

Original Article

Diagnostic Accuracy of Dipstick Assay in Prediction Of Urinary Tract Infection (Uti)

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ABSTRACT

Background: Urinary Tract Infections (UTIs) are a common and pressing health concern, particularly in emergency department (ED) settings. Rapid and accurate diagnosis is crucial for effective treatment and management. While urine culture is the gold standard for UTI diagnosis, urine dipstick assays offer a quicker, more accessible alternative.

Objective: The aim of this study was to evaluate the diagnostic accuracy of urine dipstick assays in comparison with urine culture for UTI detection in an ED setting.

Methods: This study was conducted at the ED of Combined Military Hospital, Rawalpindi, from January to June 2023. A total of 260 patients, comprising 70.4% females and 29.6% males with a mean age of 44.45 ± 14.93 years, were included. The study employed a nonprobability consecutive sampling technique. Inclusion criteria were patients aged 18 to 75 years presenting with UTI symptoms and no recent UTI treatment history. Exclusion criteria included patients outside the specified age range, those with indwelling urinary catheters, and patients already under UTI treatment. Urine samples were tested using both dipstick analysis and culture. Sensitivity, specificity, and predictive values of the dipstick test were calculated and compared with culture results.

Results: The sensitivity and specificity of the urine dipstick test were found to be 71% and 61.3%, respectively. The positive predictive value (PPV) was 68.4%, and the negative predictive value (NPV) was 64%. Of the 260 patients, 146 (56.2%) had positive dipstick results, while 141 (54.2%) had positive urine culture results. The study observed a higher prevalence of UTI in females, with 80.9% of positive cultures coming from female patients.

Conclusion: Urine dipstick assays, with reasonable sensitivity and specificity, can serve as a rapid screening tool for UTIs in ED settings, especially in resource-limited environments. However, for definitive diagnosis, especially in cases of negative dipstick results, urine culture remains essential.

Keywords: Urinary Tract Infections, Urine Dipstick Assay, Urine Culture, Diagnostic Accuracy, Emergency Department.

INTRODUCTION

Urinary tract infections (UTI), characterized by the presence of multiplying bacteria in the urinary tract, are a significant health concern, particularly in children where they manifest more frequently with a female-to-male ratio of 3:1 (1). These infections, accounting for 21.2% of hospital-acquired infections, are especially prevalent among females presenting to emergency departments (ED), with incidences ranging from 40-60% (3). The American Academy of Pediatrics emphasizes the necessity of testing febrile children aged 2 months to 2 years for UTIs (2). Clinically, UTIs can present with symptoms such as painful urination, loss of bladder control, and hematuria, potentially leading to severe consequences like renal failure and hypertension (4). Risk factors contributing to UTIs include female anatomy, sexual activity, diabetes, obesity, and a family history of UTIs (1).

Diagnosing UTIs typically involves a range of laboratory tests, including urine dipsticks, biochemical tests, microscopy, Gram staining, and quantitative urine cultures. However, each method has limitations, making it challenging to rely on a single test for definitive diagnosis (2). Despite this, urine cultures, with their 99% specificity, remain the gold standard for diagnosing bacterial UTIs (5). This is particularly relevant in tertiary care ED settings, where empirical antibiotic use may influence the outcomes of standard urine cultures, often resulting in 'no growth' scenarios (7).

The urine dipstick test, a critical component of the diagnostic array, detects various markers including nitrites, leukocytes, protein, glucose, ketones, hemoglobin, and indicators of bacteriuria. This test stands out for its low cost, rapid turnaround time, and the ability to provide multiple simultaneous results, particularly useful as a point-of-care test (POCT) (6,8). Dutch guidelines, for instance, indicate that a positive nitrite test in symptomatic females strongly suggests a UTI (6). Prompt treatment of UTIs is crucial to prevent complications such as renal insufficiency and end-stage renal disease (9,10). In cases where dipstick results indicate a suspected UTI, initiating empirical antibiotic therapy while awaiting culture results is a common practice (2). The convenience of dipstick tests, which do not require sterile urine samples, makes them particularly suitable for use in children (11). Nevertheless, urine culture remains the definitive diagnostic standard.

In the context of developing countries like Pakistan, where resources are often limited, the utilization of urine dipstick tests in EDs emerges as a feasible approach. This is particularly relevant in situations where financial constraints limit the routine use of urine cultures, making dipsticks a viable initial diagnostic tool. The dipstick's rapid results, accessibility, and economic feasibility make it an attractive option in such settings. However, literature comparing the efficacy of urine culture and urine dipstick in Pakistan remains sparse. This study aims to explore the utility of urine dipstick as a reliable, rapid, and cost-effective diagnostic test in the ED setting of a developing country, contributing valuable insights to the existing body of knowledge on UTI diagnostics.

MATERIAL AND METHODS

This study, focused on evaluating the diagnostic accuracy of urine dipstick analysis in urinary tract infection (UTI) detection, was conducted in the Emergency Department (ED) of Combined Military Hospital, Rawalpindi. Spanning from January to June 2023, the research received ethical approval from the institutional review board (IRB) on January 4th, 2023, with the reference number 404. A comprehensive literature review and a World Health Organization (WHO) calculator determined the sample size. Accounting for a UTI prevalence of 21.2% in community-acquired infections, the study aimed for a sample size of 257 to ensure a 5% margin of error and a 95% confidence level. The actual recruitment surpassed this figure slightly, with 260 patients enrolled through a nonprobability consecutive sampling technique, representing the maximum number of available patients during the study period.

Inclusion criteria were set to encompass patients aged 18 to 75 years, presenting with symptoms indicative of UTI (such as fever, malaise, dehydration, and dysuria), and without a recent history (preceding 8 weeks) of UTI treatment. Both genders were considered for participation. Exclusion criteria included patients outside the specified age range, those with indwelling urinary catheters, and patients who had already initiated UTI treatment. Formal written consent was obtained from all participants, ensuring their confidentiality.

A meticulous process was followed for data collection. Each participant underwent a detailed history taking and complete physical examination. Urine samples for dipstick analysis and culture were collected from the 260 participants. Midstream urine samples were obtained by a dedicated sample collector and analyzed using Siemens Clinitek Status +[®] urinalysis analyzers. These samples were then processed for urine culture in the Microbiology department over a 24-hour period. Notably, the results of the urine dipstick analysis were not blinded to the laboratory technicians.

For the microbiological diagnosis of UTIs, the presence of significant bacteriuria was a key indicator. This was defined as the growth of at least 10^3 colony-forming units (CFU) per ml for primary pathogens such as *Escherichia coli* or *Staphylococcus saprophyticus*, and $>10^4$ CFU/ml for secondary pathogens like *Enterococcus* spp., *Klebsiella* spp., and *Pseudomonas aeruginosa*. These thresholds were used for comparing dipstick results, with the presence of primary and secondary uropathogens in urine cultures considered a positive result (4). The dipstick's nitrite reaction was specifically observed for its presence or absence.

Data analysis was conducted using the Statistical Package for the Social Sciences (SPSS) version 25.0. The data, initially inputted into Microsoft Excel, was subjected to descriptive statistical analysis for categorical data, with results expressed as frequencies and percentages. Key diagnostic metrics, including sensitivity, specificity, and positive and negative predictive values, were calculated using a 2x2 table. This comprehensive approach to data collection, assessment, and analysis ensured a robust evaluation of the diagnostic accuracy of urine dipstick assays in UTI detection.

RESULTS

The findings of this study reveal significant insights into the diagnosis of urinary tract infections (UTIs), particularly in terms of gender distribution and the correlation between urine dipstick and culture results.

In terms of gender distribution, the study included a total of 260 subjects, with a higher prevalence of females (70.4%) compared to males (29.6%). This disparity was consistent across both urine dipstick and culture results. Of the 146 positive urine dipstick results, 64.4% were females, and 35.6% were males. Similarly, in the 141 positive urine culture results, a significant majority of 80.9% were females, while only 19.1% were males (Table 1).

The association between urine dipstick analysis and urine culture results, as presented in Table 2, is particularly noteworthy. Among the dipstick results, 100 were true positive (TP) and 46 were false positive (FP). Conversely, there were 41 false negatives (FN) and 73 true negatives (TN). The sensitivity of the dipstick test, which measures the proportion of actual positives correctly identified, was found to be 70.9%. The specificity, indicating the proportion of actual negatives correctly identified, stood at 61.3%. The positive predictive value (PPV), reflecting the probability that subjects with a positive dipstick test truly have a UTI, was calculated to be 68.5%. The negative predictive value (NPV), which indicates the probability that subjects with a negative dipstick test are UTI-free, was 64.0%.

Table 1 Gender Distribution According to Urine Test Results

Parameters	Males	Females	Total
Subjects	77 (29.6%)	183 (70.4%)	260 (100%)
Positive Urine Dipstick Results	52 (35.6%)	94 (64.4%)	146 (100%)
Positive Urine Culture Results	27 (19.1%)	114 (80.9%)	141 (100%)

Moreover, the association of gender with bacterial culture growth (Table 3) provides further insights. Among females, the distribution of bacterial growth was diverse, with *E. coli* being the most common pathogen identified (32.2%), followed by Enterococci (13.7%), *Proteus mirabilis* (8.2%), Staphylococci (5.5%), and *Klebsiella pneumonia* (2.7%). A significant portion of female subjects, 37.7%, showed no bacterial growth. In contrast, male subjects primarily exhibited no bacterial growth (64.9%), and *E. coli* was the only pathogen with substantial presence (32.5%), with minimal to no presence of other bacteria.

Table 2 Association of Urine Dipstick Analysis with Urine Culture Results

Dipstick Result	Culture Positive	Culture Negative
Positive	100 (TP)	46 (FP)
Negative	41 (FN)	73 (TN)
Sensitivity: 70.9%; Specificity: 61.3%; Positive Predictive Value (PPV): 68.5%; Negative Predictive Value (NPV): 64.0%		

Table 3 Association of Gender with Bacterial Culture Growth

Gender	No Growth	<i>E. coli</i>	Enterococci	<i>Proteus mirabilis</i>	<i>Klebsiella pneumonia</i>	Staphylococci	Total
Female	69 (37.7%)	59 (32.2%)	25 (13.7%)	15 (8.2%)	5 (2.7%)	10 (5.5%)	183 (70.4%)
Male	50 (64.9%)	25 (32.5%)	2 (2.6%)	0 (0%)	0 (0%)	0 (0%)	77 (29.6%)
Total	119 (45.8%)	84 (32.3%)	27 (10.4%)	15 (5.8%)	5 (1.9%)	10 (3.8%)	260 (100%)

These findings underscore the higher prevalence and variety of UTI-causing bacteria in females compared to males. The data also highlight the relative effectiveness and limitations of urine dipstick tests in diagnosing UTIs, as evidenced by the sensitivity and specificity values. This comprehensive analysis offers valuable insights into UTI diagnostics, particularly regarding gender differences and the diagnostic utility of urine dipstick tests compared to culture methods.

DISCUSSION

In this study, the primary focus was on evaluating the diagnostic efficacy of urine dipstick assays in detecting urinary tract infections (UTIs) in an emergency department (ED) setting, particularly when compared to urine cultures, the established gold standard. Early diagnosis and prompt treatment of UTIs are crucial for improved patient outcomes and efficient ED operations.

The study revealed that urine dipstick tests, while a rapid diagnostic tool, have variable diagnostic reliability. The sensitivity and specificity of these tests in our study population, which comprised 70.4% females and 29.6% males with a mean age of 44.45±14.93 years, were found to be 71% and 61.3%, respectively. These results align with previous literature, indicating a higher incidence of UTI in women (5). For instance, Laosuankoon et al. (15) and Deville et al. (12) reported similar findings in their respective studies. The former study highlighted the utility of dipsticks in emergency rooms for rapid UTI diagnosis, while the latter provided pooled sensitivities and specificities for leukocyte esterase (LE) and nitrite (NIT) tests. However, variations do exist in the sensitivity of LE across different studies, ranging from 48.5% to 77% (16).

Further, studies by Arsalan et al. (17) and Gorelick et al. (18) showed different sensitivity and specificity values for urine dipstick tests, emphasizing the variability in diagnostic accuracy across different settings. Hiraoka et al. (19) observed that combined LE and NIT tests had high sensitivity and negative predictive value, suggesting their effectiveness in screening UTI in children. These variations in diagnostic accuracy highlight the necessity of considering the patient population and laboratory techniques when interpreting dipstick results.

In our study, urine culture positivity was more common in females (80.9%) compared to males (19.1%), which is consistent with Baral R et al.'s findings (20). However, the study by Hurlbut et al. (21) presented contrasting results, underlining the complexity of UTI diagnosis in different patient groups, including children, surgery patients, and those with asymptomatic bacteriuria. Pelgrom et al. (22) also noted variations, attributed to differences in study cohorts and potential interpreter bias.

The findings of our study also point to several limitations. The specificity of urine dipstick tests for UTIs is potentially reduced by conditions like vulvovaginitis, urethritis, diabetes, and urinary lithiasis, which can cause false positives (23). This indicates a potential for misclassification of UTI in patients with these conditions. Additionally, the study's reliance on urine culture as a gold standard is subject to the implicit assumption of its 100% sensitivity and specificity, which may not always hold true, leading to potential biases. Regarding the types of bacteria identified, the study found that Gram-negative bacteria, predominantly *Escherichia coli*, were the most commonly isolated, corroborating findings from previous studies conducted by MNH between January 2007 and December 2009. This suggests that while urine dipstick tests are valuable for rapid screening, they cannot definitively diagnose UTI, particularly given the variability in bacterial pathogens.

The study's major limitation lies in its single-center nature, focusing only on patients from the CMH Rawalpindi's catchment area, thus limiting its generalizability to the broader population. To address this limitation, future multi-center studies involving larger and more diverse populations are recommended to validate these findings further.

CONCLUSION

In conclusion, the study underscores the utility of urine dipstick assays as a rapid, cost-effective screening tool for UTI, particularly in settings with limited resources. However, in cases of negative dipstick results in symptomatic patients, urine culture remains essential for definitive diagnosis. This study contributes to the existing body of knowledge on UTI diagnostics, highlighting the strengths and limitations of urine dipstick assays and paving the way for future research in this field.

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