Research article

Comparison of urine dipstick test with urine culture in the diagnosis of community acquired urinary tract infection in a tertiary care hospital in Colombo District, Sri Lanka

Nugahapola NWES, Chandrasiri NS

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Abstract

Introduction: Community-acquired urinary tract infection (CA-UTI) is the second most common infection in the community. The gold standard for diagnosing urinary tract infections (UTIs) is urine culture. A urine dipstick can also be used to diagnose UTIs. This study was designed to compare the urine dipstick test with urine culture in the diagnosis of community-acquired urinary tract infections in a tertiary care hospital in the Colombo district, Sri Lanka.

Methods: Four hundred and eighty-nine urine samples were inoculated into cysteine-lactose-electrolyte-deficient agar. They were tested for the presence of nitrite and leukocytes using urine dipsticks, following the manufacturer's instructions.

Results: In the entire group, the sensitivity, specificity, positive predictive value, and negative predictive value of the leukocyte esterase test were 91.92%, 76.15%, 91.41%, and 77.34%, respectively, and those of the nitrite test were 91.36%, 75.38%, 91.11%, and 75.97%, respectively.

Conclusion: The dipstick is a low-cost, user-friendly test that can be used in an outpatient setting to identify patients who require antibiotics. This will help in establishing antibiotic stewardship by limiting unnecessary prescriptions.

Keywords: *Urinary tract infections, tertiary care hospital, Sri Lanka, leukocyte esterase, nitrate*

Introduction

Urinary tract infections (UTIs) are among the commonest bacterial infections. They can be either community-acquired or nosocomial. Community-acquired urinary tract infections (CA-UTIs) are the second most common diagnosed infections in the community.[1] A CA-UTI is defined as a urinary tract infection that occurs in the community or within 48 hours of hospital admission and was incubating at the time of hospital admission.[2]

Colombo South Teaching Hospital, Kalubowila, Sri Lanka

Address for correspondence: Dr NWES Nugahapola, 638/H/44, Sparkles Residencies, Thunandahena Road, Karatota, Kaduwela, Sri Lanka.; Tel: +94 716 718 773, +44 7340 475 800; Email:enusawangi@gmail.com;

https://orcid.org/0009-0007-7353-1995

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The gold standard for diagnosing UTI is urine culture.[3] Urine culture aids in the identification of organisms as well as the determination of antibiotic sensitivity. However, the turnaround time of this test is relatively high. On the other hand, the urine dipstick test, used in the diagnosis of UTI, is less time-consuming and less expensive. It is a thin, plastic stick with strips of chemicals impregnated on it, which is dipped in urine to detect abnormalities. The chemical strips change colour if certain substances are present or if their levels are above normal. In UTIs, the dipstick will detect nitrites (NT) and leukocyte esterase (LET) (a product of white blood cells).[4] Certain bacteria can produce nitrite from nitrate in urine, and this nitrite can be chemically detected using urine dipsticks. Uropathogens of the *Enterobacteriaceae* family are capable of performing the above reaction, so that their presence can be detected by this method. The basis of the LET relies on proteins produced by human neutrophils that hydrolyse ester substrates. These proteins have esterolytic activity, producing acids and alcohols. These products will then react with chemicals on the band and change its colour. Therefore, the colour change is proportionate to the esterase amount in urine. LET will detect esterases inside white blood cells (WBC) as well as free esterases released following WBC breakdown. The dipstick test is a bedside test useful in settings where culture facilities are not available.

Though the dipstick test has some advantages over urine culture in detecting UTIs, it is not routinely used in microbiology laboratories or as a bedside test in Sri Lanka. Thus, the objective of this study was to compare the results of the urine dipstick test against the gold standard, urine culture, to determine its performance characteristics, such as sensitivity and specificity.

Methods

This laboratory-based descriptive study included all inpatient and outpatient samples from patients with evidence of CA-UTIs received by the microbiology laboratory of Colombo South Teaching Hospital (CSTH) from 04/02/2022 to 03/06/2022. A consecutive convenient sampling method was used. Patients presenting as either outpatients or inpatients with features suggestive of CA-UTI were included. Exclusion criteria were patients younger than 14 years, pregnant women, those with indwelling urinary catheters, patients with known underlying urinary tract abnormalities, duplicate samples from the same patient, refrigerated urine samples[5], and urine cultures showing mixed growth.

All urine samples received during the study period were screened, and those meeting the inclusion and exclusion criteria were processed further. Instructions on proper urine collection were displayed in the ward, outpatient department (OPD), and clinic settings. Socio-demographic details and relevant clinical information were obtained from request forms, bed-head tickets, and direct interviews when required. A structured data extraction sheet was formulated based on the study objectives and variables required for analysis. Its content was designed to capture clinically relevant information, including age, sex, inpatient or outpatient status, presenting symptoms and their duration, and prior antibiotic exposure, as these factors influence dipstick test interpretation and urine culture results.

Urine samples fulfilling the study criteria were inoculated onto cysteine-lactose-electrolyte-deficient (CLED) agar using a 1 µL calibrated loop and incubated aerobically at 35 °C overnight

(2011 Microbiology Laboratory Manual Standard Operating Procedures).[6] Bacterial isolates were considered significant when there was pure growth of $\geq 10^5$ colony forming units (cfu)/ml or 10^4–10^5 cfu/ml in the presence of compatible patient symptoms and clinical history which were assessed before classifying isolates as significant. Dipstick testing was then performed on these samples to detect nitrites and leukocyte esterase using commercially available dipsticks (URS – 10 by Teco Diagnostics) according to the manufacturer's instructions.

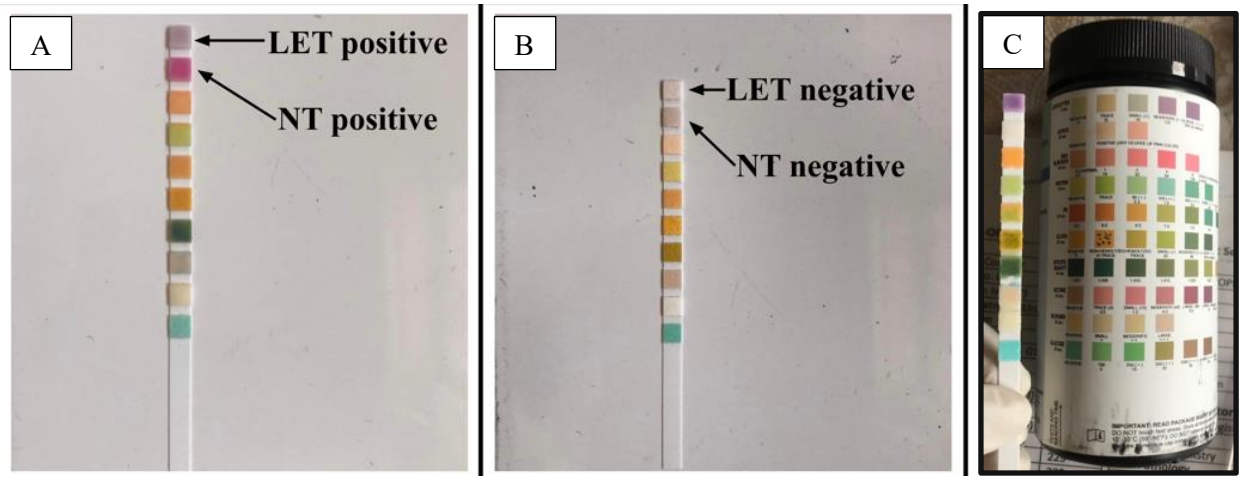

Figure 1: Interpretation of urine dipstick test.

A - positive result
B - negative result
C - urine dip stick result interpretation, manufacturer's guide

LET – Leucocyte esterase test, NT – Nitrite test)

Quality control procedures were carried out for CLED and Muller–Hinton media and biochemical tests as per manufacturer recommendations. When required, appropriate control organisms were used for quality assurance of the laboratory procedures. For data analysis, the study population was stratified into an antibiotic-exposed and a non-antibiotic group based on antibiotic consumption from symptom onset until sample collection. Statistical analysis was done using SPSS-26 software, and descriptive data were summarised using frequencies and percentages.

Results

A total of 2910 urine samples were received during the study period, and 489 met the inclusion criteria. Of the 489 samples, 359 (73.5%) became culture positive. The majority of the patients in the study sample (N=291, 59.51%) had not received antibiotics prior to collecting urine for culture, while 198 (40.49%) patients had received prior antibiotics. In the non-antibiotic group, 85.22% (248/291) were culture positive, whereas in the antibiotic group, the culture

Table 1: Distribution of culture and dipstick test results according to antibiotic exposure

	Culture		LET	NT	LET/NT/both
	Positive (N=359)	Negative (N=130)	Positive (N=361)	Positive (N=360)	Positive (N=371)
Received antibiotics (N=198)	111 (30.9%)	87 (66.9%)	128 (35.5%)	122 (33.9%)	130 (35%)
Not received antibiotics (N=291)	248 (69.1%)	43 (33.1%)	233 (64.5%)	238 (66.1%)	241 (65%)

positivity was 56.1% (111/198). Table 1 shows these data along with dipstick positive numbers in both groups.

The performance characteristics of LET, NT and both tests together were calculated separately in the whole group, non-antibiotic group and antibiotic group, as shown in Table 2.

Table 2: Performance Characteristics of dipstick tests compared with the gold standard, urine culture

		LET (N=361)	NT (N=360)	Both (N=371)
Sensitivity %	Whole group	91.92	91.36	93.04
	Non-antibiotic group	91.13	91.53	92.74
	Antibiotic group	93.69	90.99	93.69
Specificity %	Whole group	76.15	75.38	71.45
	Non-antibiotic group	83.72	74.42	74.42
	Antibiotic group	72.41	75.86	70.11
PPV %	Whole group	91.41	91.11	90.03
	Non-antibiotic group	97	95.38	95.44
	Antibiotic group	81.25	82.79	80
NPV%	Whole group	77.34	75.97	78.81
	Non-antibiotic group	62.07	60.38	64
	Antibiotic group	90	86.84	89.7

Discussion

This study assessed the sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) of the dipstick test in diagnosing CA-UTIs. The analysis was performed across three subgroups: the entire study population, patients with no prior antibiotic exposure, and patients who had already consumed antibiotics.

In the entire study population, the performance of LET and NT was nearly identical. When both tests were combined, the sensitivity and NPV improved to 93.04% and 78.81% respectively. However, the specificity and PPV decreased to 71.54% and 90.03%, respectively. These findings suggest that using both tests together offers a slight advantage as a screening tool for the diagnosis of CA-UTIs, particularly in improving sensitivity and minimising missed cases.

The results in the subgroup of patients with no prior antibiotic exposure indicate that combining both tests provides a slight improvement in sensitivity and NPV compared to individual tests, while maintaining a high PPV. These findings suggest that the combined test is a reliable screening tool for community-acquired UTI in patients who have not received prior antibiotics.

When comparing the non-antibiotic and antibiotic groups, the antibiotic group showed higher sensitivity and NPV for both LET and the combined test. These findings indicate that urine dipstick tests remain effective as a screening tool for suspected UTIs, even in patients who have received antibiotics prior to testing. This makes the dipstick test a practical option in clinical scenarios where prior antibiotic use is common.

In a Sri Lankan study conducted in 2016 to validate three rapid tests for the detection of urinary tract infections, the sensitivities of the three strips (LET: 81.2%, 81.2%, 84.3%; NT: 45.1%,

46.8%, 43.7%) were lower than those observed in our study (LET: 91.92%; NT: 91.36%). The specificity of LET in the 2016 study (60.7%) was also lower than our findings (76.15%). However, the specificity of NT reported in the 2016 study (85.8%, 85.7%, 80.4%) was higher than that observed in our study (75.38%).[7]

Another Sri Lankan study conducted in 2023 which assessed the performance of dipsticks for diagnosing UTIs in adults, reported that the combined use of dipstick analysis (LET and NT) and microscopy yielded the highest sensitivity (81.5%) and specificity (99.2%).[8] Compared to this, our study demonstrated higher sensitivity but lower specificity.

The higher sensitivities observed in our study compared to these studies may reflect methodological and population-level differences. For instance, the inclusion criteria or the thresholds applied for dipstick positivity could influence diagnostic performance. Similarly, the lower specificity for nitrate in our study may relate to differences in the prevalence of non-nitrate-producing organisms within the study population. These factors, in addition to prior antibiotic use, likely contribute to the observed variations across studies.

A study conducted in Pakistan in 2013 reported significantly lower sensitivity values for both LET and NT compared to our study.[9] However, consistent with our findings, the sensitivity improved when both tests were combined. In terms of specificity, LET and the combined test showed similar specificity in both studies. The specificity of NT was notably higher in the Pakistan study. Additionally, both the PPVs and NPVs reported in the Pakistan study were lower than those observed in our study. These differences may reflect variations in patient populations, study settings, or laboratory methodologies, underscoring the importance of context when interpreting diagnostic test performance.

An Indian study (Mambatta, 2015) reported lower sensitivity values for both LET and NT, as well as their combination, compared to our study.[10] However, similar to our findings, the sensitivity improved when both tests were used together.

The sensitivity of the urine dipstick test in our study was similar to that of Glissmeyer et al (2014).[11] However, the specificity and NPV were higher, and the PPV was comparatively lower. These variations highlight the influence of patient populations, age groups, and study methodologies on diagnostic test performance, emphasising the need for locally validated data for clinical application. An Indian study, which included patients who had not taken antibiotics within two weeks also reported lower sensitivity values for both LET and NT individually and in combination when compared to our study.[12] However, the specificity was higher for NT and the combined test in their findings.

Based on the data discussed, it can be inferred that the performance characteristics of both LET and NT vary widely across studies. Notably, the values observed in the current study fall within the upper range of this spectrum. Several factors may have contributed to this outcome, including false positive results resulting from characteristics of individual urine samples, such as contamination or the presence of non-infective conditions and subjectivity in interpretation, as dipstick results use colour change, which requires interpretation and may introduce subjective errors. These limitations highlight the importance of considering the variability and potential

biases inherent in dipstick testing, while emphasising the value of confirming results with urine culture when necessary.

The urine dipstick test offers several advantages in the diagnosis and management of UTIs. Those include ease of use and accessibility as it is simple, quick, and cost-effective, making it an ideal diagnostic tool in resource-limited settings where urine culture facilities are unavailable. A rapid turnaround time with a result time of approximately five minutes allows for timely decision-making, such as whether to start antibiotics in patients with suspected UTI. It assists in antibiotic stewardship by minimising unnecessary antibiotic prescriptions in both community and hospital settings. In addition, it reduces unnecessary urine cultures and associated costs, as a dipstick test is approximately one-eighth the cost of a urine culture

However, dipstick testing has several limitations. First, it does not allow for pathogen identification or determination of antimicrobial susceptibility, thereby necessitating confirmatory urine culture in positive cases. Second, there is a risk of false positive results, which may occur in the context of asymptomatic bacteriuria or due to contamination during urine collection. Proper sample collection instructions are essential to minimise errors. Finally, a correct clinical diagnosis remains critical, as the test is most effective when used in conjunction with clinical evaluation. Despite its limitations, the dipstick test is a valuable tool, particularly in settings where timely and cost-effective decision-making is necessary.

The calculated dipstick positivity rates exceeded the culture positivity rate in the antibiotic group. This disparity underscores the reduced sensitivity of the gold standard urine culture in patients who have been treated with antibiotics. In such cases, the higher dipstick positivity rates suggest that dipstick tests may serve as a more practical and reliable screening tool compared to culture for patients with prior antibiotic exposure.

It is important to note that the PPV and NPV values derived in this study are specific to symptomatic patients seeking treatment within this particular clinical setting and may not be generalisable to other populations or contexts.

The study initially intended to include the pediatric population, where dipstick testing is particularly advantageous. However, this population had to be excluded following instructions from the Ethics Review Committee. The low sensitivity of the gold standard urine culture, particularly in patients treated with antibiotics posed another limitation. Nevertheless, this limitation can be effectively mitigated by adhering to good antibiotic stewardship practices.

Further studies are needed to validate dipstick testing in local settings. Future research should focus on including the paediatric population to evaluate the test's performance in this group, where its benefits may be greater.

Conclusions

The urine dipstick test is a low-cost, user-friendly diagnostic tool suitable for outpatient settings to identify patients requiring antibiotics. Its use can promote antibiotic stewardship by minimising

unnecessary prescriptions. For patients with positive dipstick results, urine culture can be requested before initiating antibiotics to confirm the diagnosis and guide the therapy.

Declarations

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Author contributions:
NWESN: Data acquisition, data analysis, writing and reviewing the manuscript
NSC: Conceptualisation, data analysis, writing and reviewing the manuscript

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