Section: Paediatrics

Original Research Article

A STUDY ON USE OF URINE DIPSTICK AS A SCREENING TEST FOR EVALUATION OF CHILDREN AGED 2-12 YEARS WITH SUSPECTED URINARY TRACT INFECTION IN A TERTIARY CARE CENTER

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ABSTRACT

Background: Urinary tract infections (UTIs) are among the most common bacterial infections in children. Early recognition and prompt management are essential to prevent renal scarring and chronic kidney disease. Although urine culture remains the diagnostic gold standard, its delayed results hinder timely decision-making. Urine dipstick testing, detecting leukocyte esterase and nitrite, provides a rapid, point-of-care alternative, yet limited paediatric data from India exist regarding its diagnostic accuracy. **Aim:** To evaluate the diagnostic accuracy and clinical utility of urine dipstick testing for detecting UTIs in children aged 2–12 years at a tertiary care hospital.

Materials and Methods: This hospital-based prospective observational study was conducted in the Departments of Paediatrics and Microbiology, Jorhat Medical College and Hospital, Assam, from September 2023 to August 2024. A total of 180 children aged 2–12 years with symptoms suggestive of UTI were enrolled. Urine dipstick results for leukocyte esterase and nitrite were compared with urine culture findings, the diagnostic gold standard. Data were analysed using SPSS version 29.0.

Results: Among the 180 participants, 60% were females, and fever (75.3%) was the most common symptom. Culture positivity was noted in 32.8% (n=59) cases, predominantly Escherichia coli (55.9%). Leukocyte esterase showed a sensitivity of 81.4% and specificity of 80.9%, while nitrite demonstrated a sensitivity of 79.7% and specificity of 90.1%. Combined testing (either positive) yielded a sensitivity of 89.8%, specificity of 74.4%, and a negative predictive value of 93.8%.

Conclusion: Urine dipstick testing is a rapid, reliable, and non-invasive screening method for early identification of paediatric UTIs, especially in resource-limited settings, and aids in rational antibiotic use.

Keywords: Urinary tract infection, dipstick test, leukocyte esterase, nitrite, urine culture.

INTRODUCTION

Urinary tract infections (UTIs) are among the most frequent bacterial infections encountered in children and occur when microorganisms invade and multiply within the urinary system. Depending on the site involved, infections may affect the lower tract—comprising the bladder and urethra—or extend to the upper tract, involving the kidneys and ureters. These infections are clinically significant because early recognition and management are

crucial to prevent renal involvement and long-term sequelae.[1]

The prevalence of paediatric UTIs varies according to age, sex, and circumcision status. A meta-analysis by Shaikh and colleagues (2008) reported that approximately 7% of febrile infants were found to have a UTI.[2] The infection was more common in females, with prevalence ranging between 5.7% and 8.3%, whereas in males below three months of age, uncircumcised infants demonstrated a markedly higher prevalence (20.1%) compared to circumcised counterparts (2.4%). Among older children presenting with urinary symptoms, the overall prevalence was estimated to be about 7.8%. These data highlight the considerable disease burden and the need for reliable, accessible diagnostic methods in the paediatric population.[2,3]

In children, UTIs typically present with nonspecific or acute symptoms such as fever, irritability, abdominal pain, or dysuria. If inadequately treated, they can lead to serious complications including renal scarring, hypertension, and chronic kidney disease. Certain anatomical or functional abnormalities, such as primary vesicoureteric reflux (VUR) and bladder–bowel dysfunction (BBD), further increase the susceptibility to recurrent infections. Hence, prompt identification of infection is vital to prevent irreversible renal damage.[3,4]

The diagnosis of UTI is conventionally based on the demonstration of significant bacterial growth on urine culture. The threshold for defining a positive culture depends on the method of urine collection: ≥1,000 colony-forming units per millilitre (CFU/mL) for suprapubic aspirates, ≥10,000 CFU/mL for catheterized samples, and 10,000–100,000 CFU/mL for midstream clean-catch urine specimens. Although urine culture remains the gold standard test, it requires specialized laboratory facilities and entails a reporting time of at least 24–48 hours.[4,5] This delay may postpone the initiation of appropriate antibiotic therapy, especially in resource-limited or emergency settings.

To overcome this limitation, rapid screening methods such as the urine dipstick test have been increasingly employed. The dipstick detects leukocyte esterase (a marker of pyuria) and nitrite (a product of bacterial nitrate reduction), thereby providing a quick, inexpensive, and minimally invasive means to screen for potential infection.[6] According to the 2023 revised guidelines of the Indian Society of Paediatric Nephrology, these tests can be effectively used for early identification of children likely to have UTIs, enabling timely initiation of treatment while awaiting culture confirmation.[4]

Globally, numerous studies have evaluated the diagnostic accuracy of dipstick testing in paediatric UTIs; however, data from Indian children remain limited. Regional variations in pathogen profile, bacterial resistance patterns, and population demographics may influence the test's performance in local clinical settings. Therefore, it is important to validate the diagnostic value of urine dipstick testing in the Indian context.[7,8]

The present study has been undertaken to assess the utility of urine dipstick testing as a screening tool for suspected urinary tract infections among children aged 2–12 years attending a tertiary care centre. By comparing dipstick findings with urine culture results, the study aims to determine its sensitivity, specificity, predictive values, and overall clinical usefulness. The findings are expected to contribute to the development of rapid, cost-effective diagnostic strategies for early detection and management of paediatric UTIs in routine healthcare practice.

Aim & Objectives

Aim

To evaluate the effectiveness of the urine dipstick test as a rapid screening tool for detecting urinary tract infections in children aged 2–12 years at a tertiary care centre.

Objectives

- The primary objectives are to determine the accuracy of urine nitrite and leukocyte esterase tests and to compare urine dipstick results with urine culture as the gold standard.
- The secondary objective is to study the antibiogram of bacterial isolates from urine culture.

MATERIALS AND METHODS

Study Design and Setting

This hospital-based prospective observational study was conducted jointly in the Department of Paediatrics and the Department of Microbiology at Jorhat Medical College and Hospital, Jorhat, Assam. The study was carried out over a period of one year, from September 2023 to August 2024.

Study Population and Sample Size

A total of 180 children aged 2 to 12 years presenting with clinical features suggestive of urinary tract infection (UTI) were included in the study. Patients were either attending the Paediatrics Outpatient Department (OPD) or admitted to the Paediatric ward during the study period.

Inclusion and Exclusion Criteria

Inclusion Criteria: Children aged 2–12 years with any of the following—fever for more than 48 hours without an identifiable focus, dysuria, increased frequency or urgency of urination, abdominal or flank pain, or other urinary symptoms.

Exclusion Criteria: Children who had received antibiotics prior to urine collection and those whose parents or guardians refused consent were excluded from the study.

Data Collection and Clinical Evaluation

After obtaining informed written consent from parents or guardians, demographic details, clinical history, examination findings, and relevant investigations were recorded using a predesigned semi-structured proforma. All children underwent

thorough clinical evaluation, and relevant comorbidities were noted. Additional investigations such as complete blood count (CBC), renal function tests (RFT), and ultrasonography of the abdomen and pelvis (USG KUB) were performed when indicated.

Urine Sample Collection and Testing

Urine samples were collected under strict aseptic precautions using one of the following methods: clean-catch midstream collection (preferred), catheterization, or suprapubic aspiration in younger or critically ill patients. Two separate samples were obtained—one for dipstick testing and another for urine microscopy and culture.

Dipstick testing for leukocyte esterase and nitrite was performed bedside using standard commercial test strips. The test strip was immersed in urine and observed for colour change; a shift from off-white to purple indicated leukocyte esterase positivity, while a change from colourless to pink within 60 seconds indicated nitrite positivity. A leukocyte esterase reading of ≥1+ was considered positive.[9]

Urine Culture and Antibiogram

Urine samples were processed within two hours of collection. Using a calibrated loop (0.001 mL), uncentrifuged urine was inoculated on CLED agar plates and incubated at 35–37°C for 18–24 hours. Colony counts were calculated, and bacterial growth ≥10^5 CFU/mL was considered significant. Isolates were identified by standard microbiological methods, and antibiotic susceptibility testing was performed using the Kirby–Bauer disc diffusion method to generate the antibiogram.

Statistical Analysis

Data were entered in Microsoft Excel and analyzed using SPSS version 29. Descriptive statistics were expressed as mean ± SD or percentage. Diagnostic accuracy of dipstick parameters was assessed against urine culture using sensitivity, specificity, PPV, NPV, and Chi-square test, with $p < 0.05$ considered significant.

Ethical Considerations

Ethical clearance was obtained from the Institutional Ethics Committee, Jorhat Medical College (Reference No: SMEJ/JMCH/MEU/841/Pt 2/2011/4996). Informed written consent was obtained from parents or guardians.

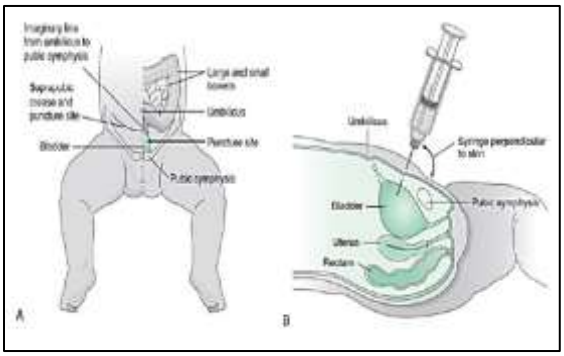

Image 1: Landmarks for suprapubic bladder aspiration. [Hughes—HK, Kahl LK, editors. *The Harriet Lane Handbook*. 21st ed. Philadelphia‖(PA): Elsevier; 2018**].**[10]

RESULTS

This study focuses on evaluating the usefulness of the urine dipstick test as a rapid screening tool for detecting urinary tract infections in children aged 2–12 years. Data were analyzed to assess the demographic distribution, clinical characteristics, and diagnostic performance of the urine dipstick test in detecting urinary tract infections among children.

In the present study among 180 cases, the majority of children belonged to the 10–12 years age group (45 cases, 25%), followed by the 4–<6 years age group (39 cases, 21.7%). The least number of cases were observed in the 8–<10 years age group (30 cases, 16.7%). Females constituted the majority of cases (60%), while males accounted for 40%.

In the symptomatology fever was the most commonly observed in 75.3% of children, followed by vomiting (30.1%), dysuria (28.9%), and abdominal pain (27.1%). Less frequent symptoms included constipation (23.5%), urgency (18.1%), burning micturition (13.3%), and hematuria (3%).

Table 1: Distribution of Children According to Degree of Pyuria on Urine Microscopy

Pyuria Level	Frequency	Percentage (%)
No pyuria	100	55.6
<5 pus cells / hpf	44	24.4
5-10 pus cells / hpf	21	11.7
>10 pus cells / hpf	15	8.3
Total	100	100%

Urine microscopy showed that more than half of the children (55.6%) had no pyuria, while 24.4% had fewer than 5 pus cells per high-power field. Moderate pyuria (5–10 pus cells/hpf) was seen in 11.7% of cases and marked pyuria (>10 pus cells/hpf) in 8.3% of cases. **(Refer Table 1)**

Among 180 cases tested with Leucocyte Esterase (LE) dipstick, 71 (39.4%) were found to be LE positive while 109 (60.6%) were LE negative. (Refer Fig. 1)

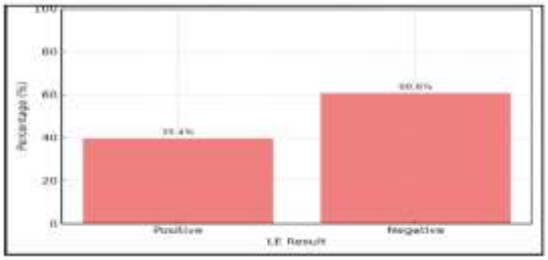

Figure 1: Leucocyte Esterase (LE) Result in Study Population (n=180)

In this study, the leukocyte esterase (LE) dipstick test showed good diagnostic performance, with positivity in 81.4% of culture-confirmed UTI cases and negativity in 81% of culture-negative cases. These findings indicate good sensitivity and fair specificity, suggesting that the LE test is a reliable screening tool but should be confirmed with urine culture to rule out false negatives.

Table 2: Sensitivity, Specificity, PPV, and NPV of LE Dipstick Test

Parameter	Value (%)
Sensitivity	81.4%
Specificity	80.9%
Positive Predictive Value (PPV)	67.6%
Negative Predictive Value (NPV)	89.9%

The leukocyte esterase (LE) dipstick test showed good diagnostic accuracy, with 81.4% sensitivity and 80.9% specificity. Its high negative predictive value (89.9%) indicates reliability in ruling out UTI, while the positive predictive value (67.6%) suggests moderate accuracy in confirming infection. **(Refer Table 2)**

In this study, the nitrite dipstick test showed positivity in 32.8% of total cases. Among culture-confirmed UTI cases, 79.7% were nitrite positive, demonstrating good sensitivity, while 90.1% of culture-negative cases were nitrite negative, indicating excellent specificity. This suggests that the nitrite test is a reliable indicator for ruling out UTI in children.

Table 3: Sensitivity, Specificity, PPV, and NPV of Nitrite Dipstick Test
Diagnostic Performance Parameters

Parameter	Value (%)
Sensitivity	79.7%
Specificity	90.1%
PPV	79.7%
NPV	90.1%

The nitrite dipstick test showed good sensitivity (79.7%) and excellent specificity (90.1%), with a high negative predictive value (90.1%), indicating its reliability as a rapid screening tool for ruling out urinary tract infection in children. **(Refer Table 3)**
The combined dipstick test (LE + Nitrite) showed excellent sensitivity (89.8%) for detecting culture-positive UTI cases and moderate specificity due to some false positives. Its high negative predictive value highlights its effectiveness as a quick screening tool to rule out UTI in children. (Refer Fig. 2).

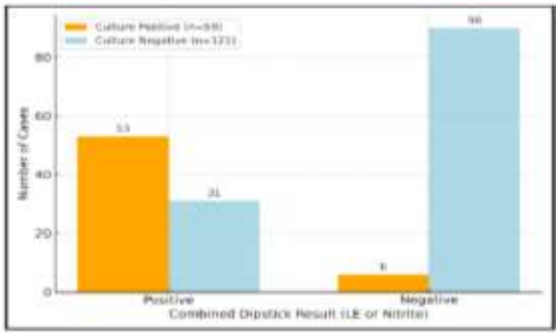

Figure 2: Combined Dipstick (LE + Nitrite) vs Culture

The combined dipstick test showed high sensitivity (89.8%) and excellent negative predictive value (93.8%), making it a reliable tool for ruling out UTI in children. Although specificity (74.4%) and PPV (63.1%) were moderate, the test remains valuable as a rapid screening method before culture confirmation. **(Refer Table 4)**

Table 4: Diagnostic performance metrics of the combined dipstick test

Parameter	Value (%)
Sensitivity	89.8%
Specificity	74.4%
Positive Predictive Value (PPV)	63.1%
Negative Predictive Value (NPV)	93.8%

The combined dipstick test showed a positive likelihood ratio of 3.51, indicating a moderately increased chance of UTI with a positive result, and a low negative likelihood ratio of 0.14, signifying excellent ability to rule out UTI when the test is negative.
Among 59 culture-positive cases, *Escherichia coli* was the predominant organism (55.9%), followed by *Enterococcus faecalis* (15.3%). Other isolates included *Klebsiella* spp., *Enterococcus faecium*, and *Acinetobacter* spp. The results indicate that Gram-negative bacteria, particularly *E. coli*, were the major causative agents of UTI in this study. **(Refer Fig. 3)**

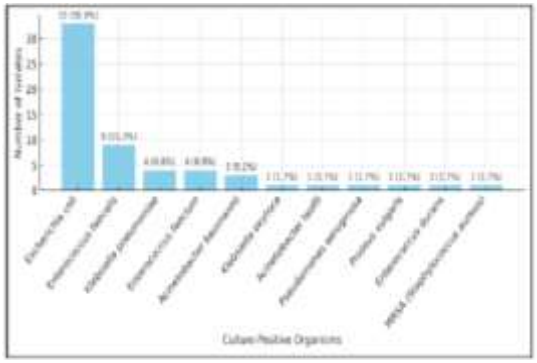

Figure 3: Distribution of Organisms in Urine Culture

Among the isolates, Gram-negative organisms (44 cases) predominated over Gram-positive (15 cases). Escherichia coli was the most common Gram-negative pathogen (33 cases), while Enterococcus faecalis was the leading Gram-positive isolate (9 cases). This highlights the predominance of E. coli as the principal uropathogen in paediatric UTIs.

Among Gram-positive isolates, Enterococcus species showed highest sensitivity to Doxycycline (100%), Teicoplanin (100%), and Linezolid (85.7%), while Vancomycin resistance was observed in 14.3% of isolates. Nitrofurantoin demonstrated moderate sensitivity (71.4%) with 14.3% resistance. The single MRSA isolate tested showed complete sensitivity (100%) to Cotrimoxazole. (Refer Fig. 4)

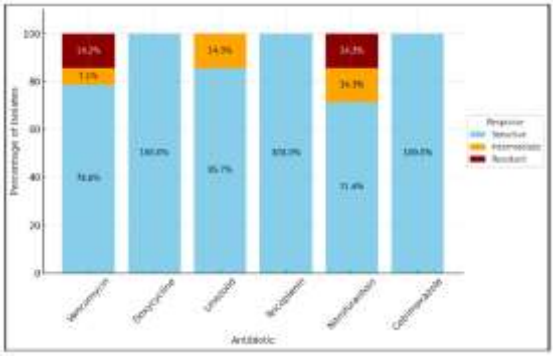

Figure 4: Antibiotic Susceptibility Pattern of Gram-positive Urinary Isolates

Table 5: E. coli Isolates: Antibiotic Sensitivity Pattern

Antibiotic	Sensitive	Intermediate Sensitive	Resistant	Total Tested	% Sensitive	% Resistant
Fosfomycin	31	1	2	33	93.9%	6.1%
Nitrofurantoin	30	2	2	33	90.0%	6.1%
Meropenem	29	1	4	33	87.9%	12.1%
Doxycycline	28	1	5	33	84.8%	15.2%
Amikacin	27	2	5	33	81.8%	15.2%
Gentamicin	26	2	6	33	78.8%	18.2%
Piperacillin–Tazobactam	25	0	7	32	78.1%	21.9%

Among 33 *E. coli* isolates from paediatric urine cultures, the highest sensitivity was observed to Fosfomycin (93.9%) and Nitrofurantoin (90.9%), followed by Meropenem (87.9%) and Doxycycline (84.8%). Moderate sensitivity was noted to Amikacin (81.8%), Gentamicin (78.8%), and Piperacillin–Tazobactam (78.1%). Overall, Fosfomycin and Nitrofurantoin emerged as the most effective oral antibiotics, while carbapenems and aminoglycosides remain suitable for severe or resistant infections. **(Refer Table 5)**

Among 34 *E. coli* isolates, moderate sensitivity was seen to Ciprofloxacin and Ampicillin–Sulbactam (67.6%), while lower sensitivity was noted to Cotrimoxazole (61.8%), Aztreonam (58.8%), Cefepime (55.9%), and Ceftriaxone (50.0%). The least sensitivity was observed with Cefazolin (17.6%). These results highlight increasing resistance to cephalosporins and emphasize the need for antibiotic selection based on local antibiogram data.

DISCUSSION

In the present study, urinary tract infection (UTI) was most observed in the 5–12 years age group (43.3%), followed by 2–5 years (40%). This finding closely aligns with the study by Mod H.K. et al. (2021), who reported a similar pattern with 46.4% cases in the 5–12 years group and 33.3% in the 2–5 years group.[11] The slightly lower representation of younger children in the present study may be attributed to the exclusion of infants below one year of age, who were included in Mod et al.'s analysis. These findings suggest that UTIs are more frequently encountered in school-aged children, possibly due to inadequate hydration, poor perineal hygiene, and delayed voiding habits.

Gender distribution in our study demonstrated a higher prevalence of UTI among females (60%) compared to males (40%), consistent with the findings of Zorc et al. (2005), who reported 77.7% female cases, and Fernandes et al. (2017), who observed 63.15% female predominance.[12,13] The higher susceptibility in girls is well documented and can be attributed to the shorter urethra and its proximity to the anal region, facilitating ascending infections by enteric bacteria.

Regarding clinical presentation, fever was the most common symptom, observed in 69.4% of cases, followed by vomiting (27.8%) and dysuria (26.7%). This pattern corroborates the findings of Hertz et al. (2023), where fever was present in 66.5% of UTI cases, and Sohail et al. (2023), who reported fever in all culture-positive patients (100%), with dysuria and increased frequency noted in 39.1% and 34.8% of cases, respectively.[14,15] These results reinforce that fever remains the most reliable clinical indicator

of UTI in the paediatric age group, whereas classical urinary symptoms such as dysuria and frequency are less consistently observed in younger children.

On clinical examination, the most frequent findings were sick/toxic appearance (35.6%) and dehydration (27.1%), followed by bladder distension (22%). These findings were comparable to those of Sohail et al. (2023), who reported similar rates of toxic appearance (34.8%) and dehydration (21.7%).[15] Mod H.K. et al. (2021) also noted bladder distension in 27% of their cases, consistent with our observations.[11] Suprapubic and renal angle tenderness were infrequent (8.5%), in line with Sohail et al. (8.7%), indicating that localized tenderness may not always be a reliable diagnostic feature in pediatric UTIs.[15]

The diagnostic accuracy of dipstick urinalysis was evaluated using leukocyte esterase (LE) and nitrite tests. The LE test in the present study showed high sensitivity (81.4%) and specificity (80.9%), like Waterfield et al. (2022) (82% and 82%, respectively) and White et al. (2011) (83% and 78%).[16] The PPV (67.6%) and NPV (89.9%) in our study were also consistent with those reported by Bagga et al. (2016) (60.2% and 88.9%), supporting the LE test as a useful initial screening tool for UTI.[17]

The nitrite test demonstrated a markedly higher sensitivity in the present study (79.7%) compared to earlier reports by White et al. (2011) (53%), Bagga et al. (2016) (37.8%), and Fernandes et al. (2018) (47.3%). Specificity remained high (91.7%), in line with previous findings (88–98%).[17,13] The high PPV (79.7%) and NPV (90.1%) observed reaffirm the test's reliability in identifying bacteriuria, particularly in infections caused by nitrate-reducing organisms such as E. coli.

When the LE and nitrite tests were combined, sensitivity improved to 89.8%, with a good NPV of 93.8%. These findings are superior to those reported by Bagga et al. (2016) (62.2%), Mod et al. (2017) (68%), and Fernandes et al. (2018) (31.5%), and comparable to Waterfield et al. (2022) (82%) and White et al. (2011) (93%).[16,11,13,16,17] Although specificity (74.4%) was slightly lower due to false positives, the combined test remains a reliable screening tool in resource-limited settings, enabling early diagnosis and prompt management.

Ultrasonographic (USG) evaluation revealed normal findings in 64.4% of cases, which closely matched Mod et al. (2017) (63.3%) but was lower than the 88% reported by Hoberman et al. (2014).[11,18] Cystitis was observed in 14.4% of cases, higher than that noted by Mod et al. (8.3%) and Kurtz et al. (2015) (12%).[11.19] Hydronephrosis was found in 5% of cases, significantly lower than in Mod et al. (21.6%) and Kurtz et al. (7.8%).[11,19] These findings emphasize the role of ultrasound in identifying underlying anatomical abnormalities, which may predispose to recurrent infections.

Overall, the present study corroborates findings from several national and international studies, demonstrating that paediatric UTI is more prevalent among school-aged girls and most commonly presents with fever. The diagnostic utility of dipstick urinalysis, particularly when combining LE and nitrite tests, offers a reliable, non-invasive screening approach. Imaging modalities like ultrasound continue to play a vital role in detecting structural abnormalities and guiding further management. These findings underscore the need for early detection and rational antibiotic use to prevent complications and resistance development in paediatric UTI cases.

CONCLUSION

The present study evaluated the diagnostic accuracy of urine dipstick testing in detecting paediatric urinary tract infections (UTIs) and found a culture positivity rate of 32.8%. Fever was the most common symptom, and *E. coli* was the predominant pathogen (55.9%), showing high sensitivity to Fosfomycin (93.9%) and Nitrofurantoin (91%). The combined leukocyte esterase and nitrite test demonstrated the highest diagnostic accuracy (sensitivity 89.8%, NPV 93.8%), making it a reliable, rapid, and cost-effective screening tool for early UTI detection in children. However, urine culture remains the gold standard for confirmation and antibiotic selection.

Limitations

- The study included children aged 2–12 years; infants below 2 years, who are at higher risk for UTI and renal complications, were excluded.
- Being a single-center, hospital-based study, the results may not reflect the true community prevalence or regional variation in pathogens and resistance patterns.
- Advanced imaging (MCUG, DMSA scan) was not routinely performed, so conditions like vesicoureteric reflux or renal scarring may have been missed.

Recommendations

- **Urine dipstick testing** (LE and Nitrite) can be used as a simple, rapid, and reliable bedside screening tool for early UTI detection in children, especially in resource-limited settings.
- **Urine culture** should be done in all suspected cases as the gold standard for confirmation and antibiotic guidance.
- **Empirical antibiotic selection** should follow local antibiogram data; Nitrofurantoin and Fosfomycin are preferred first-line options where sensitivity is high.
- **Ultrasonography (USG KUB)** should be routinely performed to detect urinary tract abnormalities or complications.
- **Multi-centre studies** with larger sample sizes and inclusion of children below 2 years are recommended for broader evaluation.

- **Regular monitoring** of local antimicrobial resistance trends should be done to ensure rational antibiotic use.
- **Training and awareness** among healthcare workers are essential for proper urine sample collection, dipstick interpretation, and adherence to diagnostic protocols.

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