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Original Article

# Diagnostic test of urine clarity in urinary tract infection

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**ABSTRACT**

***Background*** Early detection and prompt treatment are mandatory in managing urinary tract infection (UTI). Failure to early detect ion of UTI may result in declining of kidney function. Urine culture is the gold standard to diagnose UTI, but it takes 3-5 days to obtain the results. The turbidity of urine describes the presence of bacteria or leukocytes in urine. It is important to determine the relationship between the urine clarity by visual examination and the absence of bacteriuria.

***Objective*** To evaluate the diagnostic value of urine clarity by visual examination in diagnosing UTI.

***Methods*** We conducted a prospective study in emergency care unit, outpatient department, and children wards of Sardjito Hospital, Yogyakarta. The urine specimen was collected from children under 15 years old by catheterization or midstream urine collections. Two independent observers evaluated the urine clarity by the standard technique. Statistical analysis was assigned to calculate the sensitivity, specificity, positive and negative predictive values, and likelihood ratio. Kappa index was used to evaluate the agreement between two observers in determining the urine clarity.

***Results*** Two-hundred and five children were enrolled in this study. Urine clarity in diagnosing UTI produced sensitivity of 78% (95% CI 69;87), specificity of 84.5% (95% CI 78;91), positive predictive value (PPV) of 77.1% (95% CI 68;86), negative predictive value (NPV) of 85.2% (95% CI 79;92), positive likelihood ratio of 5.03 (95% CI 3.29;7.76), and negative likelihood ratio of 0.26 (95% CI 0.17;0.39).

***Conclusion*** Urine clarity is sufficiently accurate as a diagnostic test for UTI. The diagnostic value of urine clarity is expected to be useful for clinicians to detect UTI earlier and to guide them in making decision for clinical management. **[Paediatr Indones 2006;46:170-173]**.

***Keywords:*** *diagnostic test, urine clarity, urinary tract infection*

Urinary tract infection (UTI) is a condition in which microorganism proliferates in urinary tract, which in normal condition, does not contain bacteria, viruses, or other microorganisms. It includes renal parenchym and bladder infection with significant bacteriuria.[1] The incidence of UTI among babies and children, varied around 3.3-8.4%,[2-5] while in Sardjito Hospital, Ypgyakarta, it was 3.5%.[6] Babies and children who suffer from UTI are at risk of developing renal dysfunctions, if they are not managed properly. The difficulty in establishing significant bacteriuria and non specific clinical symptoms led to delaying prompt treatment.[7] The current gold standard to establish the diagnosis of UTI is urine culture; however, it takes 3-5 days to obtain the results. Previous studies using urine dipstick, urinary Gram staining, microscopic urinalysis examinations for immediate diagnosis of UTI failed to detect the diseases thoroughly. Therefore, an immediate, cheap, simple, and applicable method to detect bacteriuria becomes necessary.

Abnormal cloudy urine usually occurs on account of UTI, indicating the presence of bacteria or

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leucocytes.[8] Urine clarity test is part of macroscopic urinalysis examination, which does not require any instrument. It can be performed simply, visually, and without any cost in any health center. Urine clarity in UTI had high negative predictive value, between 96% and 100%, and it was able to be used to rule out the diagnosis of UTI.[9-12] The objective of this study was to identify the diagnostic value of urine clarity through a visual examination in children with UTI.

## Methods

This was a prospective study conducted in emergency care unit, outpatient department, and children wards of Sardjito Hospital, during the period of July 2004 to August 2005. The inclusion criteria were children aged 2 months-15 years with informed consent and were suspected to have UTI based on clinical findings according age. Samples were excluded if children were under antibiotic use, had medical indication requiring re-catheterization in neurogenic bladder, and had underlying abnormal genitourinarial tract or kidney. Sensitivity was assumed to be 90% and based on the data from previous study, where there were 18% cases of UTI,[12] the number of subjects needed was 195.

Urine clarity was examined visually. Two milliliters of urine was put in a 7 ml red-topped blood tube, labeled as tube I. Tube II contained fresh water for control. Two laboratory assistants were assigned to investigate the tubes in the same procedures. The first laboratory assistant observed the urine under the light and a piece of white paper with dark writing (letters sized 12) was held about 1 cm behind the tube. Urine was considered clear when the dark writing on the paper was readable through both tube I and II. When it was doubtful, 1 ml acetic acid was added to the urine specimen to split the phosphate, then the procedure was repeated. The second laboratory assistant conducted the same procedure without knowing the result obtained by the first. If there was different results of investigation between the two laboratory assistants, the urine would then be considered as cloudy. In addition to visual examination of urine clarity, urine culture as the gold standard was performed simultaneously, blindly, and independently.

The reliability of instruments and laboratory assistants, sensitivity, specificity, positive and negative predictive values, positive and negative likelihood ratios, of visual examination of urine clarity were compared with urine culture as the gold standard of UTI. Kappa index was used to evaluate the disagreement between two observers in determining the urine clarity.

## Results

Two-hundred and five patients who met the criteria were selected for this study. Their age ranged from 2 months-14 years (mean 5.6 years), 118 (57.6%) out of them were female. The characteristics of study subjects are shown in **Table 1**. Positive urine culture was found in 82 patients (40%) consisting of 20 (24.3%) children aged 2 months-1 year, 36 (44%) children aged >1 year-5 years, and 26 (31.7%) children aged >5 years-15 years. Ninety-five urine specimens (46%) were collected by clean-catch method, while 110 (54%) were collected by urine midstream method. Eighty-two urine cultures were positives, showing UTI prevalence of 40%. Sixty-two positive urine cultures were obtained from female patients (75%). All positive urine cultures showed the growth of one type of bacteria.

Eighteen patients with clear urine were found to have UTI. Twelve of them were children aged <2 years, who did not present clinical appearances neither as severe illness nor unknown etiology of fever.

**Table 1.** Characteristics of subjects (n=205)

| Variables | n (%) |
|---|---|
| **Age** | |
| 2 months -1 year | 56 (27.3) |
| >1 year-5 years | 77 (37.5) |
| >5 years -15 years | 72 (35.2) |
| **Sex** | |
| Male | 87 (42.4) |
| Female | 118 (57.6) |
| **Male genital (n=87)** | |
| Circumcised | 24 (27.5) |
| Uncircumcised | 63 (72.5) |
| **Symptoms** | |
| Fever | 122 (59.5) |
| Enuresis103 (50.2) | |
| Abdominal pain | 68 (33.1) |
| Vomit | 48 (23.4) |
| Dysuria | 31 (15.1) |
| Frequency | 11 (5.3) |
| Urgency | 7 (3.4) |
| Constipation | 5 (2.4) |
| Jaundice | 2 (0.9) |
| **Urine culture (+)** | 82 (40) |

Five of them had negative urine dipsticks, but positive microscopic bacteria. Of these 12 urine specimens obtained from children <2 year old, 5 contained *E. coli* and 7 contained *K. pneumoniae*. Other 6 clear urine specimens contained *E. coli*.

Compared to urine culture as the gold standard, the sensitivity of urine clarity examination was 78% and the specificity was 84.5%. The data used for analysis and the corresponding diagnostic test values can be seen in **Table 2**. Those diagnostic sensitivity and specificity provided positive predictive value of 77.1% through visual examination of urine clarity and negative predictive value of 85.2% in the prevalence of UTI cases. The visual examination had positive likelihood ratio of 5.03 and negative likelihood of 0.26. The prevalence was 40%. The calculation using odds was initiated by changing the probability using formula odds=probability/(1-probability), so pre-test odds was 40%/(1-40%)=0.66. Then pre-test odds was changed into post–test odds by multiplying it with likelihood ratio, so post-test odds was 0.66x5.03=3.35. Probability formula of odds/(odds +1) was used to return it to the post-test probability, so post-test probability was 3.35/(1+3.35)=0.77=77%. Two laboratory assistants, who had undergone agreement test, examined the urine clarity visually. The agreement test on both assistants showed Kappa value of 0.73.

**TABLE 2.** DIAGNOSTIC VALUES OF URINE CLARITY COMPARED TO URINE CULTURE AS A GOLD STANDARD IN UTI.

| | | Urine culture | | |
|---|---|---|---|---|
| | | **Positive** | **Negative** | **Total** |
| **Urine** | **Cloudy** | 64 | 19 | **83** |
| | **Clear** | 18 | 104 | **122** |
| | | **82** | **123** | **205** |

Note: the calculated diagnostic test values were as follows (figures in brackets indicate 95% CI). Prevalence: 40% (33;47); Sensitivity: 78.0% (69;87); Specificity: 84.5% (78;91); Positive predictive value: 77.1% (68;86); Negative predictive value 85.2% (79;92); Positive likelihood ratio: 5.03 ( 3.29;7.76); Negative likelihood ratio: 0.26 (0.17;0.39).

## Discussion

Forty-five percent of children with UTI presented abnormality of genitourinary tract which required therapy. If UTI fails to be diagnosed, it will lead to an inappropriate therapy which subsequently results in renal dysfunctions.

Clear Urine by visual examination was assumed to have absence of pathogenic bacterial growth. Three previous studies had investigated the correlation between urine clarity and the absence of UTI.[9-12]

Uncircumcised genital is a risk factor of UTI. In our study, there were 72.5% uncircumcised male subjects, which was consistent with Wiswell[13] that incidence of UTI decreased in circumcised men.

Clinical symptoms of UTI in children are not specific. In our study, the most common clinical symptoms was fever. It was consistent with Crain[14] who found that fever was the most common complaint in babies with UTI, found in 66% of cases. Other classical UTI symptoms such as frequency and dysuria were found in 15.1% and 5.3% cases, respectively.

Urine specimens were collected by clean-catch and midstream methods. Midstream method is non-traumatic and simple but it requires patient's cooperation. Therefore, it is more applicable in older children. Clean-catch method was applied to collect urine specimen in children less than 5 years. This method had sensitivity up to 100%, but its specificity ranged from 14 to 84%.[15] The prevalence of UTI in this study was 40%. It was higher than that conducted by Bulloch *et al*,[11] 18% only. The Kappa value of agreement test on both assistant performing the urine clarity test (0.73) showed that the examination by both of them were good.

Adding acetic acid to the urine samples were aimed to make the cloudy urine due to protein and salt precipitation to be clear. It was found that the urine specimens added with acetic acid did not change the clarity of evaluation. Therefore, it was assumed that cloudy urine was due to the presence of bacteria which indicated UTI.

Eighteen patients with clear urine specimens were found to suffer UTI. It was probably happened because of diluted urine, making it difficult to be evaluated. Accurate clinical diagnostic test will establish or rule out an abnormality or a disease. This study was aimed to determine whether clear urine by visual examination could predict negative urine culture. Negative predictive value of children with clear urine was 84.5%. Positive and negative predictive values were, however, influenced by the prevalence of diseases in population.

The sensitivity of urine clarity examination of 78% showed that the examination was able to detect UTI of 78%. Only 22% of UTI cases were undetect-

able because of false negative results. The specificity of 84.5% showed the detection capability of the same percentage in UTI cases. Only 15.5% of UTI cases were diagnosed inaccurately due to false positive results. Positive likelihood ratio of 5.03 revealed that the examination resulted in moderate change, from pre-test probability of 40% to post-test probability of 77%. It means the examination was sufficiently significant.

Visual urine clarity test was a qualitative examination, which has become a limitation of the study itself. Quantitative examination of urine clarity would be better. It was developed in order to give more benefit than other diagnostic examinations to establish UTI. It is also much simplier, easier, and faster than urine culture examination.

The consequence of early detection of bacteriuria could help clinicians determine an appropriate management for the patients. For UTI patients, early detection and appropriate management were beneficial. It could save the cost of various logistic needs and reduce the risk of complications as well as bacterial resistance due to inappropriate antibiotics use. Early decision for clinical management was expected to bring better prognosis and decrease the morbidity and mortality of children with UTI.

In conclusion, in our group of pediatric patients with the clinical findings of UTI, urine clarity examination showed the sensitivity of 78%, specificity of 84.5%, and positive likelihood ratio of 5.03 in diagnosing UTI. These figures suggest that visual examination of urine clarity were sufficiently accurate to diagnose UTI. The results of this study were expected to be useful for clinicians to make early detection of UTI in children and a decision for an accurate clinical management could be made subsequently.

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