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Diagnostic accuracy of urine routine examination for diagnosis of urinary tract infection in different pediatric age groups taking culture as gold standard: a single center study from Peshawar

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ABSTRACT

Introduction: The Urine Routine Examination (Urine RE) is used as the first step for diagnosis of urinary tract infections (UTI), even though it is not a definitive test for infection. This may result in anomalous administration of therapy for UTI in false positive cases as well as missed therapy in false negative cases.

Objective: To determine the sensitivity and specificity of urine routine examination in diagnosing urinary tract infection by taking urine culture as gold standard in pediatric age group in a tertiary care hospital.

Materials & Methods: A cross-sectional study was conducted in the department of Paediatrics, Rehman Medical Institute, Peshawar in March 2021. Retrospective data of last five years (2016-2020) were retrieved from patient medical records for demographics, clinical examination, and laboratory tests, and recorded on a purposefully designed Performa. Sensitivities, specificities, positive and negative predictive values were calculated for urine samples with 95% CI. All analyses were done at an alpha value of 0.05.

Results: A total of 368 children were included in this study, in which 144(39.1%) were male and 224(60.9%) were female. Out of 368, 184(50%) had positive urine culture; out of 184 positive urine C/S, majority (107) were positive for E-Coli, followed by enterococcus species (25), and klebsiella (23). Sensitivity, specificity, PPV and NPV of WBC vs C/S was 67.39%, 74.46%, 16.56% and 96.8% respectively considering culture as gold standard. Similarly for nitrites it was 19.02%, 90.76%, 13.41% and 93.7%.

Conclusion: Traditionally Urine Routine examination is being used as screening tool for Urinary tract infection. However, in our study low sensitivity among all pediatric age groups questions its effectivity as screening tool. This emphasizes the value of urine culture as screening investigation rather than urine RE.

Keywords: Urine; Urinary Tract Infections; Sensitivity and Specificity; Leukocytes; Nitrites.

The authors declared no conflict of interest. All authors contributed substantially to the planning of research, data collection, data analysis, and write-up of the article, and agreed to be accountable for all aspects of the work.

INTRODUCTION

Urinary Tract Infection (UTI) is a common infection among pediatric age group (up to 16 years) and is defined as the presence of significant microorganisms in the urine without any contamination. This may be with or without symptoms.[1]

Diagnosing UTI in Pediatrics is difficult due to lack of specific features and the problem with collection of clean urine sample. Symptoms can be as vague as just fever without focus, feeding problems, failure to thrive, vomiting, loose motions, abdominal distension, reduced activity, irritability, jaundice etc.[2] UTI may have significant adverse consequences, especially for young children. Once antibiotic therapy is started, the opportunity to make a definitive diagnosis is almost lost because urine may get sterilized very soon. As we are facing increasing resistance among microorganisms nowadays, a wrong or late diagnosis can easily lead to pyelonephritis, septicemia, and meningitis.

Treating febrile children with antibiotics without finding a focus can lead to missing the diagnosis of UTI in these patients. Atypical and recurrent UTI can be the only clue to underlying Vesico-Ureteric Reflux disease and other acquired or congenital disorder anatomic and functional disorders. These disorders if not diagnosed and managed often lead to Chronic Kidney Disease (CKD) and End Stage Renal Failure.

During the first year of life, UTI incidence is approximately 2.7% in uncircumcised boys and 0.7% in girls.[3,4] During the first 6 months of age, uncircumcised boys have a higher risk of developing UTI that is 10 to 12-fold.[5-7] In neonates, UTI is more common in premature infants as compared to term infants.[8] After one year of age, girls are at higher risk of developing UTI than boys[8,9] and by the age of 7 years 1.7% boys and 7.8% girls are affected.[3,10] By 16 years age, the prevalence bounces to 11.3% and 3.6% among girls and boys respectively.[3]

The gold standard test for diagnosing UTI is Urine Culture but since it takes time to have the results of urine culture, two other tests which have received most attention are biochemical analysis of urine esterase and nitrites through routine dipstick method and urine microscopic examination for white blood cells and Bacteria. One of the widely used tools for diagnosing UTI is dipstick but it comes with its own limitations. Urinary nitrite is not a sensitive marker as it takes 4 hours for a bacterium to convert dietary nitrates into nitrites while babies also micturate very frequently.

The present study was undertaken in a tertiary care hospital to determine the sensitivity and specificity of Urine Routine Examination (Urine RE) in diagnosing UTI in pediatric age group by taking Urine Culture as gold standard.

MATERIALS & METHODS

This study was conducted in March 2021 after approval from the Rehman Medical Institute (RMI) Research Ethics Committee (REC). Data were retrieved from the computerized database of the RMI hospitals for the years 2015-2020. Patient information like demographics, and clinical examination were be recorded on a specifically designed Performa. A total of 368 cases were recruited in this study. The data were entered into SPSS version 22.0 for descriptive analysis. The follow up data of these patients were evaluated for sensitivity of Urine RE in patients with UTI or Urosepsis, in accordance with their management. Data were analyzed using SPSS version 22.0. Sensitivities, Specificities, positive and negative predictive values, and positive and negative likelihood ratios were calculated for urine samples with 95% CI. All analysis were done at an alpha value of 0.05.

RESULTS

Out of total 368 children, 144(39.1%) were male and 224(60.9%) were female, with ages from 3 days to 12 years; most children, 135(36.7.%) were in age group >3months to 2 years, followed by >2years group, 108(29.3%); 80(21.7%) were in age group 0-1 months and 45(12.2%) were found in >1- 3 months of age. Of 368, 184(50%) had positive urine culture; table 1 shows the comparison of positive and negative C/S.

Table 1: Comparison of different variables with positive and negative C/S.

Variables	Bacteremia UTI	Negative Urine C/S	p value
Gender			
Male	61	83	0.012
Female	123	101	
Age group			
0-1 Months	33	47	
>1- 3 months	24	21	0.004
>3 months - 2 Years	83	52	
> 2 Years	44	64	
Urine analysis			
0-3	60	137	
4-10	57	23	<0.001
11-20	23	11	
>20	44	13	
Nitrates			
Positive	35	17	0.005
Negative	149	167	

Out of 184 positive urine C/S, majority (107, 58.2%) were positive for E. Coli, followed by Enterococcus species (25, 13.6%), and Klebsiella pneumoniae (23, 12.5%), as shown in Figure 1.

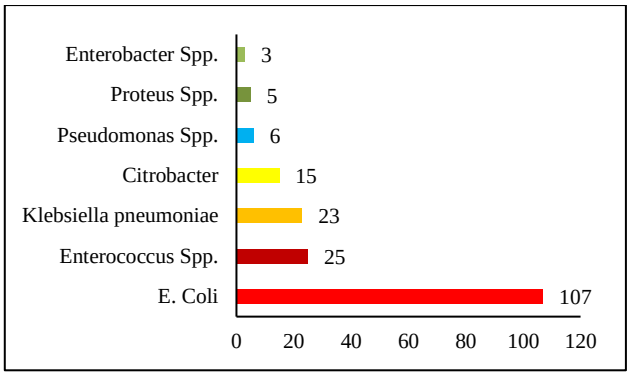

Figure 1: Organisms identified in positive urine culture

Tables 2 and 3 show the performance characteristics of WBC, and Nitrates. Table 4 shows these characteristics for different age groups of children.

Sensitivity, specificity, PPV & NPV of urinary WBC vs C/S was 67.39%, 74.46%, 16.56% and 96.8% respectively considering culture as gold standard (Table 2); overall accuracy was 70.92%.

Table 2. Sensitivity, specificity, PPV, NPV of urinary WBC, taking C/S as gold standard (n=368).

WBC (HPF)	Urine Culture		Predictive Values
	Positive	Negative	
Positive	124	47	16.57%
Negative	60	137	96.8%
Sensitivity & Specificity	67. 39%	74.46%	368

Sensitivity, specificity, PPV and NPV of urinary Nitrates was 19.02%, 90.76%, 13.41% and 93.7% (Table 3); overall accuracy was 54.89%.

Table 3. Sensitivity, specificity, PPV, NPV of urinary Nitrates, taking C/S as gold standard (n=368).

Nitrates	Urine Culture		Predictive Values
	Positive	Negative	
Positive	35	17	13.417%
Negative	149	167	93.7%
Sensitivity & Specificity	19.02%	90.76%	368

Table 4: Sensitivity and specificity of nitrate and WBC by age groups based on positive urine C/S.

Nitrate positive with bacteremia (n=35)		
Age group	**Sensitivity (95%Cl)**	**Specificity (95%Cl)**
0-1 Month	21.24%	92.14%
>1 Month- 3 Months	18.87%	89.04%
>3 Months - 2 Years	19.77%	90.54%
> 2 Years	20.87%	91.44%
WBC positive with bacteremia (n=124)		
Age group	**Sensitivity (95%Cl)**	**Specificity (95%Cl)**
0-1 Month	64.25%	72.63%
>1 Month- 3 Months	68.24%	75.78%
>3 Months - 2 Years	68.96%	75.32%
> 2 Years	67.24%	76.47%

DISCUSSION

Urinary tract infection is the major infection in children aged under five years.[11,12] Moreover, it is imperative to be able to obtain rapid diagnosis and treatment to prevent subsequent renal scarring. This entails development of quicker and cost-effective diagnostic modalities in lieu of urine cultures. Additional, diagnostic accuracy of a test determines its clinical usefulness, as false-negative tests may result in lack of proper diagnosis and treatment, whereas false-positive tests would lead to an incorrect diagnosis and treatment for UTI, thereby entailing unneeded costs as well as delayed correct diagnosis. It will also expose patients to risks associated with inappropriate antibiotic use.

The routine urine examination may afford the possibility of having a rapid, accurate, and cost-effective test available at the bedside for an early diagnosis that could provide indication for appropriate antibiotic treatment. Moreover, the test is performed routinely in most hospital and clinical laboratories, requiring little technical expertise or vast experience by the reporting staff. As such, it was decided to evaluate the test for its diagnostic accuracy and clinical application.

In our study the sensitivity and specificity of urinary WBC for UTI was 67.39%, 74.46%, respectively (overall accuracy of 70.92%) considering culture as gold standard. Similarly for urinary Nitrites it was 19.02%, 90.76%, (overall accuracy of 54.89%) which is comparable with the study done by Masinde et al[13] in Tanzania, who reported the sensitivity and specificity of the dipstick test result 38.9% and 86.7% respectively.

A recent study done in 2010 has shown that urine examinations are moderately sensitive (75%) and less specific (66%) in predicting UTI.[14] Findings of our study agree with the above study. As a corollary to above, the American Academy of Pediatrics, in 2007, advocated against the use of urine routine examination in detecting UTI as it has low diagnostic yield.[15]

Wenk et al[16] showed Urine Nitrite to be less sensitive (69%) as well, based on a series of 200 urine samples. The reasons for such low sensitivity appear to be that Nitrite associates with Gram-negative bacteria; improper urine collection, transportation, and handling techniques may also be factors that allow contamination and multiplication of colonizing bacteria, thereby resulting in positive urine nitrite tests and positive culture results.

CONCLUSION

The observed low sensitivity of Urine Routine Examination among all pediatric age groups questions its effectiveness as a screening tool. This emphasizes the value of urine culture as a screening investigation rather than urine RE.

LIMITATION

The study was based on retrospective data so errors of urine specimen handling and reporting were not controllable and could have contributed to inaccurate results.

RECOMMENDATIONS

Keeping in mind the difficulty of getting urine sample in children, it is advised to send Urine Culture from the first collected urine sample and Urine RE from subsequent sample. Keeping in mind the emergence of increased resistance, it would be advisable to send urine culture even once antibiotics have been initiated.

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