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Forecasting Urosepsis: Enhancing Urine Culture Outcomes Through Automated Urinalysis

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Abstract

Introduction: Urosepsis is a serious infection that has a high rate of morbidity and death. Improving patient outcomes requires early detection and treatment. Although automated urinalysis provides a quick and non-invasive diagnostic method, nothing is known about how well it predicts urine culture results in cases of urosepsis. With this background, we aimed to find the association between the results of urinalysis and those of concurrent urine cultures.

Methodology: This observational study was conducted in the Department of Pathology at the tertiary care hospital among 200 patients who were subjected to urine cultures for suspected UTIs and they were selected through a convenient sampling method. Automated urinalysis was performed using Laura XL's automated urine sediment analysis instrument. Data were collected and analysed using IBM SPSS v21. Fisher exact test was used to find an association between Urine analysis and urine culture.

Results: Of the 200 patients with the symptoms of UTI studied, 156 patients had positive for urine culture and Automated urinalysis showed 124 of them had Leucocyte esterase and 115 of them had nitrite in urine analysis. The majority of the patients had E. coli, followed by Klebsiella species in the urine culture. Leucocyte esterase showed 89.86% sensitivity and Nitrite 89.84% sensitivity. Both Leucocyte Esterase (0.0001) and Nitrite (0.0001) were significantly associated with Bacteria present in urine culture.

Conclusion: Automated urinalysis shows promise in predicting urine culture outcomes in patients with suspected urosepsis. Integrating AU into the diagnostic pathway may facilitate faster clinical decision-making, potentially improving patient care.

Keywords: Automated urinalysis, Urine culture and Urosepsis.

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INTRODUCTION

Urosepsis is a type of sepsis caused by urinary tract infections, such as pyelonephritis, which is an infection of the upper urinary tract and kidneys, and cystitis, which is a lower urinary tract and bladder infection. The urogenital tract is the site of origin for around 25% of sepsis cases.[1] Escherichia coli accounts for 50% of urinary tract infections (UTIs), which in turn cause urosepsis. Proteus (15%), Enterobacter (15%), Klebsiella (15%), Pseudomonas aeruginosa (5%), and gram-positive bacteria (15%) are the next most prevalent pathogens.[2]

In India, the prevalence of urinary tract infections ranges from 21.8% to 37%.[3] Most UTI cases have modest clinical symptoms, but there is a chance that the illness could worsen and cause major consequences, particularly in high-risk groups including elderly people, pregnant women, immunocompromised patients and newborns. Consequently, improving the clinical outcomes of UTI patients requires early identification and empirical antibiotic treatment.[4]

The gold standard for a conclusive diagnosis of urinary tract infection is the identification of the pathogen through the bacterial culture of a urine specimen. Testing clinical isolates can yield an antibiotic susceptibility profile. Urine culture is a laborious process, and the range of microorganisms that cause urinary tract infections is limited. Consequently, routine cultures are frequently not required for the care of patients with simple UTIs; instead, the choice to treat a patient should be based only on the results of urine analysis, either by sediment analysis or test strip analysis.[5]

Leukocyte esterase and nitrite are two test strip analysis components that are frequently utilised in standard clinical procedures to diagnose UTIs. Pyuria is indicated by urine LE positive, and the presence of nitrate-reducing bacteria is shown by urine nitrite positive. However, because of the test principle's limitations, these tests' diagnostic performance isn't high enough to be used on its own.[6]

Traditionally, test strip analysis has been performed using a dipstick based on physicochemical reactions, with a reflectometer used to interpret the data. The introduction of automated urinalysis systems, which include sample preparation, aliquoting, and reading, has increased test throughput and efficiency while decreasing labour and time. Additionally, by recognising different types of cells, casts, and crystals in a urine sample, microscopic analysis of urine sediment is also commonly used to diagnose disorders of the urinary tract.[7] With this background, we aimed to investigate the association between the results of urinalysis and those of concurrent urine cultures.

METHODOLOGY

This observational study was conducted in the Department of Pathology at the tertiary care hospital among 200 patients who were subjected to urine cultures for suspected UTIs and they were selected through a convenient sampling method. Pregnant women, patients with a prior history of urological surgery, Patients currently on antibiotic treatment, and the participants who were unwilling to participate were excluded. The European Urinalysis Guidelines were followed during the collection, transportation, specimen preparation, and urinalysis processes.[8] Thirty millilitres of midstream samples were collected and transported in spill-proof main containers before being moved to secondary containers in the lab and Automated urinalysis was performed with Laura XL automated urine sediment analysis instrument. Midstream urine samples will be collected from each patient and sent for culture and sensitivity testing. Data was collected & entered in Excel and analysed using IBM SPSS v21. Data are expressed in frequency and Fisher exact test was used to find an association with 95% confidence interval.

Figure 1: LAURA XL AUTOMATIC URINE ANALYSER

RESULTS

Table 1: Demographic characteristics

Variable		Number of patients (n = 200)
Age (years)		42.39 ± 20.75
Gender	Male	70
	Female	130

Table. 1 depicts the demographic characteristics of patients. The mean & SD of age among 200 patients are 42.39 ± 20.75 years. The majority of the patients were females.

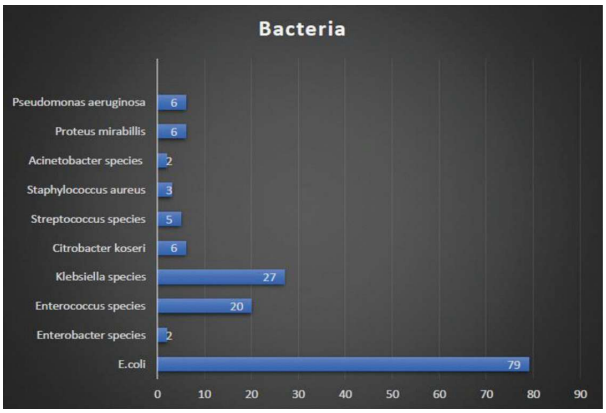

Figure 2: Bacteria isolated from Urine culture

Of the 200 patients suspected of UTI 156 patients had positive urine culture and 44 patients had negative urine culture and among the 156patients 79 of them had E.coli, 27 of the patients had Klebsiella species, 20 of the patients had Enterococcus species, 5 had Streptococcus species, 3 of the patients had Staphylococccus species, Each 6 of the patients had Pseudomonas aeruginosa, Proteus mirablis, Citrobacter koseri and Each 2 patients had Acinetobacter species & Enterobacter species.

Table 2: Urine analysis among culture positive & negative patients

Urine Analysis	Culture positive patients (n = 156)		Culture negative patients (n = 44)	
	Present	Absent	Present	Absent
Erythrocytes	97	59	6	38
Crystals (Calcium oxalate)	8	148	2	42
Bacteria	54	102	0	44
Yeast	0	156	0	44
Cast (Granular cast)	6	151	0	44
Leucocyte esterase	124	32	14	30
Nitrite	115	41	13	31

On complete urine analysis which was demonstrated in Table.2. the culture positive patients showed a greater number of erythrocytes, Crystals, Bacteria, Cast, Leucocyte esterase and Nitrite in the urine analysis than the Culture negative patients.

Table 3: Leucocytes and Epithelial cells among culture positive & negative patients

	Culture positive patients	Culture negative patients
Leucocytes	17.86 ± 11.64	3.18 ± 1.18
Epithelial cells	5.37 ± 4.83	3.25 ± 1.90

The mean & SD of Leucocytes among Culture positive patients and Culture negative patients are 17.86 ± 11.64 and 3.18 ± 1.18. The mean & SD of Epithelial cells among Culture positive patients and Culture negative patients are 17.86 ± 11.64 and 3.18 ± 1.18.

Table 4: Association between Leucocyte Esterase and Nitrite with Urine culture

Urine Culture	Leucocyte Esterase present	Leucocyte EsteraseAbsent	Odds ratio	p-value
Bacteria present	124	32	8.3	0.0001
Bacteria Absent	14	30		
Urine Culture	Nitrite positive	Nitrite negative	Odds ratio	p-value
Bacteria present	115	41	6.69	0.0001
Bacteria Absent	13	31		

$p<0.05$ considered as significant

Among the patients with Urine culture positive 8.3 times higher odds of getting Leucocyte Esterase presentand 6.69 times higher odds of getting nitrite positive in the urine analysis. Both Leucocyte Esterase (0.0001) and Nitrite (0.0001)

were significantly associated with Bacteria present in urine culture.

Table 5: Sensitivity and Specificity ofLeucocyte Esteraseand Nitrite

	Sensitivity (%)	Specificity (%)
Leucocyte Esterase	89.86	48.39
Nitrite	89.84	43.05

Among 200 patients with the symptoms of UTI, Leucocyte Esterase showed a sensitivity of 89.86% and Specificity of 48.39% and Nitrite showed asenisitivity of 89.84% and specificity of 43.05%.

Table 6: Correlation between Leucocytes and Epithelial cells among Urine culture positive patients

Leucocytes	Epithelial cells	Correlation (n = 156)	p-value (n = 156)
17.86 ± 11.64	5.37 ± 4.83	**0.31**	***0.0001***

positively correlated

p<0.05 considered as significant

Among Urine culture positive patients, we found a positive correlation of Leucocytes with epithelial cells (0.313) and found it to be significant (0.0001).

DISCUSSION

Our studyhighlights the potential of automated urine analysis as an effective indicator for urosepsis, a condition often requiring prompt diagnosis and treatment. It revealed an increased presence of Leucocyte Esterase, Nitrite, Leucocytes and Epithelial cells among culture positive patients than the culture negative patients.Patients with elevated leucocytes and positive nitrite results on automated urinalysis were more likely to have a positive urine culture, suggesting that these indicators can serve as a preliminary predictor for urosepsis-related infections.Both Leucocyte Esterase (0.0001) and Nitrite (0.0001) were significantly associated with Bacteria present in urine culture.Additionally, Leucocyte Esterase and Nitrite parameters provided a higher sensitivity and specificity for predicting positive cultures. In accordance with other research on Urinary tract Infections, the study found that positive nitrites and the presence ofLeucocyte Esterase were particularly predictive of bacterial growth.

A similar study by Yüksel H et al found Leukocyte esterase 86.1% and microscopy leucocytes 88.0% were found to have high sensitivity in diagnostic accuracy estimates, whereas bacteria 86.6% and nitrite 95.4%were found to have excellent specificity whereas in our study we found Leucocyte Esterase showing 89.86% which is close to the previous study results (9).

Another contrary study by Middelkoop SJ et al found the diagnosis of UTI was made in 143 patients (37.5%). Urine dipstick nitrite has a sensitivity of 32.9% and a specificity of 93.7%. Urine dipstick leukocyte esterase (3 +) has a sensitivity of 80.4% and a specificity of 82.8%. In our present study, we found Leucocyte Esterase showed a sensitivity of 89.86% and Specificity of 48.39% and Nitrite showed asensitivity of 89.84% and specificity of 43.05%. The difference in sensitivity and specificity is due differences in the method of analysis (10).

A meta-analysis byDevillé WL et al found Pregnant women had high nitrite accuracy, and urology patients had high leukocyte-esterase accuracy. Leucocyte Esterase showed 86% sensitivity which is close to our study findings (11).

Suresh J et al did a study among paediatric patients with dipstick analysis LE had sensitivity 96.4%, specificity 95.8% and nitrite had sensitivity 94.7%, specificity 99.5% which showed better accuracy than our results (12).

Another similar study by He H et al demonstrated the nitrite test had an 81% sensitivity while the leukocyte esterase test had a 77% sensitivity. Nonetheless, the combined nitrite and leukocyte esterase test has a 94% sensitivity. Compared to the leukocyte esterase test 54% or both tests combined 50%, the nitrite test was more specific 87% which is consistent with our study findings (13).

High sensitivity was shown by automated urine analysis in detecting urosepsis-related indicators such nitrites, and leukocytes. By using this technique for early detection, doctors may be able to start therapy sooner and lower the chance of problems. Additionally compared to manual microscopy and culture, automated systems drastically cut down on diagnostic time, which is especially helpful in emergency situations. Automation's standardisation reduces inter-observer variability, improving diagnostic accuracy and reliability. Although putting automated systems in place may be expensive initially, the long-term advantagessuch as fewer needless treatments and shorter hospital staysmake them an affordable option (14,15).

CONCLUSION

Automated urinalysis demonstrates significant potential in predicting urine culture outcomes

in patients with suspected urosepsis. The study found a strong association between the presence of leukocyte esterase and nitrite in urine analysis and positive urine culture results. With high sensitivity for detecting bacterial presence, automated urinalysis can serve as a valuable preliminary diagnostic tool, enabling faster clinical decision-making and timely treatment initiation. Its integration into routine diagnostics could reduce reliance on time-consuming urine cultures, ultimately improving patient outcomes. However, further research with larger sample sizes and diverse populations is necessary to validate these findings and optimize the application of automated urinalysis in clinical practice.

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