

Screening of Pediatric Urinary Tract Infection using Modified Nitrite Test

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Abstract

Introduction: Pyrexia of unknown origin is a common diagnostic challenge for pediatricians. Quantitative culture of urine in laboratory takes time and treatment based on a positive culture may be delayed. There are frequent situations, in which decision about initiating therapy must be made earlier.

Aim: To study the diagnostic ability of modified nitrite test as a rapid screening test for diagnosing pediatric urinary tract infection (UTI).

Materials and Methods: A total of 300 children hospitalized in our pediatric ward requiring urine culture were included in our study. The efficacy of nitrite test and modified nitrite test to predict culture positivity was studied.

Results: Modified nitrite test was positive in 30 out of the 49 culture positive urine samples (sensitivity - 61.22%) as against the nitrite test which was positive in only 5 out of 49 culture positive samples (sensitivity - 10.2%). The specificity, positive predictive value, and negative predictive value were 98.8%, 90.91%, and 92.88%, respectively. The overall diagnostic accuracy was 92.67%.

Conclusion: Modified nitrite test was a more effective rapid screening test for diagnosing pediatric UTI.

Key words: Modified nitrite test, Nitrite test, Screening test, Urinary tract infection, Urine culture

INTRODUCTION

Fever is a common manifestation of various infectious diseases, which have a wide range of severity. Fever without localizing sign or symptom is a common diagnostic dilemma for clinicians caring for infants. Urinary tract infections (UTI) occur relatively frequent in infants and children. The major significance of UTI in children is the accompanying morbidity and the possible association with anatomic abnormalities (obstruction and vesico-ureteric reflux). This may lead to renal damage and progressive renal failure and may be amenable to medical therapy or surgical repair if detected early.¹ UTI can be reliably diagnosed only by culture and it is the gold

standard test. Many indirect tests have been proposed, but all have limitations.

Aim

The objective of this study is to evaluate the diagnostic ability of modified nitrite test as a rapid diagnostic screening test for diagnosis of pediatric UTI.

MATERIALS AND METHODS

Cross-sectional diagnostic study was done in an urban pediatric tertiary care hospital in Tamil Nadu, from 2009 to 2010. Ethics committee's approval and informed consent from the parents were obtained. 300 children in pediatric ward with various clinical diagnoses, requiring urine culture were studied. Patients who were already on antibiotic therapy were excluded from the study. Both male and female children were studied. Clearance for the study was obtained from the institution's ethical committee. Urine sample was obtained by clean catch mid-stream method in previously sterilized culture bottles. Parents were instructed regarding cleaning of the genitalia and proper collection of urine in sterile

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bottles. The time of the previous emptying of the bladder was noted. Time of collection of the urine specimen was also noted. Thus, the duration of the incubation period in the bladder was calculated. Urine samples were transported to the microbiology laboratory as quickly as possible and tested. Urine culture was prepared by the standardized loop method. 4 mm calibrated loop designed to deliver a known volume of 0.01 ml of urine was used. The urine sample was mixed thoroughly. The loop was inserted vertically into the urine to allow it to adhere to the loop. The loopful of urine was spread over the surface of the MacConkey agar plate. Incubation of the plate for at least 18 h at 37°C in the incubator was done. Colonies were counted on each plate. The number of colonies was multiplied by 100 to determine the number of micro-organisms per ml in the original sample. More than 1,00,000 (10^5) colonies per ml were taken as significant bacteriuria and considered culture positive.² Nitrite test was done by dipping the reagent strips in urine and result read after 1 min. Positive test is indicated by the presence of a red change. No color change indicates negative test. If the initial nitrite test was negative, 1 drop of 1% sodium nitrate solution was added to the urine (1 g of sodium nitrate dissolved in 100 ml of sterile water). This was incubated at 37°C in the incubator for 4 h. Nitrite test was again repeated and result interpreted as for nitrite test. The result of nitrite test modified nitrite test compared with urine culture report. The sensitivity, specificity, and predictive value of positive and negative test and accuracy of the test were statistically analyzed.

RESULTS

Of the 300 children included in the study, 147 were male and 153 were female. The age of the children varied from 2 months to 12 years. 49 of the 300 urine samples were culture positive. *Escherichia coli* was positive in 24 samples, *Klebsiella* in 23 samples, *Proteus* in 1 sample, and *Enterobacter* in 1 sample.

Nitrite test was positive in only 5 out of 49 culture positive urine samples with a sensitivity of 10.2%. There were no false-positive results (Table 1). Hence, the specificity and predictive value of positive test was 100%. The accuracy was low at 85.33%. Modified nitrite test (done by adding 1 drop of 1% sodium nitrate and further incubated at 37°C for 4 h) gave 33 positive results. Out of the 33 positive tests, 30 were true positive and 3 false positive (Table 2). The sensitivity was 61.22% with a high predictive value of the positive test (92.88%) and specificity (98.8%). The overall accuracy of the screening test was 92.67% (Table 3).

Out of the 24 *E. coli* positive urine samples, nitrite test was able to identify only 3 samples with 12.5% positive

Table 1: Cross-tabulation of nitrite test with urine culture test

Nitrite test	Urine culture		
	Positive	Negative	Total
Positive	5	0	5
Negative	44	251	295
Total	49	251	300

Table 2: Cross-tabulation of modified nitrite test with urine culture test

Modified nitrite test	Urine culture		
	Positive	Negative	Total
Positive	30	3	33
Negative	19	248	267
Total	49	251	300

Table 3: Comparison of results of nitrite test and modified nitrite test results

Parameter	(%)	
	Nitrite test	Modified nitrite test
Sensitivity	10.2	61.22
Specificity	100	98.8
Positive predictive value	100	90.91
Negative predictive value	85.08	92.88
Diagnostic accuracy	85.33	92.67

rate. Modified nitrite test was able to identify 15 out of the total 24 *E. coli* with positive rate of 62.5%. Similarly for *Klebsiella*, nitrite test was able to detect only 2 out of the total 23 culture positive with positive rate of 8.7%, whereas modified nitrite test was able to detect 14 out of the 23 *Klebsiella* culture positive with the positive rate of 60.86%.

DISCUSSION

Griess nitrite test is by far the most frequently studied and commonly used test for rapid diagnosis. Nitrite test in our study had a sensitivity of 10.2% and specificity of 100%. In previous studies, the statistical analysis of nitrite test varied greatly. Goldsmith and Campos study showed sensitivity and specificity for nitrite test as 21% and 99%, respectively.³ Tahirovic and Pasic study showed sensitivity and specificity of 21% and 80%, respectively.⁴ Robertson and Duff study gives 43% and 96% as sensitivity and specificity, respectively, for nitrite test.⁵ Most of the past studies were done in adult population. A longer incubation time in the bladder (4 h) is required for conversion of nitrate into nitrite. In the pediatric population, because of frequent bladder emptying, the duration urine stays in the bladder (incubation time) was found to be less.³ The mean incubation time of urine in the bladder for the whole study

was 3 h. However, the mean incubation time in nitrite test positive children was 5 h and 15 min. False-negative results in nitrite test were mostly due to frequent bladder emptying, diuresis, and lack of dietary nitrates. The observation that bacteria that reduces nitrate require incubation in urine for some hours was consistent with the finding that a higher yield of positive result was obtained from samples collected early in the morning or whose incubation time in the bladder was more than 4 h.⁶ Since in pediatric patients, it is difficult to measure dietary nitrate intake and prevent frequent bladder emptying, modified nitrite test is used. Even if the dietary nitrate is inadequate, bacteria in urine reduce nitrate added to the urine sample during the incubation time of 4 h. Nitrite test is then repeated. This modified method improved sensitivity considerably and especially useful in pediatric patients.³

CONCLUSION

Modified nitrite test showed good reliability in detecting the UTI in pediatrics. Modified nitrite test will be useful as

alternative to culture for screening in resource constraint settings. Early diagnosis of asymptomatic children is great importance in intervention can reduce the mortality and morbidity.

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