



## Diagnostic Value of Dipstick Test (Leukocyte Esterase and Nitrite) in Diagnosis of Urinary Tract Infection

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### Abstract

**Background:** The accurate UTI diagnosis is crucial in the laboratory. **Objective:** The objective was to assess the sensitivity and specificity of the nitrite test, leukocyte esterase, both nitrite and leukocyte esterase, and urine microscopy in UTI diagnosis. **Methodology:** This was a cross-sectional study in which 100 adult patients, who were suspected to have UTI and did not receive antibiotics for at least 1 week, were included in this study performed in Shahabuddin Medical College and Hospital, Gulshan-2, Dhaka. Urine samples were collected and sent to laboratory for urine analysis and urine culture. Nitrite and leukocyte esterase dipsticks tests were done as well. The sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) were measured for nitrite, leukocyte esterase, both nitrite and leukocyte esterase. **Results:** According to the results of the urine dipstick test, microscopy, and urine culture, nitrite was positive in 17.0% of the cases, leukocyte esterase was positive in 53.0% of the cases, both nitrite and leukocyte esterase were positive in 17.0% of the cases, urine microscopy was positive in 71.0% of the cases, and urine culture was positive in 41.0% of the cases. In the detection of urinary tract infections, the sensitivity, specificity, PPV, and NPV of leukocyte esterase were 87.8%, 71.2%, 67.9%, and 89.4% respectively, using urine culture as the gold standard test. Based on urine culture as gold standard test, the sensitivity, specificity, PPV, and NPV of both nitrite and leukocyte esterase were 34.1%, 94.9%, 82.4%, and 67.5% respectively, in detecting urinary tract infections. **Conclusions:** Efficacy of leukocyte esterase was found better in detecting UTI comparing nitrite test. *Escherichia coli* is the most common isolated organism.

**Keywords:** Diagnostic Value; Dipstick Test; Leukocyte Esterase; Nitrite; Urinary Tract Infection

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### Introduction

Presence of bacteria in urine along with physical symptoms is referred as UTI. One of the illnesses that still has a high mortality and morbidity rate, even after receiving numerous treatments and numerous antibiotics, is urinary tract infection<sup>1</sup>. Because the urinary tract is typically free of bacteria, viruses, fungi,

and parasites, infections there lead to urinary tract infections. Renal failure is the most fatal of its complications, according to Mandell et al<sup>2</sup>.

Bacteriuria refers to the presence of bacteria in the urine, which increases the risk of urinary tract infection. Urine analysis and urine culture should be used to confirm urinary tract infection. If the urine culture obtained by clean catch midstream has more than 100,000 colony units per mL or catheterization method has more than 100 colony units per ml, it is considered positive<sup>2</sup>. Urinary infection is diagnosed if the patient has symptoms such as dysuria, urinary frequency, suprapubic pain, burning sensation during micturition with fever<sup>1</sup>. Dipstick test like leukocyte

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esterase and nitrite tests for urine sample with presence of leukocyte in urine, is more helpful and faster than urine culture in detecting UTI<sup>3-4</sup>. The Nitrite test (converting nitrate to nitrite in urine) is consistent with the presence of Enterobacteriaceae.

Nitrate is converted to nitrite in urine by Gram-negative bacteria. Nitrite in urine reacts with p-arsanilic acid in an acidic environment to form diazonium salt. Pink colour is produced when this salt is combined with 1,2,3,4 tetra benzo-(h)-quinoline-30d. A positive nitrite test indicates that UTI is very likely, but the test may be falsely negative if the bladder is emptied frequently or if the infection is caused by an organism that does not metabolize nitrate including all Gram-positive organisms. Dipstick test in urine also include leukocyte esterase, a combination produced by the destruction of white blood cells<sup>5</sup>.

Since the leukocyte esterase test measures pyuria indirectly, it may result in a false negative if there are only trace amounts of leukocytes present. Leukocytes, a sensitive marker of inflammation connected to infection, are important to look for in a microscopic urinalysis to see if they are present. With the aid of the urine culture (U/C) standard test, we sought to determine the diagnostic value of rapid tests that are frequently performed on urine samples in this study. Therefore, this preset study was undertaken to determine the sensitivity, specificity, positive predictive value, and negative predictive value of these tests.

## Methodology

**Study Design and Population:** This cross-sectional study was carried out on suspected adult UTI patients in Department of Microbiology at Shahabuddin Medical College and Hospital, Dhaka, Bangladesh from January 2022 to March 2022 for a period of three months. The patients did not receive antibiotics for at least a week. The studied patients were presented with one or more of the following symptoms: fever, dysuria, frequency, urgency, enuresis, nocturnal, flank pain, suprapubic pain, vomiting, and hematuria.

**Study Procedure:** Urine sample were collected aseptically and was submitted to urinalysis, urine culture and Dipstick test. Urinalysis was performed which was included direct microscopic examination and this was useful to determine whether there were white blood cells in the urine. The finding of  $\geq 5$  WBCs per high power field was considered abnormal. Nitrite test as a rapid dipstick test measure the conversion of dietary nitrate to nitrite by Gram-negative bacteria, a

positive test makes urinary tract infection very likely. Cultures were considered contaminated if more than one organism or non-pathogens were isolated.

**Statistical Analysis:** Statistical analyses were performed with SPSS software, versions 27.0 (IBM SPSS Statistics for Windows, Version 27.0. Armonk, NY: IBM Corp.). Continuous data that were normally distributed were summarized in terms of the mean, standard deviation, median, minimum, maximum and number of observations. Categorical or discrete data were summarized in terms of frequency counts and percentages. Chi-square test was used for categorical variables and an analysis of variance (Student t Test) for continuous outcomes. Baseline characteristics were presented by treatment group. When values are missing, the denominator were stated. A two-sided P value of less than 0.05 was considered to indicate statistical significance.

**Ethical Clearance:** All procedures of the present study were carried out in accordance with the principles for human investigations (i.e., Helsinki Declaration) and also with the ethical guidelines of the Institutional research ethics. Formal ethics approval was granted by the local ethics committee. Participants in the study were informed about the procedure and purpose of the study and confidentiality of information provided. All participants consented willingly to be a part of the study during the data collection periods. All data were collected anonymously and were analyzed using the coding system.

## Results

One hundred suspected adult UTI patients were included in this study. Females (78.0%) were predominant than male (22.0%) (Figure I).

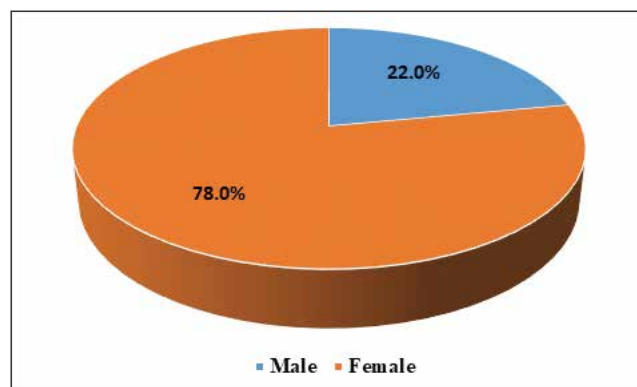


Figure I: Map of Manikganj District showing the COVID-19 Cases

According to the results of urine dipstick test, microscopy and urine culture, nitrite was positive only

in 17.0% cases, leukocyte esterase was positive only in 53.0% cases, both nitrite and leukocyte esterase was positive in 17.0% cases, positive in urine microscopy in 71.0% cases and urine culture positive in 41.0% cases (Table 1).

Table 1: Result of Urine Dipstick Test, Microscopy and Urine Culture

Name of Tests	Frequency	Percent
Nitrite only	17	17.0
Leukocyte Esterase Only	53	53.0
Both Nitrite & Leukocyte Esterase	17	17.0
Urine Microscopy	71	71.0
Urine Culture	41	41.0

Nitrite test was positive in 17 cases of which 14 cases were culture positive. Again among 83 cases of negative Nitrite test, 27 cases were culture positive. The difference between the leukocyte esterase and culture results were statistically significant (p=0.001) (Table 2).

Table 2: Nitrite Test in Comparison with Urine Culture (n=100)

Nitrite Test	Urine Culture		Total	P value
	Positive	Negative		
Positive	14	3	17	0.001
Negative	27	56	83	
<b>Total</b>	<b>41</b>	<b>59</b>	<b>100</b>	

Leukocyte esterase was positive in 53 cases of which 36 cases were culture positive. Again among 47 cases of negative Leukocyte esterase test, 5 cases were culture positive. The difference between the leukocyte esterase and culture results were statistically significant (p=0.001) (Table 3).

Table 3: Comparison of Leukocyte Esterase with Culture

Leukocyte Esterase	Urine Culture		Total	P value
	Positive	Negative		
Positive	36	17	53	0.001
Negative	5	42	47	
<b>Total</b>	<b>41</b>	<b>59</b>	<b>100</b>	

Nitrite leukocyte was positive in 17 cases of which 14 cases were culture positive. Again among 83 cases of negative nitrite leukocyte 27 cases were culture positive. The difference between the Nitrite leukocyte and culture results were statistically significant (p=0.001) (Table 4).

Table 4: Comparison of Nitrite Leukocyte with Culture

Nitrite Leukocyte	Urine Culture		Total	P value
	Positive	Negative		
Positive	14	3	17	0.001
Negative	27	56	83	
<b>Total</b>	<b>41</b>	<b>59</b>	<b>100</b>	

Urine microscopy was positive in 71 cases of which 38 cases were culture positive. Again among 29 cases of negative nitrite leukocyte 3 cases were culture positive. The difference between the Nitrite leukocyte and culture results were statistically significant (p=0.001) (Table 5).

Table 5: Urine Microscopy in Comparison with Urine Culture

Urine Microscopy	Urine Culture		Total	P value
	Positive	Negative		
Positive	38	33	71	0.001
Negative	3	26	29	
<b>Total</b>	<b>41</b>	<b>59</b>	<b>100</b>	

Sensitivity, specificity, PPV, NPV of nitrite were 34.1%, 94.9%, 82.4% and 67.5% in detection of urinary tract infections considering urine culture as gold standard test. Sensitivity, specificity, PPV, NPV of leukocyte esterase were 87.8%, 71.2%, 67.9% and 89.4% in detection of urinary tract infections considering urine culture as gold standard test. Sensitivity, specificity, PPV, NPV of both nitrite & leukocyte esterase were 34.1%, 94.9%, 82.4% and 67.5% in detection of urinary tract infections considering urine culture as gold standard test. Sensitivity, specificity, PPV, NPV of urine microscopy were 92.7%, 44.1%, 53.5% and 89.7% in detection of urinary tract infections considering urine culture as gold standard test (Table 6).

Table 6: Diagnostic Validity of Nitrite Test, Leukocyte Esterase Test and Nitrite Leukocyte

Validity	Nitrite Test	Leukocyte Esterase Test	Nitrite Leukocyte	Urine Microscopy
Sensitivity	34.1%	87.8%	34.1%	92.7%
Specificity	94.9%	71.2%	94.9%	44.1%
PPV	82.4%	67.9%	82.4%	53.5%
NPV	67.5%	89.4%	67.5%	89.7%

Most common bacteria found in UTI was *Escherichia coli* (36.6%) followed by *Enterococci species* (26.8%), *Staphylococcus aureus* (22.0%), *Klebsiella species* (7.3%), *Pseudomonas species* (4.9%) and *Proteus species* (2.4%) (Figure II).

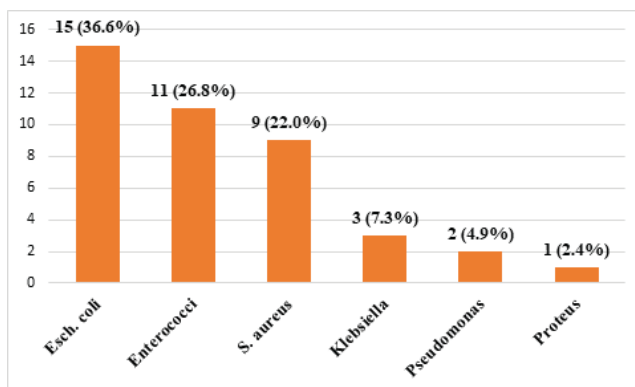


Figure II: Bacteria Found in Urine Culture Positive Cases

### Discussion

In this study sensitivity and specificity of Nitrite test was 34.1% and 94.9% respectively which was almost similar with Koeijers et al<sup>6</sup> where sensitivity and specificity was 47.0% and 98.0% respectively but in the study of Nava et al<sup>7</sup>, sensitivity of nitrite test was 2.3 fold higher than this study but specificity was near about same. Positive predictive and negative predictive value was 82.4% and 67.5% respectively in this study. Positive predictive value was higher than Nava et al<sup>7</sup> (73.0%) but lower than Koeijers et al<sup>6</sup> (96.0%). Negative predictive value was lower than Nava et al<sup>7</sup> (95.9%). The test has a low positive predictive value of 25.0% and a high negative predictive value of 98.1%<sup>8</sup>. Whereas positive predictive value was higher and negative predictive value was lower in this study.

In this study, the dipstick Leukocyte Esterase test was found to have a sensitivity of 87.8% and a specificity of 71.2%. The positive and negative predictive values were 67.9 and 89.4%, respectively. Additionally, the sensitivity of leukocyte esterase test in this study was slightly higher than the study of Nava et al<sup>7</sup> (72.05%) and lower in Koeijers et al<sup>6</sup> (78.0%). Moreover, the specificity of this test in our study was much lower than Nava et al<sup>7</sup> (84.65%) and higher than Koeijers et al<sup>6</sup> (59.0%). This study showed a higher sensitivity compared to the study by Hoberman and Wald<sup>9</sup> who had a sensitivity of 52.9%.

Interestingly, studies of the dipstick Leukocyte Esterase test in adults have shown that the test is both sensitive and specific in detecting pyuria<sup>9-10</sup>. The differences between studies in adults and children might relate to either the degree of pyuria and the enzyme content of immature leukocytes, or both<sup>9</sup>. The high negative predictive value (98.1%) appeared favorable in this regard though 28.6% cases of UTI tested negative according to the LE test. If microscopic examination had not been performed, these 28.6%

patients would not have been confirmed to have UTI. Hence, the dipstick Leukocyte Esterase test cannot be used solely as a screening test in selecting urine samples for microscopic examination or bacterial culture. We support the idea that the test still serves as a genuine backup tool for laboratory diagnosis in several urban and rural communities where both necessary laboratory personnel and facilities for appropriate diagnosis are still lacking. This is true even though the Leukocyte Esterase Dipstick Method seems limited in its applicability in diagnosing UTIs in children<sup>11</sup>. In remote areas, microscopy is impractical, so clinicians may rely on the LE test. The limitations of the LE dipstick test should be considered when interpreting the results. These factors include the period of time the urine sample was collected during the infection's progression, the circumstances of transport and storage, and the degree of accuracy in the test interpretation<sup>12</sup>. The results of the LE test are adversely affected by these elements. Both Whiting et al<sup>13</sup> in Bristol, UK, and Lammers et al<sup>14</sup> in Kalamazoo, USA, emphasized that while the dipstick test is useful, it should not be interpreted in isolation but rather in conjunction with culture results, whenever this is possible.

In comparison with Bolann et al<sup>15</sup> the sensitivity of nitrite and leukocyte esterase test in our study was lower than Bolann study<sup>15</sup>, whereas level of their specificity in our study are more than Bolann study<sup>15</sup>. While our study results compared with Etienne et al<sup>16</sup> showed that the sensitivity and specificity of this test were more in our study than in Etienne et al<sup>16</sup>. Overall, the results of this study shows the efficacy of leukocyte esterase and nitrite tests for detection of UTI. This study showed the specificity and PPV of nitrite and leukocyte esterase test (urine strip test) had relatively high and good to diagnose UTI. Considering that doing nitrite and leukocyte esterase tests requires less than one minute with low cost and high specificity. It could be used as a screening test in the emergency wards in order to prevent UTI complications leading to early diagnosis and treatment before culture results be ready.

### Conclusion

The efficacy of leukocyte esterase was found to be better at detecting UTI compared to the nitrite test. *Escherichia coli* is the most common isolated organism. Urine culture is the gold standard test for the detection of UTI, but it takes time and is not available in the periphery. In cases of urgency, a dipstick test can

be used.

#### Acknowledgements

None

#### Conflict of Interest

The authors have no conflicts of interest to disclose.

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#### Authors' contributions

Huda N, Nabonee MA conceived and designed the study, analyzed the data, interpreted the results, and wrote up the draft manuscript. Huda N contributed to the analysis of the data, interpretation of the results and critically reviewing the manuscript. Sabiha K, Yusuf MA, Hossain M involved in the manuscript review and editing. All authors read and approved the final manuscript.

#### Data Availability

Any inquiries regarding supporting data availability of this study should be directed to the corresponding author and are available from the corresponding author on reasonable request.

#### Ethics Approval and Consent to Participate

Ethical approval for the study was obtained from the Institutional Review Board. As this was a prospective study the written informed consent was obtained from all study participants. All methods were performed in accordance with the relevant guidelines and regulations.

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