Original Article

Diagnosis Of Urinary Tract Infection Using Standard Urinalysis Or Hemocytometer Leukocyte Count

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Background and Objective: **This study was undertaken to assess the ability of standard urinalysis (UA) and hemocytometer white blood cell (WBC) counts for the diagnosis of urinary tract infection (UTI) in patients with urinary symptoms.**

Materials and Methods: **A total of 600 patients with symptoms of urinary tract infection were enrolled in this prospective study. Standard UA, hemocytometer WBC counts, and quantitative urine culture tests were performed on the specimens. The results of UA and hemocytometry were compared with urine culture findings to determine the accuracy of these two methods in the diagnosis of UTI. In this regard, sensitivity, specificity, positive and negative predictive values, accuracy, and likelihood ratios were determined for each of the screening tests.**

Results: **There were 91 positive urine cultures with at least 105 bacteria per milliliter. Sixty-seven patients were female. The results of UA and hemocytometry were as follows: sensitivity 64.8% and 77%; specificity 89% and 90.3%; positive predictive value (PPV) 51.3% and 58.8%; negative predictive value (NPV) 93.4% and 95.6%; and accuracy 85.3% and 88.4% respectively.**

Conclusion: **Although hemocytometer WBC counts have a higher sensitivity, specificity, and positive predictive value than standard UA, the differences are not statistically significant ($p>0.05$).**

Key words: **Urine, Infection, Urinary tract infection, Urinalysis, Hemocytometer**

Introduction

Urinary tract infection is an extremely common diagnosis among patients evaluated in the emergency wards (1, 2). Every year, thousands of people encounter renal failure needing dialysis and renal transplantation after UTI. Therefore, its rapid and accurate diagnosis and treatment is of high importance. In symptomatic patients, bacteria are usually present in the urine in large numbers (a minimum of 105 bacteria/ml). Determination of the number and type of bacteria is an important diagnostic procedure. A presumptive diagnosis based on rapid diagnostic

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tests is important in managing this clinical problem (3). One of these tests is standard urinalysis (UA), a microscopic analysis of a centrifuged specimen in which at least 5 WBC per high power field (HPF) is commonly considered positive. Lin et al (4) reported a sensitivity of 64.9% for standard UA. Similarly, several studies indicate that sensitivity of standard UA is low (5-7). The poor predictability of standard UA promoted consideration of a new method. Counting cells in uncentrifuged urine using a hemocytometer is another rapid test. Presence of at least 10 WBC/mm³ (in some studies, at least 8 WBC/mm³) indicates pyuria (3- 5, 8, 9). A greater sensitivity and positive predictive value is significantly reported for hemocytometer WBC counts as compared with the standard UA (4). Also, a study by Lin et al (7) on febrile infants reported that hemocytometer WBC count had the highest sensitivity, specificity, accuracy, and likelihood ratios for identifying UTI in very young infants. Therefore, this study was conducted to compare the performance of hemocytometer WBC counts with standard UA in detecting pyuria in symptomatic patients.

Materials and Methods

A total of 600 patients with urinary symptoms including both outpatients who referred to Imam Hossein hospital for urinalysis and culture and inpatients that had developed symptom was enrolled in this study for a period of 6 months in 2001. Patients with only UA were excluded. None of the patients in the study was receiving antibiotic therapy at the time of obtaining urine specimen. All urine specimens were analyzed microscopically by standard UA and hemocytometer WBC counts and quantitative urine cultures were performed. Urinalysis was performed by centrifuging 10 mL of urine at 2500 rpm for 10 minutes and its examination microscopically for WBC. Cut-off point of at least 5 WBC/HPF was considered positive. Hemocytometer WBC counts were performed by transferring a drop of uncentrifuged urine on improved Neobauer slides using sampler. Cut-off point of at least WBC /mm³ was considered positive. The urine samples were cultured on blood agar and EMB plates using a 0.01 ml loop. Cultures were incubated at 35° C for 24 hours. The negative cultures were incubated for another 24 h. No growth after 48 h was considered negative and colony count of at least 105 CFU/ml was taken as positive result. Cultures with growth of mixed organisms or non-pathogenic Gram negative Cocci were considered contaminated. The diagnosis of UTI was based on a positive urine culture. The sensitivity, specificity, PPV, NPV, accuracy, and positive and negative likelihood ratios (LR) for both standard UA and hemocytometer WBC counts were calculated with a positive urine culture as the standard. The chi square test was used for comparison of diagnostic sensitivity and specificity and $p<0.05$ was considered statistically significant. The LR (+) for a positive test is the ratio of the frequency of a finding among the diseased patients (true positive rate) and among the non-diseased patients (false positive rate), or the sensitivity/(1 - specificity). The LR (-) or a negative or normal test result is the false negative fraction divided by the true negative fraction, or the (1 - sensitivity)/ specificity. A test result with a LR less than 1 raises the probability of disease and is often referred as a positive test result. A test result with LR less than 1.0 lowers the probability of disease and is often called a negative test result.

Results

Out of 600 patients, 337 were female and 263 were male. Of these, 327 cases were inpatients and 273 were outpatients. Out of 600 studied specimens, only 91 (15.2%) cultures were positive including 67 (74%) female and 24 (26%) male cases. By standard UA, 115 (19.2%) results were positive (at least 5 WBC/HPF) as compared with 119 (19.8%) results from hemocytometry (at least 8 WBC/mm³). True positive (TP), false positive (FP), true negative (TN), and false negative (FN) results are shown in Tables 1 and 2.

Sensitivity, specificity, PPV and NPV, accuracy, and LRs for standard UA and hemocytometry in relation to the presence of positive urine culture are presented in Table 3. The results of the two tests were compared and statistical test showed no significant

differences ($p<0.05$). In addition, Escherichia coli was the most common pathogen (56%). Other pathogens (in order of frequency) were Klebsiella (11%), Staphylococcus epidermidis, candida, proteus, Staphylococcus aureus, and Enterococci.

Table 1. True positive (TP), false positive (FP), true negative (TN) and false negative (FN) results of hemocytometry

Test		Urine culture		Total
		+	-	
Hematocytometer WBC counts	+	70 (TP)	49 (FP)	119
	-	21 (FN)	460 (TN)	481
Total		91	509	600

Table 2. True positive (TP), false positive (FP), true negative (TN) and false negative (FN) results of standard U/A

Test		Urine Culture		Total
		+	-	
Standard U/A	+	59 (TP)	56 (FP)	115
	-	32 (FN)	453 (TN)	485
Total		91	509	600

Table 3. Sensitivity, specificity, positive and negative predictive value, accuracy, and likelihood ratios (LR) of standard UA and hemocytometry in predicting positive urine culture

Test		U/A		Total
		TP (+)	TN (-)	
Hemocytometer WBC counts	TP (+)	59	11	70
TN (-)		0	453	460
Total		59	453	

Discussion

Urinary tract infection is a common and treatable disease and a missed diagnosis could result in failure to appropriately treat a patient and possibly lead to renal damage (5, 7, 10). Traditionally, the gold standard test for diagnosing UTI has been culturing the urine, which is time-consuming and relatively expensive. A rapid, simple, inexpensive, and accurate test would be ideal. Multiple studies have examined the ability of rapid tests such as dip sticks and microscopic UA in detection of UTI (11-13). None of these studies have produced a screening test with 100% sensitivity. Several studies (4, 5-7) as well as the present study have evaluated the diagnostic validity of standard UA and hemocytometer WBC counts. Lin et al (4) compared these two methods among 230 febrile

Table 4 . Sensitivity, specificity, positive and negative predictive value, accuracy and likelihood ratios (LR) of standard U/A and hemocytometry in predicting positive urine culture

	Standard U/A	Hemocytometer WBC count
Pyuria cut off point	>5 WBC/hpf	>8 WBC/mm3
Sensitivity	64.8%	77%
Specificity	89%	90.3%
Positive predictive value	51.3%	58.8%
Negative predictive value	93.4%	95.6%
Accuracy	85.3%	88.4%
LR(+)	5.89	7.7
LR(-)	0.39	0.25

infants with an age less than 12 months and reported that sensitivity, specificity, PPV, and accuracy in hemocytometry were higher than standard UA and the sensitivity of hemocytometer WBC counts was 83.8%. In a review of 5 published studies using counting chamber in 291 symptomatic patients, sensitivity was 97% (9). It is suggested that the poor performance of standard UA may be due to lack of standardization of the volume of the urine specimens, the duration of centrifugation, the volume used for resuspension, the size of the drop, and the number of fields examined microscopically. Hemocytometer WBC counts reduce variability in results caused by centrifugation and resuspension enables evaluation of a fixed volume of urine and facilitates accurate counting by providing a marked visual field with uniform illumination (4, 5, 7).

To improve the efficacy of hemocytometer WBC counts, Shaw (14) and Hoberman (5, 6) demonstrated that enhanced UA (hemocytometry plus Gram stain) provided the highest specificity and PPV for identifying patients with UTI. In our study, sensitivity, specificity, predictive value, accuracy, and likelihood ratios of standard UA and hemocytometer WBC counts were compared. In this regard, the sensitivity of standard UA and hemocytometry were 64.8% and 77% respectively. The results of standard UA support other observations (4, 11-13). We also reported a higher PPV (58.8% versus 51.3%) and sensitivity (77% versus 64.8%) for hemocytometer WBC counts than standard UA. However, the sensitivity of hemocytometry was lower in our study as compared to previous studies (4, 5, 7, 9), and when the results of the two methods were compared, no significant differences were statistically present.

Conclusion

Although previous studies indicate that hemocytometry is more valid and accurate for diagnosis of UTI and its predictive value is more than standard UA, our results showed no significant difference.

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