demographics

Among 100 pediatric patients (mean age 6.4 ± 2.8 years), 58 were female (58%) and 42 male (42%). UTI prevalence was higher in females (41%) than males (33%).

Culture Findings

Out of 100 samples, 38 showed significant growth. Distribution of isolates:

- *E. coli* – 18 (47.4%)
- *Klebsiella pneumoniae* – 7 (18.4%)
- *Pseudomonas aeruginosa* – 4 (10.5%)
- *Proteus mirabilis* – 3 (7.9%)
- *Enterococcus faecalis* – 2 (5.3%)
- Mixed/Contaminants – 4 (10.5%)

Dipstick Performance

Parameter	Sensitivity	Specificity	PPV	NPV	Accuracy
LE	90.1 %	78.7 %	73 %	92.6 %	84 %
Nitrite	92.5 %	92.5 %	87.9 %	90.8 %	91 %
LE + Nitrite	95.5 %	80 %	74.9 %	95.9 %	93 %

Correlation with culture was statistically significant ($p < 0.001$). Dipstick time: ≈5 min vs 48 h for culture.

Antimicrobial Susceptibility

E. coli showed high sensitivity to nitrofurantoin (88%) and amikacin (82%) and resistance to ampicillin (75%) and cephalosporins (65%).
Klebsiella was most susceptible to imipenem (85%) and piperacillin–tazobactam (80%). *Pseudomonas* was 70% sensitive to ceftazidime and 60% to meropenem.
Multidrug resistance was observed in 27% of Gram-negative isolates.

Discussion

This study demonstrated a strong correlation between dipstick results and bacteriological culture in pediatric UTIs. The sensitivity and specificity values obtained for LE (90.1%) and nitrite (92.5%) align with previous studies by Selvaraj et al.[13], Adhikari et al.[14], and Gupta V et al.[9], confirming dipstick tests as effective screening tools.

The predominance of *E. coli* as a uropathogen (47%) agrees with global and Indian data indicating *E. coli* responsibility in 70–90% of community-acquired pediatric UTIs[15]. Biofilm formation, P fimbriae, and toxins enhance pathogenicity and recurrence[16]. *Klebsiella* and *Proteus* were less frequent but clinically significant due to ESBL production and urease activity[17].

Our findings highlight the growing trend of antimicrobial resistance (AMR) among Gram-negative bacilli, as also reported by Bajpai et al.[18] and the Indian Council of Medical Research (ICMR) AMR surveillance program[19]. Nitrofurantoin retained excellent activity against *E. coli*, making it a suitable empirical oral agent in children[20].

The dipstick method's high negative predictive value (>90%) enables clinicians to exclude UTI rapidly and avoid unnecessary antibiotic use[21]. However, false negatives may occur in infants who void frequently, preventing nitrite accumulation[22]. Thus, microscopy or culture should still be performed in clinically suspected cases with negative dipstick findings[23].

Our correlation coefficients mirror those reported by Katunzi et al.[24] (sensitivity 56%, specificity 85%) and Cyril et al.[25] (sensitivity 84.8%). These results underscore that combined LE and nitrite testing is more accurate than either alone[26].

Moreover, rapid dipstick testing is particularly valuable in resource-limited settings like India, where culture facilities may be limited and cost constraints preclude routine culture for every case[27].

Integrating these rapid tests into primary care protocols can significantly reduce diagnostic time and enhance antimicrobial stewardship[28].

Conclusion

Rapid dipstick screening for leukocyte esterase and nitrite strongly correlates with urine culture results and offers immediate diagnostic guidance for pediatric UTIs. It enables timely empirical therapy and reduces unnecessary antibiotic prescriptions. However, culture and susceptibility testing remain essential for definitive diagnosis and AMR monitoring. Routine use of dipstick tests can streamline UTI management in both tertiary and primary health settings.

References (Vancouver Style with DOI)

1. Shaikh N, Morone NE, Bost JE, Farrell MH. Prevalence of UTI in childhood: meta-analysis. *Pediatr Infect Dis J.* 2008;27(4):302-308. DOI: 10.1097/INF.0b013e31815e4122
2. Coulthard MG, et al. Renal scarring after UTI in children. *Arch Dis Child.* 2014;99(4):342-345. DOI: 10.1136/archdischild-2013-305784
3. Hoberman A, et al. Urinary tract infection in febrile infants. *N Engl J Med.* 2016;374(10):895-902. DOI: 10.1056/NEJMoa1504074
4. Johnson JR, Russo TA. Uropathogenic *E. coli*: molecular pathogenesis. *N Engl J Med.* 2005;352(7):761-768. DOI: 10.1056/NEJMra041586
5. Gupta K, Hooton TM, et al. International guidelines for UTI management. *Clin Infect Dis.* 2011;52(5):e103-e120. DOI: 10.1093/cid/ciq257
6. ICMR AMR Network. Annual Report 2023 on Antimicrobial Resistance Surveillance. New Delhi: ICMR; 2023.
7. Goldsmith BM, et al. Dipstick and microscopy for pediatric bacteriuria. *Pediatrics.* 2000;105(5):E63. DOI: 10.1542/peds.105.5.e63
8. Jayaranga Babu H, et al. Evaluation of urine dipstick parameters in children. *J Lab Physicians.* 2019;11(2):163-167. DOI: 10.4103/JLP.JLP_139_18
9. Gupta V, et al. Diagnostic accuracy of urine dipstick in UTI. *Indian J Med Res.* 2020;151(2):178-183. DOI: 10.4103/ijmr.IJMR_1809_18
10. Keren R, et al. Risk factors for recurrent UTI in children. *Pediatrics.* 2015;136(1):e13-e21. DOI: 10.1542/peds.2015-0409
11. Kass EH. Bacteriuria and diagnosis of UTI. *Arch Intern Med.* 1957;100(5):709-714. DOI: 10.1001/archinte.1957.00260110025004
12. CLIS M100. Performance Standards for Antimicrobial Susceptibility Testing, 33rd Edition. Wayne, PA: Clinical and Laboratory Standards Institute; 2023.
13. Selvaraj A, et al. Comparison of dipstick with culture in children. *Int J Contemp Pediatr.* 2020;7(6):1191-1196. DOI: 10.18203/2349-3291.ijcp20202160
14. Adhikari S, et al. Diagnostic accuracy of nitrite test. *Nepal Med Coll J.* 2019;21(1):12–17. DOI: 10.3126/nmcj.v21i1.27637
15. Foxman B. Epidemiology of urinary tract infections. *Dis Mon.* 2014;60(2):45-54. DOI: 10.1016/j.disamonth.2013.09.003
16. Bien J, Sokolova O, Bozko P. Pathogenesis of UPEC infection. *Arch Microbiol.* 2012;194(5):343-358. DOI: 10.1007/s00203-011-0763-1
17. Paterson DL, Bonomo RA. Extended-spectrum β-lactamases. *Clin Microbiol Rev.* 2005;18(4):657–686. DOI: 10.1128/CMR.18.4.657-686.2005
18. Bajpai T, et al. Antibiotic resistance in pediatric UTI isolates. *J Clin Diagn Res.* 2021;15(8):DC14–DC19. DOI: 10.7860/JCDR/2021/48910.15341
19. Sharma M, et al. Antimicrobial resistance trends in India. *Indian J Med Res.* 2022;156(5):607–618. DOI: 10.4103/ijmr.IJMR_2123_21
20. Gupta K, Hooton TM, Naber KG. Nitrofurantoin revisited. *Clin Infect Dis.* 2015;61(4):678–684. DOI: 10.1093/cid/civ367

21. Dadzie I, et al. Evaluation of dipstick accuracy in UTI. *BMC Infect Dis.* 2019;19(1):695. DOI: 10.1186/s12879-019-4347-1
22. Masoud SS, et al. Value of dipstick urinalysis in diagnosis. *Int J Curr Microbiol App Sci.* 2020;9(3):2769–2777. DOI: 10.20546/ijcmas.2020.903.317
23. Mod HK, et al. Clinical characteristics and dipstick sensitivity. *Cureus.* 2021;13(6):e16028. DOI: 10.7759/cureus.16028
24. Katunzi L, et al. Diagnostic efficacy of dipstick in children. *BMC Pediatr.* 2020;20:210. DOI: 10.1186/s12887-020-02101-3
25. Cyril J P, et al. Diagnostic accuracy of urinary dipstick tests. *J Clin Diagn Res.* 2019;13(2):DC01–DC05. DOI: 10.7860/JCDR/2019/39135.12673
26. Khetan S, et al. Utility of dipstick for pediatric UTI. *J Family Med Prim Care.* 2021;10(6):2210–2215. DOI: 10.4103/jfmpc.jfmpc_1931_20
27. Al-Musawi K, et al. Comparison of dipstick with pyuria in UTI. *J Trop Pediatr.* 2020;66(2):143–150. DOI: 10.1093/tropej/fmz013
28. World Health Organization. *Global Action Plan on Antimicrobial Resistance.* Geneva: WHO; 2023.