

Comparative Study of Dipstick, Urine Microscopy and Urine Culture in the Diagnosis of Urinary Tract Infection in Children Under Five Years

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Abstract

Background: Urinary tract infection is a common source of bacterial infection in children under five years old; urinalysis is one of the important and useful urological tests for diagnosis of infection, microscopic examination of urine and the dipstick urinalyses (leukocytes esterase test, nitrite test) are common tests used for detecting bacteriuria and pyuria.

Objective: Comparison of the rapid tests: dipstick (leukocytes esterase test, nitrite test), microscopic examination, and urine culture in detecting urinary tract infection in children under five years old.

Method: The study conducted on 246 patients less than 5 years old admitted with clinical suspicion of urinary tract infection in Kerbala pediatric teaching hospital in the period from July to December 2008. All urine samples were collected then submitted for routine urinalysis and bacterial culture, dipstick and microscopy were done.

Results: Urinary tract infection was identified in 117 patients, The sensitivity of leukocytes esterase test was 83.7% higher than nitrite test 39.3% while specificity was 70% which is lower than nitrite test 87.6%, the positive predictive value and negative predictive value for nitrite test were 74%, 61% respectively while for leukocytes esterase test record 76.6%, 82% respectively.

The positive predictive value and negative predictive value for pyuria (96.2%, 99.1%) were higher than that recorded in both nitrite test and leukocytes esterase.

Conclusion: 1-The dipstick tests (nitrite and leukocyte esterase) have high positive predictive value for presence of urinary tract infection.

2- The high negative predictive value of these tests doesn't exclude urinary tract infection.

3-A combination of microscopic examination and dipstick tests improve the sensitivity of detecting urinary tract infections.

الخلاصة

المقدمة: يعد التهاب المجاري البولية من الالتهابات البكتيرية الشائعة في الأطفال تحت عمر خمس سنوات، يعد التحليل البولي من الفحوصات البولية المهمة والمفيدة لتشخيص المرض، الفحص المجهري للبول وتحليل البول بالأشرطة القياسية (فحص خميرة الاسترات لخلايا الدم البيضاء وفحص النترية) من الفحوصات الشائعة المستخدمة للتحري عن البكتريا البولية والبول الصديدي.

الهدف: مقارنة الفحوصات السريعة بالأشرطة القياسية (فحص خميرة الاسترات لخلايا الدم البيضاء وفحص النترية)، الفحص المجهري للبول و الزرع الجرثومي للبول في التحري عن الإصابة بالتهاب المجاري البولية في الأطفال تحت عمر الخمس سنوات.

طريقة العمل: أجريت دراسة 246 مريض أعمارهم اقل من خمس سنوات مع اشتباه سريري للإصابة بالتهاب المجاري البولية في مستشفى كربلاء التعليمي للأطفال للفترة من تموز إلى كانون الأول للعام 2008. جمعت عينات البول في أكواب نظيفة و بعد ذلك خضعت للتحليل البولي الروتيني و الزرع البولي، تم الفحص بالأشرطة القياسية لعينات البول التي لم تتعرض للطررد المركزي في حين تم الفحص المجهري للبكتريا البولية و البول

الصددي للعينات التي تعرضت للطرد المركزي.

النتائج: الإصابة بالتهاب المجاري البولية عينت في 117 مريض، البكتريا الأوسع نموا كانت

Enterococcus (%7.6), *Pseudomonas sp.* (%16.3), *Proteus sp.* (يليها % 65 *E.coli* (%4.3). *Klebsiella sp.* (%6.8) و كانت حساسية فحص خميرة السترات لخلايا الدم البيضاء كانت %83.7 و هي أعلى من حساسية فحص النتريت %39.3 في حين خصوصية فحص خميرة السترات لخلايا الدم البيضاء كانت %70 وهي أقل من خصوصية فحص النتريت %87.6. القيمة التنبؤية الموجبة و القيمة التنبؤية السالبة لفحص النتريت سجلت %74، %61 على التوالي.

القيمة التنبؤية الموجبة و القيمة التنبؤية السالبة لفحص خميرة السترات لخلايا الدم البيضاء سجلت %76.6 و %82 على التوالي. القيمة التنبؤية الموجبة و القيمة التنبؤية السالبة لفحص البول الصددي كانت (%99.1، %96.2) وهي أعلى مما سجل في فحصي خميرة السترات لخلايا الدم البيضاء و فحص النتريت.

الاستنتاجات: 1- الأشرطة القياسية لها قيمة تنبؤية موجبة عالية لوجود الإصابة بالتهاب المجاري البولية.

2- إن القيمة التنبؤية السالبة العالية لهذه الفحوصات لا تنفي الإصابة بالتهاب المجاري البولية.

3- توافق استخدام الفحص ألمجهري و فحص الأشرطة القياسية يحسن حساسية التشخيص لالتهاب المجري البولية.

Introduction

Urinary tract infections are common in children under five years old, the incidence are 7.8% in girls and 1.6 % in boys⁽¹⁾.

The incidence in boys susceptible is more during the first year of age then, the occurrence of urinary tract infection becomes 8% in girls and 1.2% in boys by the age of five years; This gender differences are due to shorter female urethra and its location close to the anus, The urinary tract infection has been considered an important risk factor for development of hypertension, renal failure and end stage renal disease.⁽²⁾

Diagnosis of Urinary tract infection is primarily based on symptoms and signs but the definitive diagnosis depends on positive bacterial culture of urine (gold standard), The laboratory changes to make urine culturing expensive and time consuming because the result usually takes 24 -48 hours to be available for the clinician, The quality of urine sample will affect the ability to detect bacteria and confirm the diagnosis of urinary tract infection⁽³⁾.

The leukocyte esterase is a semi quantitative test detects the neutrophil

–specific esterase activity released from degraded white blood cells, The nitrite reduction test detects nitrite produced by urinary bacterial pathogens, nitrites not found in urine normally but usually result when urinary bacteria reduce nitrates to nitrites, many gram negative and gram positive bacteria are capable to do so.⁽⁴⁾

A positive dipstick nitrite test indicates that those organisms are present in significant numbers (more than 100,000 per ml)⁽⁵⁾.

In this study we tried to compare the performance of the dipstick (leukocytes esterase, nitrite) testing, urine microscopy and urine culture in detection of urinary tract infection in children under five years ,improving the diagnostic tests for detection of urinary tract infection helps to avoid unnecessary antibiotics, which are contributing in the growing the problem of antibiotics resistance.

Materials and Methods

This prospective study was conducted on urine samples collected from 246 children less than five years of age ,who were admitted with clinical suspicion of urinary tract infection in Kerbala pediatric teaching hospital during the period of July-to December

2008.

All urine specimens were collected from patients who should have the following criteria to be included in the study :

- 1-Age less than 5 years.
- 2-No antibiotics treatment to the patients prior to admission.
- 3-No distinct cause for fever.

Urine specimens were collected either by clean catch mid stream collection or by adhesive urine collection bags for children who are not potty trained. The samples were collected in clean cups and were submitted for urinalysis and bacterial culture. Dipstick test was done to fresh and uncentrifuged using CYBO (DFI Co .Ltd Korea) reagent strips (quality control of strips was performed daily as part of (standard laboratory practices) microscopy for bacteria and pyuria were performed on centrifuged specimens (pyuria was defined as ≥ 10 white blood was cells per high power field taken to be positive result.),In all children urine samples were sent for cultures using standard methodology (6).

By using 0.001 ml calibrated loops for

inoculation onto (blood agar, McConkey and EMB) "Oxoid" plates the plates were inoculated aerobically and read after 12-24 hours bacterial identification and colony count and also diagnosis of bacterial species were done based on biochemical reactions on the selective media (TSI)"Oxoid", (citrate)"Difco",(urea, SIM, MRVP) "Oxoid". The sample that showed two different pathogen or non pathogen were excluded and considered contaminated.

Results

During the study period (July to December 2008), Of the 246 total cultures 117 (47.6%) were positive for urinary tract infection.

A total of 246 urine specimens submitted for routine examination and bacterial culture all of the specimens were tested with dipstick test(Nitrite, Leukocyte Esterase)out of 246 subjects studied 115(46.7%)were males and 131(53.3%) were females, with their ages ranging from(3months to five years).

Table 1. Results of urine culture.

sex	No. of Specimens	No. of Positive bacterial culture	percentage %
Male	115	34	37.4
Female	131	83	63.4
total	246	117	47.6

The vast majority grew *E.coli* (65%) followed by *Proteus* sp.(16.3%), *Pseudomonas* sp.(7.6%), *Enterococcus* sp.(6.8%) and *Klebsiella* sp.(4.3%) respectively.

Table 2. Distribution of patients according to isolated bacterial uropathogens from urine cultures.

Causative bacteria	Male		female		total	
	No.	%	No.	%	No.	%
<i>Escherichia coli.</i>	21	61.8	55	66.3	76	65
<i>Proteus</i>	9	26.5	10	12	19	16.3
<i>Pseudomonas</i>	3	8.8	6	7.2	9	7.6
<i>Enterococcus</i>	0	0	8	9.7	8	6.8
<i>Klebsiella</i>	1	2.9	4	4.8	5	4.3
total	34	100	83	100	117	100

urine cultures were positive in 117 samples 47.6%.

The results of urine dipstick of nitrite test and leukocyte esterase test compared

with their relationship to the results of urine culture and microscopic examination for pyuria are explained in table (3).

Table 3. Results of Dipstick , Urine culture and Urine microscopy.

Urine culture	Nitrite test		Leukocyte esterase test		Urine microscopy	
	positive	negative	positive	negative	positive	negative
positive	46	71	98	19	112	5
negative	16	113	30	89	1	128
total	62	184	128	108	113	133

The sensitivity of leukocyte esterase test was (83.7%) higher than the nitrite test (39.3%) while its specificity was (70%) lower as compared to nitrite test (87.6%).

The Positive and negative predictive value for nitrite test were (74%) and (61%) respectively and for leukocyte

esterase test was (76.6%) and (82%) respectively while the sensitivity ,specificity, positive predictive value and negative predictive value for pyuria were higher than that recorded in both nitrite test and leukocyte esterase as explained in table 4.

Table4. Sensitivity, specificity, predictive values of dipstick and urine microscopy

Screening test (n=246)	Sensitivity (%)	Specificity (%)	Positive predictive value (%)	Negative predictive value (%)
Nitrite	39.3	87.6	74	61
Leukocyte esterase	83.7	70	76.6	82
Urine microscopy	95.7	99.2	99.1	96.2

Discussion

The most common tests used for detecting bacteriurea and pyuria in patients who are suspected with urinary tract infection are dipstick urinalysis and direct microscopy, the dipstick is rapid, inexpensive and require little technical expertise.⁽⁷⁾

The risk of renal damage from urinary tract infection is greatest in young children so early diagnosis and prompt treatment are important only limited number of studies in children have so far been reported.⁽⁸⁾

Although a number of studies have evaluated the use of urinary dipstick (leukocyte esterase, nitrite) in infant and children the result obtained from investigation are fairly different.^(9,17)

Considerable differences (heterogenisity) exist between studies in term of (method, samples, population, analysis) etc. so the results should be interpreted with caution.⁽¹⁰⁾

In our study we reported the

sensitivity,specificity,positive predictive value, negative predictive value for nitrite (39.3%, 87.6%, 74%, 61%)respectively and for leukocyte esterase (83.7%, 70%, 76.6%, 82%) respectively .

Previous investigators have reported on sensitivity of various components of rinalysis to detect urinary tract infection, including leukocyte esterase,nitrite,microscopy ,for white blood cells and bacteria and Gram stain, differences in study population make it difficult to compare and interpret the result of these studies.⁽¹¹⁾

Our result is nearly similar to a study conducted by Sadika et al (2007) of 132 children found that (nitrite test and Leukocyte esterase test) give sensitivity, specificity, positive predictive value, negative predictive value38.2%, 88.4%, 87.2%, 40.9% (for nitrite test respectively) and 85.4%, 58%, 80%, 65.8% (for leukocyte esterase respectively).⁽¹²⁾

While in study done by Sheriff et al they found that the sensitivity, specificity, positive predictive value and Negative predictive value for nitrite was (4.6%, 96.8%, 37.5%, 98.4%) and for leukocyte esterase was (100%, 78.1%, 13.9%, 100%) respectively.⁽¹³⁾

Another study by Ayazi and Daneshi of 100 children showed the urinalysis by (Nitrite test and Leukocyte esterase test) to give Sensitivity, Specificity, Positive predictive value and negative predictive value 56%, 81%, 88%, 71%, 69%, 60%, 72.6%, 80% respectively.⁽¹⁴⁾

While Weunberg and Gan found that Sensitivity, Specificity, Positive edictive value and negative predictive value for nitrite was (56%, 98.1%, 54.7%, 98.1%) and for leukocyte esterase (85.4%, 92.7%, 33.7%, 99.3%) respectively.⁽⁶⁾

Loher et al found different Sensitivity, Specificity, Positive predictive value and negative predictive value for nitrite it was (37.3%, 100%, 100%, and 90.2%) respectively and for leukocyte esterase was (79.4%, 72.7%, 33.6%, 95.3%) respectively.⁽¹⁵⁾

While Cannon et al found by their study Sensitivity, Specificity, Positive predictive value and Negative predictive value (72.7%, 99.6%, 96.8%, 94.6%) for nitrite respectively and (71.4%, 33.6%, 96.9%, 91%) for leukocyte esterase respectively.⁽¹⁶⁾

Also study by Arsalan et al of 100 children found overall urinalysis (Nitrite test and Leukocyte esterase test) to have sensitivity (74%) and specificity of (3.5%).⁽¹⁷⁾

The differences between studies might related to the degree of pyurea, the enzyme content of immature leukocyte or both.⁽¹⁸⁾

The Nitrite test give lower sensitivity as compared to leukocyte esterase in our study can be explained by the fact

that a minimum of 4 hours is required for pathogenic bacteria to reduce nitrate to nitrite. so the nitrite test is likely to be the in random urine sample, than the first morning voided specimens⁽³⁾.

Many studies have investigated the reliability of the dipstick (Nitrite test and Leukocyte esterase test) in detecting pyuria in children have suggested that the dipstick tests (Nitrite test and Leukocyte esterase test) are as accurate as microscopic examination in predicting pyuria and bacteriurea.^(6,19)

Hoberman and wald have demonstrated that the dipsticks test have low sensitivity (52.9%) in detecting pyuria in febrile children.⁽²⁰⁾

The high positive predictive value of tests in our study is reflection to the high incidence of urinary tract infection.⁽¹⁵⁾

Dipstick test has been found less sensitive than urine microscopy and both techniques have only modest sensitivity and specificity around (80%) when compared to quantitative culture, one consistent result reported in most studies as well as in our study high negative predictive value more than (80%) this may reflect the low prevalence of urinary tract infection (4-14.8%) in these studies.⁽²¹⁾

A study reported from France showed negative predictive value 99.4% with no difference between boys and girls while our result was 82% also we haven't seen any differences of negative predictive value in both sexes boys and girls.⁽²²⁾

Generally, in ill febrile children both negative dipstick and negative microscopy which has a negative predictive value virtually excludes urinary tract infection.⁽²³⁾

High negative predictive value (in both dipstick and urine microscopy) is extremely useful as it to help to decide which urine sample should be cultured

and which to be discarded.⁽²⁴⁾
 False positive and false negative results are not unusual in dipstick urinalysis.⁽²⁵⁾
 False positive and false negative urinalysis results are due to variety of factors including specimens' contamination ,certain organism ,timing of specimen's collection interfering substances (urobilinogen, glucose, ascorbic acid, drugs, urine cells, bacteria) other urine properties (specific gravity , PH, concentration) and biological factors (exercise ,cold exposure, prolonged recumbancy, medical illness).⁽²⁶⁾
 The sensitivity of this test can be improved by obtaining first morning

specimens ,instead of performing random collection.⁽²⁷⁾
 The microorganisms isolated from urine culture in this were more or less similar to other literatures.^(28,29)

Conclusion

- 1.The dipstick tests (nitrite and leukocyte esterase) have high positive predictive value for presence of urinary tract infection.
- 2.The high negative predictive value of these tests doesn't exclude urinary tract infection.
- 3.A combination of microscopic examination and dipstick tests improve the sensitivity of detecting urinary tract infections.

Table 5 . Comparison of our study results with others studies.

study	Nitrite test				Leukocytes esterase test			
	Sensitivity %	specificity %	Positive Predictive Value%	negative Predictive Value%	Sensitivity %	specificity %	Positive Predictive Value%	negative Predictive Value%
Our study	39.3	87.6	74	61	83.7	70	76.6	82
Weinberg and Gan (6)	56	98.1	54.7	98.1	85.4	92.7	33.7	99.3
Sadika et al (8)	38.2	88.4	87.2	40.9	85.4	58	80	65.8
Sheriff et al (9)	54.6	96.8	37.5	98.4	100	78	13.9	100
Ayazi and Daneshi(10)	56	81	88	71	69	60	72.6	80
Loher et al (11)	37.3	100	100	90.2	79.4	72.7	33.6	95.3
Cannon et al (12)	72.7	99.6	96.8	94.6	71.4	33.6	96.9	91

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