

Original Article

A Comparative Analysis of Point-of-Care Dipstick Testing with Culture for Detection of Urinary Tract Infection

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ABSTRACT

Background: Urinary tract infections are among the most frequent bacterial infections encountered in clinical practice and require timely diagnosis to guide appropriate patient management. Although urine culture remains the reference standard for confirming infection, its longer turnaround time may delay early clinical decision-making. Point-of-care urine dipstick testing provides a rapid and low-cost screening option by detecting leukocyte esterase and nitrite, which serve as indirect markers of urinary inflammation and bacteriuria. **Objective:** This study aimed to evaluate the diagnostic accuracy of combined leukocyte esterase and/or nitrite urine dipstick testing compared with urine culture for the detection of urinary tract infection. **Methods:** A comparative cross-sectional diagnostic accuracy study was conducted on 100 urine samples collected from clinically suspected urinary tract infection cases. Each sample was analyzed using urine dipstick testing and standard urine culture. Dipstick results were considered positive when leukocyte esterase and/or nitrite showed positivity. Urine culture was used as the reference standard. Sensitivity, specificity, positive predictive value, negative predictive value, and overall diagnostic accuracy were calculated. **Results:** Urine culture was positive in 60 samples and negative in 40 samples. Dipstick testing identified 68 positive and 32 negative samples. Compared with culture, dipstick testing produced 48 true-positive, 20 false-positive, 20 true-negative, and 12 false-negative results. Sensitivity was 80.0%, specificity 50.0%, positive predictive value 70.6%, negative predictive value 62.5%, and diagnostic accuracy 68.0%. **Conclusion:** Combined leukocyte esterase and/or nitrite dipstick testing is useful as a rapid initial screening method for suspected urinary tract infection, but urine culture remains essential for definitive diagnosis and antimicrobial guidance.

Keywords: Urinary Tract Infection; Urine Dipstick Test; Urine Culture; Leukocyte Esterase; Nitrite; Diagnostic Accuracy.

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INTRODUCTION

Urinary tract infections are among the most common bacterial infections encountered in clinical practice and remain a major cause of patient morbidity, diagnostic workload, and antimicrobial use worldwide. They affect individuals across all age groups, with a particularly high burden among women because of anatomical, physiological, and behavioral risk factors. Globally, nearly 50–60% of women experience at least one urinary tract infection during their lifetime, and the annual burden is estimated to reach approximately 150 million cases. In developing healthcare settings, including Pakistan, urinary tract infections also represent a frequent reason for outpatient visits, laboratory testing, and empirical antibiotic prescription, with reported prevalence ranging from 20–30% among women and even higher rates among hospitalized or catheterized patients (1,2).

Accurate and timely diagnosis is central to effective management because delayed diagnosis may prolong symptoms and increase the risk of ascending infection, whereas overdiagnosis may contribute to unnecessary antibiotic use and antimicrobial resistance. Urine culture is widely accepted as the reference standard for confirming urinary tract infection because it allows detection of bacterial growth and supports organism identification and antimicrobial susceptibility testing. However, culture requires microbiology laboratory infrastructure, trained personnel, proper specimen handling, and an incubation

period that commonly delays reporting for 24–48 hours. These limitations are particularly relevant in outpatient clinics, emergency departments, and resource-limited settings where early treatment decisions often need to be made before culture results are available (3,4).

Point-of-care urine dipstick testing offers a rapid, inexpensive, and easily performed alternative for the initial evaluation of suspected urinary tract infection. Dipstick reagent strips detect biochemical markers in urine, particularly leukocyte esterase and nitrite, which are commonly used as indirect indicators of urinary inflammation and bacteriuria. Leukocyte esterase reflects the presence of white blood cells in urine and suggests pyuria, while nitrite positivity indicates the activity of nitrate-reducing bacteria, especially many gram-negative uropathogens. Because results are available within minutes and the test does not require complex equipment, dipstick testing is widely used as a first-line screening method in primary care and hospital settings (5,6).

Despite these practical advantages, the diagnostic reliability of dipstick testing remains variable. False-positive results may occur because of contamination, sterile pyuria, inflammatory conditions, improper sample collection, or delayed testing, while false-negative results may occur in infections caused by non-nitrite-producing organisms, low bacterial counts, frequent urination, dilute urine, or recent antibiotic exposure. Therefore, although dipstick testing may help clinicians rapidly identify patients who are likely to have urinary tract infection, its ability to replace culture remains uncertain. The diagnostic value of dipstick testing also depends on the population being tested, disease prevalence, clinical setting, and whether leukocyte esterase and nitrite are interpreted individually or in combination (7,8).

In this context, there is a need for locally relevant diagnostic accuracy data comparing point-of-care urine dipstick testing with urine culture among patients clinically suspected of urinary tract infection. The population of interest in the present study was patients presenting with suspected urinary tract infection; the index test was combined urine dipstick positivity based on leukocyte esterase and/or nitrite; the comparator or reference standard was standard urine culture; and the outcomes of interest were sensitivity, specificity, positive predictive value, negative predictive value, and overall diagnostic agreement. This study was therefore conducted to evaluate the diagnostic accuracy of urine dipstick testing compared with urine culture for detecting urinary tract infection and to determine whether dipstick testing can serve as a useful initial screening tool while preserving the role of culture for definitive diagnosis.

MATERIALS AND METHODS

This comparative cross-sectional diagnostic accuracy study was conducted at Lahore General Hospital to evaluate the performance of point-of-care urine dipstick testing against urine culture for the detection of urinary tract infection. The study population comprised patients clinically suspected of having urinary tract infection, from whom urine samples were obtained for routine diagnostic evaluation. A total of 100 urine samples were included and each specimen was assessed using both urine dipstick testing as the index test and standard urine culture as the reference standard.

Urine specimens were processed under standard laboratory conditions using calibrated equipment and routine microbiological procedures. Point-of-care urine dipstick testing was performed using urine reagent strips according to standard laboratory procedure. Dipstick results were interpreted for leukocyte esterase and nitrite, the two principal biochemical indicators used for screening urinary tract infection. Leukocyte esterase positivity was considered an indicator of pyuria and urinary tract inflammation, while nitrite positivity was considered an indirect marker of nitrate-reducing bacteria.

Microscopic examination of urine samples was performed where required using a standard light microscope to support preliminary assessment through identification of white blood cells, red blood cells, and bacteria. Data was entered and analyzed using descriptive diagnostic accuracy statistics. Frequencies and percentages were calculated for culture-positive, culture-negative, dipstick-positive, and dipstick-negative results. A two-by-two diagnostic table was constructed using urine culture as the

reference standard, and diagnostic performance indices were calculated from true-positive, false-positive, true-negative, and false-negative values. Data integrity was maintained through standardized result recording, consistent operational definitions, and cross-checking of diagnostic classifications before final analysis.

RESULTS

A total of 100 urine samples from clinically suspected urinary tract infection cases were analyzed using both point-of-care urine dipstick testing and urine culture. Urine culture confirmed bacterial growth in 60 samples, giving a culture-positive proportion of 60.0%, while 40 samples were culture negative. Dipstick testing classified 68 samples as positive and 32 as negative. Compared with urine culture, dipstick testing identified 48 true-positive cases and 20 true-negative cases, while 20 samples were false positive and 12 were false negative. Therefore, 68 of 100 samples were correctly classified by dipstick testing, giving an overall diagnostic accuracy of 68.0%.

The culture-positive rate was 60.0%, indicating that more than half of clinically suspected cases were confirmed by the reference standard. Dipstick positivity was higher at 68.0%, showing that dipstick testing classified an additional 8.0% of samples as positive compared with culture. This difference reflects the presence of false-positive dipstick results among culture-negative samples.

Table 1. Distribution of Urine Culture and Dipstick Test Results

Diagnostic Category	Number (n)	Percentage (%)
Total urine samples analyzed	100	100.0
Culture positive	60	60.0
Culture negative	40	40.0
Dipstick positive	68	68.0
Dipstick negative	32	32.0

Table 2. Diagnostic Cross-Tabulation of Dipstick Testing Against Urine Culture

Dipstick Result	Culture Positive, n	Culture Negative, n	Total, n	Culture Positivity Within Dipstick Group (%)
Dipstick positive	48	20	68	70.6
Dipstick negative	12	20	32	37.5
Total	60	40	100	60.0

Among the 68 dipstick-positive samples, 48 were confirmed positive by urine culture, corresponding to a culture-confirmed positivity rate of 70.6% within the dipstick-positive group. Among the 32 dipstick-negative samples, 20 were culture negative, while 12 were culture positive, indicating that 37.5% of dipstick-negative samples were missed by the screening test. The distribution shows that dipstick positivity was more frequent among culture-positive samples than culture-negative samples.

Table 3. Classification Outcomes of Dipstick Testing Compared with Urine Culture

Diagnostic Outcome	Definition	Number (n)	Percentage of Total Samples (%)
True positive	Dipstick positive and culture positive	48	48.0
False positive	Dipstick positive and culture negative	20	20.0
True negative	Dipstick negative and culture negative	20	20.0
False negative	Dipstick negative and culture positive	12	12.0
Correctly classified	True positive + true negative	68	68.0
Incorrectly classified	False positive + false negative	32	32.0

The largest diagnostic category was true-positive results, accounting for 48.0% of all samples. False-positive results represented 20.0% of the total sample, while false-negative results represented 12.0%. Correct classification occurred in 68.0% of samples, whereas 32.0% were misclassified. Among all misclassified cases, false positives were more frequent than false negatives, contributing 20 of 32 diagnostic errors.

Table 4. Diagnostic Performance of Combined Leukocyte Esterase and/or Nitrite Dipstick Testing

Diagnostic Measure	Formula	Value	95% CI
Sensitivity	TP / (TP + FN)	80.0%	67.7–88.8
Specificity	TN / (TN + FP)	50.0%	35.2–64.8

Positive predictive value	TP / (TP + FP)	70.6%	58.9–80.1
Negative predictive value	TN / (TN + FN)	62.5%	45.2–77.1
Diagnostic accuracy	(TP + TN) / Total	68.0%	58.3–76.3
False-positive rate	FP / (FP + TN)	50.0%	35.2–64.8
False-negative rate	FN / (FN + TP)	20.0%	11.2–32.3

Table 5. Association Between Dipstick Result and Culture Positivity

Statistical Parameter	Value
Odds ratio	4.00
95% CI for odds ratio	1.66–9.62
Relative risk of culture positivity in dipstick-positive samples	1.88
Chi-square statistic	9.19
p-value	0.0024

Dipstick testing demonstrated a sensitivity of 80.0%, meaning that 48 of 60 culture-confirmed urinary tract infection cases were correctly detected. Specificity was lower at 50.0%, showing that only 20 of 40 culture-negative samples were correctly identified as negative. The positive predictive value was 70.6%, indicating that approximately seven out of every ten dipstick-positive results were confirmed by culture. The negative predictive value was 62.5%, indicating that more than one-third of dipstick-negative samples were culture positive. Overall diagnostic accuracy was 68.0%, with a false-positive rate of 50.0% and a false-negative rate of 20.0%.

Dipstick-positive samples had fourfold higher odds of being culture positive compared with dipstick-negative samples. The relative risk of culture positivity among dipstick-positive samples was 1.88, indicating that culture-confirmed infection was nearly twice as frequent in dipstick-positive cases as in dipstick-negative cases. The association between dipstick result and urine culture outcome was statistically significant, with a chi-square value of 9.19 and $p = 0.0024$. These findings indicate that combined leukocyte esterase and/or nitrite dipstick positivity was significantly associated with culture-confirmed urinary tract infection, although the modest specificity and negative predictive value show that dipstick testing should be interpreted as a screening tool rather than a definitive diagnostic replacement for culture.

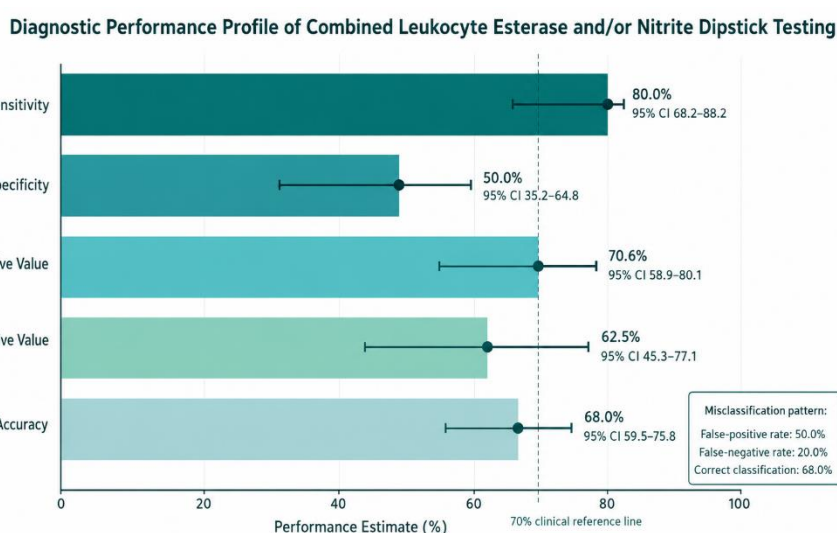


Figure 1. Diagnostic Performance Profile of Combined Leukocyte Esterase and/or Nitrite Dipstick Testing

The diagnostic performance profile shows that combined leukocyte esterase and/or nitrite dipstick testing achieved its strongest performance for sensitivity at 80.0% with a 95% CI of 67.7–88.8%, indicating that most culture-confirmed urinary tract infection cases were detected. Positive predictive value was 70.6% with a 95% CI of 58.9–80.1%, while overall diagnostic accuracy was 68.0% with a 95% CI of 58.3–76.3%. In contrast, specificity was limited at 50.0% with a 95% CI of 35.2–64.8%, and negative predictive value was 62.5% with a 95% CI of 45.2–77.1%, demonstrating weaker performance in excluding non-infected cases. The misclassification pattern further highlights this imbalance, with a

50.0% false-positive rate among culture-negative samples and a 20.0% false-negative rate among culture-positive samples, supporting the role of dipstick testing as a rapid screening tool rather than a stand-alone confirmatory method.

DISCUSSION

The present study evaluated the diagnostic performance of combined leukocyte esterase and/or nitrite urine dipstick testing against urine culture in suspected urinary tract infection cases. The dipstick showed good sensitivity (80.0%), detecting most culture-confirmed infections, but low specificity (50.0%), with a high false-positive rate (50.0%). The positive predictive value was 70.6% and negative predictive value was 62.5%, with an overall diagnostic accuracy of 68.0%, indicating only moderate agreement with culture.

Leukocyte esterase reflects pyuria, while nitrite indicates bacterial metabolism; therefore, their combination improves detection of urinary tract infection. However, false-positive results may occur due to contamination, sterile pyuria, or non-infectious urinary conditions, while false-negative results may be seen with low bacterial counts or non-nitrite-producing organisms (9,10). Predictive values are also influenced by disease prevalence (11).

Overall, dipstick testing is useful as a rapid, low-cost screening tool for early clinical decision-making, but due to limited specificity and moderate negative predictive value, it cannot replace urine culture. Urine culture remains essential for confirmation, organism identification, and antimicrobial susceptibility testing, especially in complicated or high-risk cases (12,13).

CONCLUSION

This study shows that combined leukocyte esterase and/or nitrite urine dipstick testing is a quick and useful screening tool for suspected urinary tract infections. It has good sensitivity (80%), meaning it detects most true infections, but low specificity (50%), so false positives are common. Its moderate ppv (70.6%), npv (62.5%), and overall accuracy (68%) indicate it cannot replace urine culture. Therefore, dipstick testing should be used for initial screening, while urine culture remains essential for confirmation, pathogen identification, and antibiotic sensitivity testing, especially in complicated or high-risk cases.

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