Original Article

The Diagnostic Accuracy of Urine Dipstick in Early Detection of UTI in Children Keeping Urine Culture as a Gold Standard

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ABSTRACT

Objective: To determine the diagnostic accuracy of urine dipstick in detection of UTI in children keeping urine culture as a gold standard.

Study Design: Cross sectional validation study

Place and Duration of Study: This study was conducted at the Paediatric department, KRL Hospital, Islamabad from July 2015 to December 2015.

Materials and Methods: 406 female patients age 2 months to 5 years with signs and symptoms of urinary tract infection were included. Urine was collected using a midstream clean catch sample or suprapubic aspiration. A rapid dipstick analysis for leukocyte esterase and nitrite was done. All dipstick positive and dipstick negative samples underwent cultures by sending samples in a clean container to the pathology lab. A study proforma was used to record the information regarding patient age, gender and the results of urine dipstick and urine culture tests.

Results: The diagnostic accuracy of urine dipstick in detection of UTI in children keeping urine culture as a gold standard was recorded as 80.95%, 62.42%, 35.98%, 92.63% and 66.26% for sensitivity, specificity, positive predictive value, negative predictive value and accuracy rate.

Conclusion: The diagnostic accuracy of urine dipstick in detection of UTI in children keeping urine culture as a gold standard is higher and this cost effective technique may be used in our routine practice for early detection and treatment of UTI in children in order to avoid renal damage and when urine cultures are available only after 7 days.

Key Words: Urinary tract infection, diagnostic accuracy, urine dipstick

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INTRODUCTION

A UTI is defined as colonization of a pathogen anywhere along the urinary tract: upper urinary tract infection (kidney, ureter), and lower urinary tract infection (bladder, and urethra).

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The prevalence of UTIs ranges from 1-73% worldwide. In Pakistan UTI is one of the common problems for hospital visits in pediatric ages and girls are the most affected[1]. A recent study from Karachi reported 18% prevalence[2].

The overall prevalence of UTI among infants presenting with fever, was 7.0% (CI: 5.5– 8.4). The pooled prevalence rates of febrile UTIs in female aged 0–3months, 3–6 months, 6–12 months, and more than 12 months was 7.5%, 5.7%, 8.3%, and 2.1%respectively. Among febrile male infants less than 3months of age, 2.4% (CI: 1.4 –3.5) of circumcised males and 20.1% (CI: 16.8 –23.4) of uncircumcised males had a UTI. Among older children (>9 years) with urinary symptoms, the pooled prevalence of UTI(both febrile and afebrile) was 7.8% (CI: 6.6–8.9).[3,4]The Incidence in the term neonate is approximately 1% & in the preterm3%, both with male preponderance (male to female ratio is 5:1).During infancy, risk of developing UTI is equal in boys and girls and thereafter higher in girls.[5] Pediatric urinary tract infections (UTI) account for 0.7% of physician office visits and 5–14% of emergency department visits by children annually.

Clinical features suggesting UTI include a history of prior UTI, temperature greater than 39°C or 40°C, duration of temperature for more than 24 hours, suprapubic tenderness, and lack of circumcision[1,6].

The clinical presentation of UTI depends on the age of the child. Neonates may present with poor feeding, vomiting, jaundice, irritability, sepsis, lethargy, or failure to gain weight, and may not always have fever. Infants most commonly present with fever, diarrhea, vomiting, irritability, foul smelling diapers and constipation. In older children with pyelonephritis, fever is the predominant symptom, often without dysuria. In children older than 2 years with febrile UTIs, only 32% of boys and 40% of girls had dysuria. Flank pain was even more uncommon.[7]

However, due to the lack of reliability of clinical features any child presenting with fever without a localizing source should undergo workup for a UTI.

Most uncomplicated UTIs are caused by a large family of gram negative, aerobic bacilli known as Enterobacteriaceae. Others include Escherichia, Klebsiella, Enterobacter, Citrobacter, Proteus, Providencia, Morganella, Serratia, and Salmonella species. Of these, Escherichia coli is by far the most frequently isolated organism, being responsible for approximately 80% of UTIs. The most common gram-positive organisms found in UTIs are Staphylococcus and Enterococcus sp. Anaerobic fecal flora rarely produce UTIs despite being 100 to 1000 times more abundant than E. coli in stool.[8]

The gold standard for the diagnosis of UTI is the urine culture. However, culture results are not typically available until 24 to 48 hours after the initial patient evaluation.[9,10] Early identification is particularly important in attempting to avoid renal involvement.[11] Rapid screening performed by a urine dipstick test primarily looks for the presence of leukocyte esterase (LE) or nitrites in the urine sample.

Nitrites are far more specific than LE in identifying likely UTI; however, sensitivity is quite poor. The meta-analysis by Williams and colleagues produced sensitivity and specificity estimates of nitrite only positive dipstick as 49% (95% CI, 41%–57%) and 98% (95% CI, 96%–99%), respectively.

Williams and colleagues[12] found that the presence of either nitrites or LE was more accurate than LE alone, with a sensitivity and specificity of88% (95% CI, 82%–91%) and 79% (95% CI, 69%–87%), respectively.

The traditional cutoff for urine obtained by noninvasive collection methods (clean-catch or clean bag) has remained 10^5 (100K) CFU/mL for decades. Investigators use a cutoff of 10^4 (10K) CFU/mLto define infection with specimens obtained by catheterization.[13] Because it was recognized very early that urine obtained by suprapubic aspiration (SPA) in non-infected children is almost invariably sterile, most authorities use 10^2 (0.1K) CFU/mL as the cutoff for defining a positive culture in an SPA sample.[14]

Urine culture is the gold standard for diagnosing UTIs[1], however, the time span for results is a serious issue similarly urine analysis is time consuming, a urine dipstick for a lab analysis may be less time consuming. However, a recent study done in 2010 has shown that urine dipsticks are moderately sensitive (75%) and less specific (66%) in predicting UTI[15].

MATERIALS AND METHODS

This study was conducted at Pediatric department KRL Hospital Islamabad from 1st July to 31st December 2015.

Sample Size: Sample size has been calculated by using sensitivity and specificity sample size calculator with following statistical assumptions:

Confidence level: 95%
Sensitivity: 75%
Specificity: 66%

Our study sample size came out to be 406 children with suspicion of UTIs.

Inclusion Criteria:

- Females
- Age from 2months to 5 years
- Fever up to 101°F
- Presenting complaints (lower /suprapubic abdominal pain), burning micturition and frequency of micturition 10 to 15 times per day.

Exclusion Criteria:

- Patients who have taken antibiotics in the previous 48 hours.

Those with underlying congenital renal anomalies i.e. cystic kidney, obstruction in renal tract, Renal Tumors, Renal Syndromes, Acute Renal failure and CKD.

Data Collection Procedure: After taking permission from the hospital ethical committee all female patients age 2 months to 5 years presenting in the inpatient or outpatient department with signs and symptoms of urinary tract infection were included. Urine was collected using a midstream clean catch sample or suprapubic aspiration.

A rapid dipstick analysis for leukocyte esterase and nitrite was done by a staff nurse using Meditest Combi 10 SGL. The reaction of dipstick strip was read visually by a trained nurse. All dipstick positive and dipstick negative samples underwent cultures by sending samples in a clean container to the pathology lab of KRL hospital within one hour of the urine collection. In the lab, the urine sample was incubated in a CLED medium at 37^0C. Next day after 24 hour the medium was checked for the growth of pink glistening colonies indicative of the gram negative organisms.

Data analysis: SPSS version 10 was used for the analysis. Mean and standard deviation was calculated for all quantitative variables i.e. age. Frequency and

percentage was presented for all qualitative variables i.e., true positive, false positive, false negative and true negative. Sensitivity, specificity, positive and negative predictive value was calculated using 2x2 table (Table 1).

RESULTS

A total of 406 cases were enrolled. Age distribution of the patients is shown in Table No. 2.

Frequency of UTI in children on urine culture as a gold standard with positive results were 20.69 %(n=84) while 79.31%(n=322) were not positive. (Table No. 3).

Table No.1:Urine dipstick with urine culture

Urine dipstick	Urine culture		
	Test result	Positive	Negative
	Positive	Tp	Fp
	Negative	Fn	Tn

Table No.2: Age distribution(n=406)

Age(in years)	**No. of patients**	%
2-3yrs	281	69.21
4-5yrs	125	30.79
Total	406	100

Table No.3: Frequency of UTI in children on urine culture as a gold standard (n=406)

Ti	No. of patients	%
Yes	84	20.69
No	32	79.31
Total	406	100

Table No. 4: Diagnostic accuracy of urine dipstick in detection of UTI in children (n=406)

Urine dipstick	Urine Culture		Total
	Malignant (positive)	Malignant (negative)	
Positive	True positive 68(16.75%)	False positive 121(29.80%)	189(46.55%)
Negative	False negative 16 (3.94%)	True negative (d) 201(49.51%)	217(53.45%)
Total	84(20.69%)	322(79.31%)	406(100%)
Urine dipstick	urine culture		Total
	Malignant (positive)	Malignant (negative)	
Positive	True positive 68(16.75%)	False positive 121(29.80%)	189(46.55%)
Negative	False negative 16 (3.94%)	True negative (d) 201(49.51%)	217(53.45%)
Total	84(20.69%)	322(79.31%)	406(100%)

Sensitivity =80.95%, Specificity = 62.42%, Positive predictive value =35.98%, Negative predictive value=92.63%, Accuracy rate = 66.26%

Diagnostic accuracy of urine dipstick in detection of UTI in children was recorded as 80.95%, 62.42%, 35.98%, 92.63% and 66.26% for sensitivity, specificity, positive predictive value, negative predictive value and accuracy rate (Table No. 4).

DISCUSSION

Urinary tract infection (UTI) is one of the most common sources of infection in children under five. Prompt diagnosis and treatment is important to reduce the risk of renal scarring.

Rapid cost-effective, methods of UTI diagnosis are required as an alternative to culture. The current study was planned to detect UTI early by the use of urine dipstick as it is an easy modality, an inexpensive test to reduce the complications associated with late detection of UTI.

In our study, frequency of UTI in children on urine culture as a gold standard was recorded in 20.69%(n=84), the diagnostic accuracy of urine dipstick in detection of UTI in children was recorded as 80.95%, 62.42%, 35.98%, 92.63% and 66.26% for sensitivity, specificity, PPV, NPV and accuracy rate.

A recent study done by Eric in 2014 showed that PPV of dipstick was significantly greater than combined urine analysis (66.8% (66.2%-67.4%)vs 51.2%(50.6%-51.8%)[16]. Our study findings are in agreement with the above study. Contrary to above, in 2007, American Academy of Pediatrics discouraged the use of dipstick in detecting UTI as it has low diagnostic yield.

Smith P and others[17]evaluated the sensitivity, specificity, positive and negative predictive values of microscopy and dipstick to predict culture results and recorded sensitivity 83%, specificity 76%, PPV 94%, NPV 76%, which is supporting our study results. A study by whiting et al[18] revealed similar results.

In a study conducted at turkey where urine cultures were compared with dipstick analysis for detection of UTI, negative predictive values for LE, nitrite, bacteriuria and WBC were very close to 100%.[19]

In a recent randomized controlled trial done in 2010, it was concluded that use of targeted antibiotics with dipstick testing becomes the most cost effective strategy but there are insufficient local data available.[20]

In summary, the results of our study supports the use of urine dipstick to detect UTI early as it is an easy modality, an inexpensive test and we can start early treatment with antibiotics and hence can decrease the complications associated with late detection of UTI. Though, it is not routinely performed in our hospital setting however, considering the results of our study in accordance with other studies, the use of this effective modality may guide us towards the early treatment and hence prevention of complications.

CONCLUSION

We conclude that the diagnostic accuracy of urine dipstick in detection of UTI in children keeping urine culture as a gold standard is higher and this cost effective and easy technique may be used in our routine practice for prediction and early treatment of UTI in children.

Author's Contribution:

Concept & Design of Study:	Maryam Naseem
Drafting:	Aroma Tariq, Sumbal Saeed
Data Analysis:	Maryam Rafiq Ghuncha, Nighat Jabeen, Mariam Raza
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Final Approval of version:	Maryam Naseem

Conflict of Interest: The study has no conflict of interest to declare by any author.

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