

Evaluation of Complete Urinalysis and Infection Markers in the Prediction of Urine Culture Results in All Age Groups: A Cross-Sectional Study

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Abstract— *Background:* While diagnosing a urinary system infection, infection indicators such as a complete urinalysis and white blood cell count (WBC), c-reactive protein (CRP), and sedimentation rate (ESR) can be used with the urinary culture which is the gold standard method. We aimed to compare these tests in patients with positive and negative urine culture results. **Materials- methods:** Data belonging to 604 patients with requested tests of complete urinalysis, complete blood count (CBC), CRP, ESR, and urine culture were retrospectively analyzed from the records of our hospital. The results of 222 children (<18 years) and 382 adults (≥18 years) achieved from the software system were evaluated. Patients with urine cultures resulting as contaminated were excluded from the study. All statistical tests were performed with a SPSS 17.0 and the significance level for all tests was accepted as $p < 0.05$. **Results:** Growth occurred in the urine cultures of 103 (%17) patients. In children, while the presence of leukocyte esterase, nitrite positivity, and microscopic leukocyturia in the complete urinalysis was found to be statistically significant in those with growth in their urine cultures, no significant difference was detected in terms of leukocytosis, ESR, and CRP levels. In adult patients, all of the leukocyte esterase, nitrite, protein, and microscopic leukocyturia values from the complete urinalysis were statistically significant in the group with growth in the urine culture. Although there was no significant difference in terms of WBC elevation, CRP and ESR were found to be higher in the group with growth in the urine culture. **Conclusion:** Evaluation of a complete urinalysis, especially in children, compared to blood tests, may be useful in the early diagnosis of urinary tract infections. ESR and CRP levels in addition to full urinalysis in adults, may be useful in the early diagnosis of urinary tract infections. If one or more of these tests are positive together, urine culture should be requested immediately and appropriate antibiotic therapy should be started according to the antibiogram result.

Keywords— Urinalysis, infection markers, urine culture.

I. INTRODUCTION

The disease setting which is created by the settlement of numerous microorganisms in any area of the urinary system is usually expressed as urinary tract infection (UTI) [1]. *Escherichia coli* is the most commonly observed microorganism in acute infections. In recurrent UTI, especially in the presence of structural abnormalities such as obstructive uropathy, congenital anomalies, neurogenic bladder and, fistulization, the *Proteus*, *Pseudomonas*, *Klebsiella*, *Enterobacter*, *Enterococcus*, and *Staphylococcus* incidence is higher [2]. In some studies, coagulase-negative staphylococci are reported as a common cause of UTIs. *Staphylococcus saprophyticus* is responsible for 5-15% of acute cystitis attacks seen in sexually active young women [3]. In more than 95% of UTIs, only one type of bacteria is responsible. However, *Staphylococcus epidermidis*, diphtheroids, lactobacilli, *Gardnerella vaginalis* and various anaerobics often colonize in the distal urethra and skin of both men and women, and in the vagina of women but, do not play a role in the etiology of UTIs. For this reason, a urine sample must be considered as contaminated if there is growth of

multiple species of bacteria or any of such colonizing bacteria in the culture [4].

The first step in the laboratory diagnosis of UTI is the microscopic examination of urine. Pyuria is the presence of at least 5-10 leukocytes/L in a fresh, non-centrifuged mid-stream urine by chamber counting. Pyuria is a nonspecific finding, and the presence of pyuria without infection is frequent.

Dipstick leukocyte esterase test can also be used to determine pyuria. Sensitivity and specificity of this test is lower than those of microscopy (75-96% and 94-98%). In symptomatic patients with negative dipstick leukocyte esterase, urine microscopy should be applied or urine culture should be extracted [5].

In the majority of UTIs proteinuria (<2g/day) and, microscopic and sometimes macroscopic hematuria can be observed. A fast and indirect method for the detection of bacteriuria is the displaying of the presence of nitrite in the urine. This is created through the reduction of nitrate by the bacteria [6].

While diagnosing a urinary system infection, infection indicators such as a white blood cell count (WBC), mean platelet volume (MPV), c-reactive protein (CRP), and

sedimentation rate (ESR) can be used with the urinary culture [7]. However, urinary culture is the gold standard method. [8].

We aimed to compare these tests in patients with positive and negative urine culture results.

II. MATERIALS AND METHODS

The results of patients from our hospital inpatient and outpatient clinics with urine culture, urinalysis, white blood cell count (WBC), mean platelet volume (MPV), C-reactive protein (CRP), and erythrocytes sedimentation rate (ESR) examinations concurrently requested and studied in our laboratory were retrospectively evaluated from the laboratory software system. The results of 222 children (<18 years) and 382 adults (≥18 years) achieved from the software system were evaluated. Patients with urine cultures resulting as contaminated were excluded from the study.

Urinary culture: Urine sample in a sterile container was added to Chromagar™ Orientation (CHROMagar, France) broth medium in the form of inventory plaques with 0,001 mL of extract. Planting plaque was incubated at 37°C for 18-24 hours. Growth ≥10⁵ cfu/mL in the culture was deemed as significant in terms of UTI and the identification process was initiated. The identification of microorganisms were made according to the color changes in Chromagar in outpatients and by using Phoenix™ automated identification and susceptibility testing system (BD, USA) in inpatients.

Complete urine examination: The chemical and microscopic analyses of urine was conducted by DIRUI H-800/FUS-200 urine analyzer (DIRUI Industrial Co. Ltd., China). In the chemical analysis, protein results (protein-strip) >0.3 g/L were considered positive and, leukocyte esterase-strip and nitrite-strip results were delivered as negative/positive. In the microscopic analyses, >5/hpf was accepted positive for leukocyte counting [leukocyte-(microscopy)].

Measurement of WBC: WBC counting was done by XE-2100 hematology analyzer (Sysmex Corporation, Japan), using the fluorescence flow cytometry method. Results with WBC >10⁹/L were considered high.

Measurement of ESR: ESR was measured by ALS-100 analyzer (Alaris Medical and Laboratory Products, Turkey), using the Westergren Method. Results, >10 mm/hr in children; for <50 years old >15 mm/hr and, for >50 years old >20 mm/hr in men; for <50 years old >20 mm/hr and, for >50 years old >30 mm/hr in women were evaluated as high.

Measurement of CRP: Serum CRP level was measured by BN-II nephelometric analyzer (Siemens, Germany). Results >47.6 nmol/L were evaluated as high.

Statistical analysis: Urinalysis parameters (leukocyte esterase-strip, protein-strip, nitrite-strip, leukocyte-microscopy) were categorized as negative/positive while WBC, ESR, and CRP were categorized as normal/high. Chi-square and Fisher's exact tests were used for the comparisons of negative and positive culture groups. All statistical tests were performed with a SPSS 17.0 (SPSS Inc., Chicago, USA) and the significance level for all tests was accepted as p<0.05.

III. RESULTS

From the total of 604 patients were included in the study, 222 (36.7%) patients were under 18 years of age and 382 (63.3%) were over 18 years of age.

Mean age of the adult patients was 51 ± 18, 24% of these were male (91), 76% were female (291). Mean age of the children was 9 ± 4, 21% male (46) and 79% female (176). 93.3% of the patients were outpatients.

There were 103 patients (17%) with growth in the urinary culture, of which 77 were adults (74.7%), 26 were children (25.3%), and there were 501 people with no growth in the urinary culture (83%). The most frequently isolated agents were E. coli, Klebsiella spp., Enterococcus spp. Proteus spp., Candida spp. Pseudomonas spp., Acinetobacter spp., respectively.

Leukocyte esterase-strip and nitrite-strip positivity, and the presence of leukocyte-microscopy were significant difference in the complete urinalysis of the children with positive urine culture. There was no significant difference in WBC count, ESR, and CRP results of them. The results are given in table 1.

TABLE 1: Parameters of urine analysis and WBC, ESR, CRP values according to culture results for children patients

	Culture Negative		Culture Positive		p
	Negative (Normal) n (%)	Positive (High) n (%)	Negative (Normal) n (%)	Positive (High) n (%)	
Leukocyte esterase-strip	149(76)	47(24)	15(57.7)	11(42.3)	<0.05^{a,b,c}
Protein-strip	185(94.4)	11(5.6)	25(96.2)	1(3.8)	0.578
Nitrite-strip	193(98.5)	3(1.5)	18(69.2)	8(30.8)	<0.001^{a,b}
Leukocyte-microscopy	164(83.7)	32(16.3)	11(42.3)	15(57.7)	<0.001^{a,c}
WBC	172(87.8)	24(12.2)	21(80.8)	5(19.2)	0.351
ESR	75(38.3)	121(61.7)	7(26.9)	19(73.1)	0.260
CRP	145(74)	51(26)	18(69.2)	8(30.8)	0.607

^ap<0.05, ^bChi-square, ^cFisher's exact tests

Leukocyte esterase-strip, nitrite-strip, protein-strip, and leukocyte-microscopy results were statistically significant in adult patients with growth in urine culture. There was no significant difference in WBC count, whereas CRP and ESR were found higher in these patients. The results are shown in table 2.

TABLE 2: Parameters of urine analysis and WBC, ESR, CRP values according to culture results for adult patients^a

	Culture Negative		Culture Positive		p
	Negative Normal n (%)	Positive High n (%)	Negative Normal n (%)	Positive High n (%)	
Leukocyte esterase-strip	202(66.2)	103(33.8)	29(37.7)	48(62.3)	<0.001
Protein-strip	276(90.5)	29(9.5)	50(64.9)	27(35.1)	<0.001^a
Nitrite-strip	297(97.4)	8(2.6)	49(63.6)	28(36.4)	<0.001^{a,b}
Leukocyte-microscopy	226(74.1)	79(25.9)	21(27.3)	56(72.7)	<0.001^{a,c}
WBC	269(88.2)	36(11.8)	62(80.5)	15(19.5)	0.077
ESR	198(64.9)	107(35.1)	38(49.4)	39(50.6)	0.012^a
CRP	180(59)	125(41)	29(37.7)	48(62.3)	0.001^{a,c}

^ap<0.05, ^bChi-square, ^cFisher's exact tests

IV. DISCUSSION

UTIs are the most common cause of bacterial infections and can be seen in both sexes and all age groups [9]. Its clinical types vary from asymptomatic bacteriuria to sepsis. These infections are more common in women than in men and nearly half of women are reported to have had a UTI at a time in their life [10]. In our study, we also observed that the majority of cases were of the female sex.

The most frequently isolated agent of urinary tract infection is E.coli (70-90%). Less frequently, Klebsiella, Proteus and Pseudomonas can also be detected in these types of infections [9,11]. In our patients as well, E.coli growth frequency ranked as first with 70% in children and 61% in adults.

Anamnesis, symptoms, clinical findings, whole blood count, urinalysis, urine and blood culture, as well as endoscopic and radiological investigations if deemed necessary, should be performed for diagnosis [3,10]. In patients with pyelonephritis, leukocytosis, elevations of ESR and CRP, and leukocyte cylinders are detected in urine [12]. As the result of the urine culture which is used as gold standard for diagnosis arrives late, urinalysis and other specified parameters are used at the beginning of the treatment until the culture results are yielded. For this reason, diagnostic effectiveness of these tests gain importance.

In our study, leukocyte esterase-strip and nitrite-strip positivity, and the presence of leukocyte-microscopy were significant difference in the complete urinalysis of the children with positive urine culture. There was no significant difference in WBC count, ESR, and CRP results of them.

We found that leukocyte esterase-strip, nitrite-strip, protein-strip, and leukocyte-microscopy results were statistically significant in adult patients with growth in urine culture. There was no significant difference in WBC count, whereas CRP and ESR were found higher in these patients.

In a study of children's age group made by Yıldırım et al. [13], there was no significant correlation between CRP elevation and culture positivity, whereas the correlation with white blood sphere count was found to be statistically significant. This may be due to a higher risk of contamination arising from the difficulty in obtaining urine samples in sterile conditions for culture in child patients.

In this study, it was found that the majority of the culture results of 604 patients (83%) were negative. In the studies made by Yüksel et al. [14], Kayaalp et al. [15], Okada et al. [16], and Martinez et al. [17], negative culture results were reported respectively as 65.7%, 97.7%, 68.3%, 52%. In these studies, it was also observed that the majority of the culture requests yielded negative results. This situation might have been due to prior use of antibiotics, the exclusion of growths under 10^5 cfu/mL in culture, or simultaneous requests of urine culture from the patients who were thought to have urinary tract infections before checking the results of urinalysis.

In order to prevent increased costs and loss of labor, urinalysis and effective evaluation of other infection indicators in adult patients should be performed before making a request for urine culture.

V. CONCLUSION

Evaluation of a complete urinalysis, especially in children, compared to blood tests, may be useful in the early diagnosis of urinary tract infections. ESR and CRP levels in addition to full urinalysis in adults, may be useful in the early diagnosis of urinary tract infections. If one or more of these tests are positive together, urine culture should be requested immediately and appropriate antibiotic therapy should be started according to the antibiogram result.

Limitations: Retrospective; lack of information on whether the patients received prior treatment.

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