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Original Article

The value of urinalysis in presumptive diagnosis of urinary tract infection in children

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Abstract

Background Definite diagnosis of urinary tract infection (UTI) should only be established based on culture of urine specimen, otherwise it would be considered presumptive. Since urinalysis provides more rapid information than urine culture, clinicians should consider to utilize urinalysis as a decision-making tool for initiating treatment of UTI.

Objective To determine the sensitivity, specificity, predictive values, and accuracy of several urinalysis parameters, namely the nitrite, leukocyte esterase (LE), Gram staining, and methylene blue reductase (MBR) tests, in supporting the diagnosis of UTI.

Methods This diagnostic test was done on 30 subjects with pyuria during the period of April to June 2004. The sensitivity, specificity, positive predictive value (PPV), negative predicitve value (NPV) as well as the accuracy were calculated for each urinalysis parameter with urine culture as the gold standard. The relationship between categorical variables was analyzed by Fisher's exact test or chi square test.

Results The sensitivity, specificity, PPV, NPV and accuracy for nitrite test, leukocyte esterase (LE) test, Gram staining, and MBR test were respectively as follows: nitrite test showed 90.5%, 66.7%, 86.4%, 75%, and 83.3%; LE test yielded 95.2%, 33.3%, 76.9%, 75%, and 76.4%; Gram staining100%, 44.4%, 80.8%, 100%, and 83.3%; and MBR test 85.7%, 100%, 100%, 75%, and 90%.

Conclusions The MBR, among other urinalysis routine tests, has the highest specificity and accuracy as well as high sensitivity in establishing a presumptive diagnosis of UTI **[Paediatr Indones 2008;48:199-203]**.

Keywords: *presumptive diagnosis, urinalysis, UTI*

The term urinary tract infection (UTI) denotes infection within the urinary tract and encompasses both renal parenchyma and urinary bladder infection.[1] This infection is important in childhood because of its symptoms that may be either troublesome or overlooked and the potential risk of renal involvement.[2] Early recognition and appropriate treatment of such patients are essential in order to preserve renal function and prevent permanent damage.[3]

The symptoms of children with UTI depend on the level of the infection as well as the age of the child. In classical acute pyelonephritis, patients have high fever and other systemic symptoms accompanied by back or flank pain and renal tenderness.[2] However, symptoms of lower urinary tract such as dysuria, frequent voiding and incontinence are usually not detected in infants but it might be identified in preschool and school-age children.[1,2]

The diagnosis of UTI is based on the growth of microorganisms in a culture of a properly collected urine specimen. Unfortunately, urine culture

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is relatively expensive and requires several days to find out the results. Urinalysis might be very helpful in providing immediate information to support the diagnosis of a UTI, hence prompt initiation of treatment is possible.[2,3] Several urinalysis parameters for making a presumptive diagnosis of UTI are leukocyte esterase (LE), nitrite, Gram staining and methylene blue reductase (MBR) tests.[3,4] To our knowledge no such study has been published; hence, the purpose of the study was to obtain the sensitivity, specificity, positive predictive values, ,and accuracy of the nitrite, LE, Gram staining and MBR tests in the diagnosis of UTI in children.

Methods

A cross-sectional study on all children with pyuria who were admitted to Pediatric Outpatient Department and Pediatric Emergency Department of Hasan Sadikin Hospital was performed during the period April to June 2004. Parental informed consent was obtained and parents were interviewed regarding the history of illness and symptoms. Gender, age, physical findings, and laboratory results were recorded. The specimens for urinalysis were obtained by clean-catch mid stream urine method, except for children under 12 months of age whose samples were taken by suprapubic aspiration. All urine specimens were collected in sterile containers without urine preservatives, transported immediately to the laboratory, and processed for urinalysis and culture.

Quantitative cultures were performed by the microbiology laboratory with pour plate method. A positive urine culture was defined as growth of a single pathogen at a concentration of >100,000 CFU/ml. Laboratory personnels performed disptick nitrite and LE test (Ames Multistix reagent strip read with a Clinitek 10 analyzer, Miles Laboratories, Inc. Elkhart, Ind) on unspun urine. The results of LE and nitrite tests were read after 2 minutes and 60 seconds respectively, and reported as positive or negative. Smears were prepared using centrifuged urine that were air dried, and Gram stained. It was considered positive when bacteria were seen on any of the ten oil-immersed microscopic fields. MBRT test was done by adding 0.04 ml of methylene blue solution to 5 ml of urine and watching for the discoloration. This test was considered positive if discoloration occurred within 6 hours.

Sensitivity, specificity, positive and negative predictive values, and the accuracy were calculated for each test with a positive urine culture as the gold standard. Relationship between categorical variables were analyzed by Fisher's exact test or the chi square test.

Results

Urine specimens were collected from 30 children consisting of 12 boys and 18 girls. The mean age of the patients was 40.8 months (SD 29.2 months), the youngest was five months old and the oldest was 144 months old. Age and sex distribution of the subjects is shown in **Table 1**.

Fever was found in 19 out of 30 children with mean duration of 8.4 days (SD 6.1 days; range 1-21 days). Local symptoms of UTI, i.e., dysuria, frequency, urgency or enuresis, were found in 19 subjects, with the mean duration of 7.8 days (SD 5.1 days; range 2-18 days). **Table 2** shows that neither fever nor local symptoms of UTI had statistically significant association with positive urine culture (P>0.05). Results of urine culture showed that Escherichia coli was the commonest pathogen (17), followed by Klebsiella (2), Micrococcus (1) and Pseudomonas (1).

Thirty urine specimens were tested for nitrite and LE dipsticks t, Gram staining, and MBR. The

Table 1. Age and sex distribution of the study subjects

Age group	Boy	Girl	Total
0 -12 months	3	1	4
> 12–60 months	8	15	23
> 60 months	1	2	3
Total	12	18	30

Table 2. Correlation between symptoms of UTI and urine culture

Symptoms		Urine Culture		P*
		Positive n=21	Negative n=9	
Fever	Yes	12	7	
	No	9	2	0.419
Local	Yes	13	6	
	No	8	3	1.00

P* = Fisher-Exact test

association of of each test and urine culture is shown in **Table 3**. Sensitivity, specificity, predictive values and accuracy of each test were calculated using urine culture as the gold standard as shown in **Table 4.**

Discussion

Our study showed that boys were more affected by UTI than girls in infancy, whereas girls were the predominant proportion in older children. This result was similar with the study of Winberg *et al*[5] which stated that with increasing age, there was a progressive increase in the incidence among females compare to males.[5,6] The reasons were that male infants are more sensitive to infection due to immaturity of the immunologic defense mechanisms[7] and higher ratio of urinary tract obstructive malformations.[8] The increasing incidence of UTI in girls compared to boys has been attributed to the shorter length of the female urethra providing easy access to the bladder. Aside from that, older girls have high susceptibility for periurethral colonization with Gram negative bacteria.[9]

Table 2 shows that neither fever nor local symptoms of UTI had statistically significant association with positive urine culture. Positive urine culture was found in 21 of 30 subjects. This was higher than that reported by Lohr[3] found102 positive cultures of the 689 subjects (14.8%) and Weinberg and Gan[10] who found 41 from 1019 subjects (4.0%). The different results were caused by the different designs of the studies. In our study, urine samples were taken from subjects with pyuria, whereas those studies involved subjects with symptoms suggestive for UTI. Specimens for urinalysis in our study were obtained by midstream urine method and suprapubic aspiration for children under 12 months, while Lohr,[3] Winberg and Gan[10] studies used various collection methods except with urine bag.

In this study, we found no statistically significant associations between either nitrite, LE, Gram staining, or MBR tests and the results of urine culture. The calculated sensitivity, specificity, and PPV of fever in diagnosing UTI were 57.1%, 22.2%, and 63.1 % respectively, while those of local symptoms were 66.7%, 33.3%, and 70% respectively. Local symptoms had better diagnostic value than fever in diagnosing UTI. All of those values were lower than those reported by

Table 3. Association between nitrite, LE, Gram staining, or MBRT and urine culture

Test	Results	Urine culture		X^2M	P
		Positive	Negative		
Nitrite	Positive	19	3	0	1.0
	Negative	2	6		
LE	Positive	20	6	2.3	>0.05
	Negative	1	3		
Gram staining					
Positive	21	5	3.2		>0.05
	Negative	0	4		
MBR	Positive	18	0	1.33	> 0.05
	Negative	3	9		

X^2M = X2 Mc- Nemar

Table 4. Sensitivity, specificity, predictive values and accuracy of nitrite test, LE test, Gram staining and MBR with urine culture as validating standard

Test	Sensitivity (95%CI)%)	Specificity (95%CI) %	Predictive value (95%CI)%		Accuracy (%)
			Positive	Negative	
Nitrite	90.5 (80.0;100)	66.7 (49.8; 83.6)	86.4 (74.1; 98.7)	75.0(59.5; 90.5)	83.3
LE	95.2 (87.6;83.6)	33.3 (16.4; 50.2)	76.9 (61.8; 92.0)	75.0(59.5; 90.5)	76.7
Gram staining	100.0	44.4 (26.6; 62.2)	80.8 (66.7; 94.9)	100.0	83.3
MBR	85.7 (73.2;98.2)	100.0	100.0	75.0 (59.5; 90.5)	90

95%CI = 95%confidence interval

Tokan and Kari11, except for the specificity for local symptoms (33.3% vs. 16.6%). Since quantitative urine culture is the gold standard of UTI diagnosis, both fever and local symptoms should not be used as a diagnostic tool, but only as supporting tools in making presumptive diagnosis of UTI.

Escherichia coli were the most common organisms growing in urine culture. This finding was similar to that of previous studies.[10,11] Predominance of E. coli was mainly attributed to some characteristics that was not found in other organisms, such as p-fimbriae, adherence to uroepithelium in O and K serotype, hemolysin production, and the resistance to the bactericidal action or normal human serum.[1]

For many years clinicians have used Gram–staining urine for screening test of UTI in symptomatic outpatients. In an extensive review, Jenkins *et al*[12] concluded that examination of a Gram-staining smear of uncentrifuged specimen provided the best microscopic method for detecting bacteriuria. Several previous studies in adults howed that LE and nitrite tests could be used for screening test of UTI, but only the study by Goldsmith and Campos had addressed this issue in pediatric patients.[13]

Table 4 shows that the test with highest sensitivity was Gram staining of urinary smear. This result was similar with that of Olson *et al*[14] The test with lowest sensitivity was MBR. The sensitivity of nitrite test in this study was higher than that reported by Goldsmith and Campos,[13] Weinberg and Gan,[10] and Hoberman and Wald.[2] The sensitivity of LE test was also higher than that of previous studies.[2,10,13]

The test with highest specificity was MBR, 100%, followed by nitrite test (66.7%), Gram staining (44.4%), and LE tests (33.3%). In this study, the specificities of nitrite, LE test, and Gram staining were lower than those reported by others.[2,10,13]

Highest PPV was come from MBR (100%), followed by the nitrite test (86.4%) (, Gram staining (80.8%), and LE (76.9%). The PPV of nitrite and LE tests were lower than those reported by Hoberman and Wald.[2] The PPV of Gram staining was higher than that reported by Weinberg and Gan.[10]

The highest NPV was obtained from Gram staining (100%), followed by BMR test and nitrite or LE tests. The NPV of Gram staining was similar to that of Weinberg and Gan study,[10] while the NPV of dipstick tests was lower than that of another study.[2]

The MBR test in this study has sensitivity of 85.7%, specificity of 100%, PPV of 100%, NPV of 75% and accuracy of 90%. The accuracy was highest than theother tests. The accuracy of nitrite test, LE test and Gram staining were 83.3%, 76.7%, and 83.3%, respectively. Hence, the MBR test was the best for detecting significant bacteriuria. This result was similar as that reported by Supardi.[15] It was concluded that among other urinalysis routine tests, MBR has the highest specificity and accuracy, as well as high sensitivity in establishing a presumptive diagnosis of UTI.

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