How Sensitive is Urine Dipstick Analysis in Predicting Urinary Tract Infections in Symptomatic Adults in a Primary Care Setting

Mokhtar Shatla (1)  
Abdulrahman Almisfer (2)  
Shamsuldin Zawawi (2)  
Baraah Damanhouri (2)  
Fahad Alharthi (2)

(1) Department of Family Medicine, Faculty of Medicine, Menoufia University, Egypt; and Department of Family Medicine, Faculty of Medicine, Umm Alqura University, Saudi Arabia  
(2) Student, Faculty of Medicine, Umm Alqura University, Saudi Arabia

Abstract

Background: Urinary tract infection (UTI) is a common clinical problem in the primary care setting. Urine dipstick analysis is a quick, cheap and widely used test to predict UTI in clinically suspected patients.

Objective: To evaluate the sensitivity of urine dipstick analysis as a screening test in predicting UTI in symptomatic adults in the primary care setting.

Methods: A total of 420 culture-positive urine samples from patients with symptomatic UTI, who had dipstick urinalysis in a primary care center were the materials of this study from March to October 2015. The sensitivity of urine dipstick nitrates (NT), leukocyte esterase (LE) and blood was calculated and compared with positive culture samples either individually or in combination.

Results: The sensitivity of dipstick NT alone was the lowest of all tests (20.7%), while LE alone was marginally higher than NT (31.42%), whereas dipstick blood test when considered alone was the highest sensitive (61.9%). In combination, NT and/or LE were marginally higher than either test alone (41.2%), while NT and/or blood were (64.5%). The highest sensitivity of dipstick is obtained when all the three parameters were considered together (NT and/or LE and/or Blood, sensitivity 81.4%).

Conclusion: Dipstick NT, LE, and blood are poor screening tests when used individually. Dipstick sensitivity significantly increases, and it could be considered a good screening test to predict UTI in symptomatic adults in the primary care setting when its three components are considered together. However, negative dipstick analysis should not rule out UTI in symptomatic adults, and urine culture is necessary for accurate diagnosis.

Key words: Urinary tract infection, dipstick analysis, screening, urine culture, nitrates, leukocyte esterase, blood.

Correspondence:  
Mokhtar Shatla MD  
Department of Family Medicine, Faculty of Medicine, Menoufia University, Egypt  
Department of Family Medicine, Faculty of Medicine, Umm Alqura University, Saudi Arabia  
Email: mokhtarshatla@gmail.com
Introduction

Overall, urinary tract infections (UTI) are the second most common infectious complaint in outpatient primary care clinics, and the most common outpatient complaint caused by bacteria. [1] It is estimated that, 2-3% of all consultations, and even 6% in the case of women, are due to symptoms suggesting UTI. [2] According to one estimate, 1 out of every 2 women will experience a UTI in her lifetime. [3] Almost 20% of UTIs are found in men especially the elderly due to prostatomegaly and distorted anatomy of the urinary tract. [4]

Symptoms of uncomplicated UTI include frequency, burning, straining, urgency, and pain with voiding. Patients may also experience hematuria, suprapubic pain or tenderness, and a change in the odor of the urine. [5]

Early diagnosis of uncomplicated UTI could significantly improve patient management in addition to providing optimum cost-effectiveness. [6, 7] Urine culture is the gold standard for the diagnosis of UTI but is expensive and time consuming, requiring at least 24 hours to produce results. These limitations have made urine analysis including dipstick a preferred first-step investigation among primary care clinicians. [8]

The urine dipstick is a standard diagnostic tool of UTI, but there is much debate about its utility and role. There is doubt that this test is rapid, cheap, quick, and easy to administer. [9] Leukocyte esterase (LE, an enzyme produced by neutrophils) and nitrite (NT, the end product of bacterial nitrate reductase acting on nitrate in the urine), two important parameters of dipstick urinalysis, have been frequently used to predict UTI. Positive results of LE and NT are often used as a reflex to confirm diagnosis by urine culture (both in the presence and absence of clinical symptoms of UTI), or start of empiric antimicrobials. [10] Dipstick detection of blood in urine has been reported to possess a high sensitivity but poor specificity to detect UTI. [11]

There is much debate about the utility and role of Dipstick screening in predicting UTI. [9] Some studies have found negative urine dipstick analysis to be valuable in ruling out UTI. [12] However, other studies have shown a lack of sensitivity and specificity of these tests as indicators of UTI. [13]

So, there is marked heterogeneity in interpretation of results of dipstick analysis. The purpose of this study was to evaluate the sensitivity of dipstick urine analysis with emphasis on NT, LE and blood test, in predicting UTI in symptomatic patients in a primary care setting.

Materials and Methods

This study evaluated the urine dipstick analysis of 420 culture-positive urine samples of patients who attended the family medicine and internal medicine outpatient clinics of Umm Alqura University Medical Center, Makkah, Saudi Arabia, from March to October 2015. The center provides primary health care to the university employees and their families.

Urine samples from patients of both sexes and complaining of symptoms suggestive of UTI were included. Samples of patients less than 16 years of age, and pregnant women were excluded. The study was approved by the Research and Ethics Committee of Umm Alqura Faculty of Medicine.

Samples were collected by the patients themselves where they were asked to provide a midstream clean catch urine sample in the same day of the test. Dipstick urine analysis was done using multistix 10 SG (Siemens) and clinitek advantus analyzer. The reagent strip contains test pads for NT, LE, blood, glucose, protein, ketone, pH, specific gravity, bilirubin and urobilinogen. In this study, urine parameters considered in dipstick analysis were NT, LE, and blood. Reading time for NT and blood was one minute, and two minutes for LE. Cut-off values for a positive result was trace or more of LE, nitrite (+) and blood (+).

The presence of infection in this study was determined by quantitative urine culture. This is the gold standard criterion against which the three dipstick tests were compared. The cultures were done using blood agar and MacConkey agar plates. The cultures were read after 24 hours of incubation at 37°C. A colony count of more than 104 organisms/ml (for one organism) was defined as a positive urine culture for clean catch specimens. Full bacterial identification and antimicrobial susceptibility testing were performed for all positive specimens. [14] Specimens that contained more than two isolates (with any quantitation) were considered contaminated and were not included in the analysis. Dipstick urinalysis data as regards NT, LE, and blood were compared with positive culture results. The comparison was made for every individual test alone, then in combinations.

Results

In this study, the urine dipstick analyses of 420 culture-positive urine samples of symptomatic adults were studied. Age of included patients ranged from 21 to 64 years. The mean age of the patients was 39 years. Among 420 patients, 77.6% were females (n=326), and 22.4% were males (n=94).

Of the 420 culture positives samples, E. coli (62.1%) was the predominant isolate followed by Enterococcus species, Klebsiella, Proteus, Pseudomonas, Streptococcus species, Candida, and staphylococcus aureus, and others [Table 1].
The sensitivity of dipstick NT alone was the lowest of all tests (20.7%), while LE alone was a little higher than NT (31.42%), whereas dipstick blood test when considered alone was the highest sensitive (61.9%). In combination, NT and/or LE were marginally higher than either test alone (41.2%), while NT and/or blood were (64.5%). The sensitivity increases when LE and/or blood were considered (69.7%). The highest sensitivity of dipstick screening is obtained when all the three test parameters are considered together (81.4%) [Table 2].

Table 2: Sensitivity of the urine Dipstick analysis used for screening UTI

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Sensitivity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrite test</td>
<td>20.7% (n=87)</td>
</tr>
<tr>
<td>Leukocyte esterase test</td>
<td>31.42% 132</td>
</tr>
<tr>
<td>Blood test</td>
<td>61.9% 260</td>
</tr>
<tr>
<td>Nitrite and/or leukocyte esterase</td>
<td>41.2% 173</td>
</tr>
<tr>
<td>Leukocyte esterase and/or blood</td>
<td>69.7% 293</td>
</tr>
<tr>
<td>Nitrite and/or blood</td>
<td>64.5% 271</td>
</tr>
<tr>
<td>Nitrite and/or blood and/or</td>
<td>81.4% (342)</td>
</tr>
<tr>
<td>leukocyte esterase</td>
<td></td>
</tr>
</tbody>
</table>

UTI: urinary tract infections

Discussion

Urinary tract infection is the second common bacterial infection in the primary care setting. It is more common in females especially during their reproductive age. In this study, most patients diagnosed with UTI were females. This coincides with many studies which reported higher prevalence of UTI in adult women compared to men mainly due to the anatomy of the female genito-urinary tract.[3]

Diagnosis of UTI is based on clinical symptoms, together with positive urine culture.[15] However, the concerns of cost-effectiveness and lengthy processing time in urine culture have stimulated the use of other rapid diagnostic tools to predict UTI.[16] Dipstick analysis is a common rapid laboratory screening tool used by many primary care clinicians to predict UTI in symptomatic patients. It assesses presence of bacteriuria, pyuria, and hematuria associated with UTI. Notably, several studies have demonstrated significant heterogenicity in interpretation of dipstick results.[17]

Dipstick nitrite test (NT) is used to detect bacteriuria. Normally, nitrites are not found in urine but result when bacteria reduce urinary nitrates to nitrites. Many gram-negative bacteria including E. Coli, and some gram-positive bacteria are capable of this conversion, and a positive dipstick nitrite test indicates that these bacteria are present in significant numbers (i.e., more than 10,000 per mL). [18] However, non-nitrate-reducing organisms

Table 1: Number and percentage of the isolated organisms on the culture positive specimens

<table>
<thead>
<tr>
<th>Organism</th>
<th>Number of Isolates</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Escherichia Coli</td>
<td>261</td>
<td>62.14%</td>
</tr>
<tr>
<td>Enterococcus aeruginosa</td>
<td>52</td>
<td>12.4%</td>
</tr>
<tr>
<td>Klebsiella pneumoniae</td>
<td>30</td>
<td>7.14%</td>
</tr>
<tr>
<td>Proteus mirabilis</td>
<td>22</td>
<td>5.23%</td>
</tr>
<tr>
<td>Pseudomonas aeruginosa</td>
<td>15</td>
<td>3.6%</td>
</tr>
<tr>
<td>Streptococcus pyogenes</td>
<td>13</td>
<td>3%</td>
</tr>
<tr>
<td>Candida species</td>
<td>9</td>
<td>2.14%</td>
</tr>
<tr>
<td>Staphylococcus aureus</td>
<td>7</td>
<td>1.66%</td>
</tr>
<tr>
<td>Streptococcus saprophyticus</td>
<td>5</td>
<td>1.2%</td>
</tr>
<tr>
<td>Streptococcus agalactiae</td>
<td>3</td>
<td>0.72%</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td>3</td>
<td>0.72%</td>
</tr>
<tr>
<td>Total</td>
<td>420</td>
<td>100%</td>
</tr>
</tbody>
</table>
e.g. Candida and Streptococci including Enterococci do not reduce nitrates, and may cause false-negative results. Although E. coli was the predominantly isolated organism in this study (62.1%), similar to other studies,[19-21] almost 20% of the isolates were Enterococci, Candida, and Streptococcus species, which do not produce nitrates.

Also, for bacteria to be able to reduce nitrates and produce nitrates, urine should contain sufficient dietary nitrates and have been retained in the bladder for more than 4 hours before voiding.[22,23] Performing this test on dilute urine may contribute to false-negative findings.[24] In patients who urinate frequently, dilution of NT may result in negative results. The first voided urine morning specimen has been proven to be accurate for nitrate, but such sample collection was not possible in all patients in this study.[25] Also, NT may be affected by common antibiotics e.g. nitrofurantoin, cephalaxin, doxycycline, as well as vitamin C and phenazoperidine leading to suboptimal detection of bacteria.[26] Hence, an absence of urinary nitrite cannot rule out UTI.

All mentioned above may be the likely explanations for the low sensitivity of nitrite test in this study when done alone. This has been supported by findings from other similar studies.[27, 28] However, the sensitivity of nitrates in other studies varied between 39% and 81%.[19, 25, 29]

The leukocyte esterase (LE) test detects esterase, an enzyme released by neutrophils and may indicate white cells in urine (pyuria) associated with UTI.[22] Normally, urine is negative for LE. Positive value of the test correlates with the number of WBC/hpf urine sediment, and can vary from trace to many.[30] However, there are many conditions other than UTI causing pyuria and subsequent positive LE test results e.g. chlamydial urethritis, analgesic nephropathy and bladder tumors. False positives are seen in conditions when the urine is contaminated with bacteria, eosinophils or trichomonas. These reasons cause the positive predictive value of the LE test to vary from 19% to 88%.[31, 32]

False negative results may occur in the presence of significant levels of protein or glucose and in urines with high specific gravity which can crenate the white blood cells, leaving them unable to release esterases.[26, 33]

Similar to NT, LE results may be affected by common antibiotics mentioned above, as well as vitamin C, phenazoperidine, glycosuria, and urobilinogen. Also, high proteinuria has been shown to inhibit LE test.[26,34,35]

Hence, LE when considered alone as a parameter for diagnosing UTI is not as sensitive as when it is combined with nitrates in urine. A similar finding by Bhavsar et al.,[36] found only substantial improvement of sensitivity when NT and LE are combined together to predict UTI in urine culture positive patients. This finding was different from other studies where the sensitivity of LE alone was high and varied between 61.7% and 77%.[29, 37, 38]

The explanation for low sensitivity of LE in this study may be attributed to some patients’ self-initiation of common antibiotics to treat their condition. These medications are given over-the-counter in Saudi Arabia. Moreover, false negative LE test may be attributed to glycosuria and proteinuria, a common association of a prevalent medical problems in Saudi Arabia, diabetes mellitus.

The dipstick test for blood detects the peroxidase activity of erythrocytes in case of hematuria with UTI. However, myoglobin and hemoglobin also will catalyze this reaction, so a false positive test result may occur with conditions other than UTI including hematuria and myoglobinuria e.g. ureteric calculus, glomerular diseases, menstrual blood, malignancy, medications, concentrated urine, and strenuous exercise.[34] False negative results occur if pH of urine is less than 5.1, high specific gravity, and ascorbic acid (vitamin C) is present in the urine.[22] Blood test was the highest sensitive single test in this study. It has been reported that dipstick sensitivity for blood ranges from 91-100%.[22,39,40]

In this study, the sensitivity of dipstick was highest (81.4%) when its three parameters (NT/LE/blood) were all considered together, where any positive dipstick test results for detection of bacteruria by NT and/or detection of pyuria by LE and/or detection of blood improves sensitivity significantly, a finding comparable with that of Mambatta et al. with sensitivity 74%,[40] and Memişoğlu et al. with a sensitivity of 80%, [41]. However, in almost one fifth of the patients, there will be no positive dipstick test results and the patient’s diagnosis might be missed. Hence, correlation of the dipstick test results with the patient’s clinical condition is essential for accurate diagnosis.

Conclusion

Dipstick NT, LE, and blood are poor screening tests when used individually. However, Dipstick sensitivity significantly increases, and it could be considered a good screening test to predict UTI in symptomatic adults in the setting of primary care when its three components are considered together. However, negative dipstick analysis should not rule out UTI in adult patients with symptoms suggestive of UTI, and urine culture is recommended for these patients for proper diagnosis and management.

Recommendations

Primary care and family physicians are encouraged to utilize the quick, cheap, sensitive dipstick screening to predict UTI in symptomatic adults in primary care centers, and to delegate the expensive, time consuming urine culture for highly suggestive conditions of UTI with negative dipstick screening. Larger studies are recommended for larger samples from multiple primary care centers for more data generalizability.
References


