Original Article

How Sensitive are Dipstick Urinalysis and Microscopy in Making Diagnosis of Urinary Tract Infection in Children?

Kene Ebuka Maduemem, Yurelis Diaz Rodriguez, Brian Fraser

Department of Paediatrics, Cork University Hospital, Cork, Ireland

Abstract

Background: Urinary tract infection (UTI) is a common reason for referral to the emergency department (ED) especially in unwell infants. Upper UTIs are particularly at risk of significant complications later in life. Rapid dipstick urinalysis and microscopy are often used in unwell children as a screening tool to guide early diagnosis and treatment. This study aims to evaluate the sensitivity of dipstick urinalysis and microscopy in the diagnosis of UTI. **Methods:** A retrospective review of children aged 16 years and below with positive urine culture (UC) over a 3-year period was done. The results of urine dipstick and microscopy were compared with the positive UC and sensitivities calculated. **Results:** Dipstick urinalysis and microscopy of 262 children were studied. Female-to-male ratio of 1.8:1. Median age was 0.79 (range: 0.02–15.95) years. The sensitivity of nitrite, blood, and leukocyte esterase (LE) were 0.54, 0.74, and 0.86 (95% confidence interval [CI] = 0.46–0.62, 0.68–0.80, and 0.82–0.91), respectively. The sensitivity of pyuria of ≥100 cells/mm^3 was 0.92 (95% CI = 0.89–0.95). The presence of any of the 3 dipstick parameters increased the sensitivity to 0.97 (95% CI = 0.95–0.99). The lowest sensitivity 0.49 (95% CI = 0.40–0.58) was found with combined positive LE and nitrite. There was a significant comparison between positive LE dipstick test and pyuria (P = 0.000004). **Conclusions:** Dipstick urinalysis may not be reliable in ruling out UTI in children. However, considering both positive dipstick and pyuria will be more useful in making the diagnosis.

Keywords: *Mass screening, microscopy, pyuria, urinalysis, urinary tract infections*

Introduction

Urinary tract infection (UTI) is a common cause of serious bacterial infection in young children. The American Academy of Pediatrics UTI clinical practice guidelines recommends that UTI should be highly suspected in febrile children between the ages of 2 months and 2 years.[1] Febrile UTIs have the highest incidence during the 1st year of life in both sexes.[2]

UTI in infancy and childhood can present with clinical features that are nonspecific, and culture results are not available at the time of initial evaluation. Consequently, care providers must make decisions on rapid results of the dipstick urinalysis whether to initiate empiric antibiotic therapy for a presumed UTI while awaiting culture results. Qualitative urine culture (UC) is the gold standard for diagnosing UTI.

UC results are not readily available in the emergency department (ED). Hence, decisions in the ED are often based on the initial dipstick result. Dipstick urinalysis is a quick and inexpensive screening method requiring limited expertise. Microscopic examination of urine samples for white cells is considerably more time-consuming and labor-intensive than the dipstick urinalysis. However, unlike UC, it can be used to give results within the primary care setting. In practice, microscopy and culture are generally requested in combination; microscopy has the advantage of being quicker to provide a result.

Relying on dipstick testing alone may lead to either delayed treatment or unnecessary antibiotic therapy because of the limitations of leucocyte esterase (LE) and nitrite. The studies of dipstick urinalysis have shown considerable heterogenicity, thus results are interpreted cautiously. The previous results strongly suggest that a dipstick test positive for both LE, and nitrite is good for ruling in UTI while a negative test is good for ruling out.[3,4]

The objective of this study was to determine the sensitivity of dipstick urinalysis and microscopy in the diagnosis of UTI.

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Address for correspondence:
Dr. Kene Ebuka Maduemem, University Hospital, Galway, Ireland.
E-mail: ebukakene@rocketmail.com

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Methods

This was a retrospective review of children with a positive UC between January 2014 and December 2016. Data were retrieved from the Hospital In-Patient Enquiry System. The study was approved by the institutional clinical governance unit because of no direct human subject involvement. Using the sample size calculator Raosoft™ (Raosoft Inc., Seattle, WA, USA), at a margin of error of 5%, confidence level of 95%, the sample size was projected to be 260.

UTI was defined as the growth of a single colony/organism of at least 10^5/mL. Only children with a positive UC were included. Electronic medical records were reviewed for demographic data, urine microscopy, and culture results. Medical notes were reviewed for dipstick urinalysis results.

Urine samples were obtained by clean catch method for infants and children not yet toilet trained. Older children produced mid-stream urine samples. Dipstick urinalysis was performed using Siemens multistix 10SG, Siemens Healthcare Diagnostics Inc. NY, USA and CLINITEK Advantus analyzer. In our study, the parameters considered were LE, nitrites, and blood. Reading time for nitrites and blood was 1 min and 2 min for LE. Cutoff values for a positive result were 1+ or more of LE, blood (+), and nitrite (+).

Microscopy was done using the manually counting chamber (HYCOR KOVA System). Cutoff value for microscopy taken as significant was white blood cells (WBC) ≥100 per mm^3 based on local guidelines. The cultures were done using cystine lactose electrolyte deficient agar. The cultures were read after 48 h of incubation at 37°C. Positive UC was defined as at least 10^5 colony forming units (CFU) per mL of a single uropathogen. Mixed growths were excluded. The results of dipstick urinalysis, microscopy was compared with the positive UC. The data were analyzed using SPSS 21.0 version. Statistical significance was set at $P < 0.05$. Comparison of variables was analyzed using Fischer's exact test.

Results

262 children had positive UC as defined by this study. The median age of children was 0.79 (range: 0.02–15.93) years. With respect to age distribution, 37.4% of positive cultures were in infants under 6 months of age with 70.4% male predominance. The overall female-to-male ratio was 1.8:1. The highest male incidence was seen in <12 months age group. Female preponderance existed in other age groups. Figure 1 illustrates the age and sex distribution.

Median of length of hospital stay was 3 (range: 1–23) days. 23 (60/262) of children had more than one positive UC in the study period; 55% female. Urinary structural anomalies were present in 35%. Noncoliform recurrent positive UC was found in only 20%.

Among dipstick test parameters, positive LE was present in 86% (225/262), positive nitrite in 53% (140/262), and positive blood in 74% (192/262). The combination of parameters and their sensitivities at 95% confidence interval are shown in Table 1. Pyuria of ≥100 cells/mm^3 was present in 92% (241/262). Age distribution of the positive urine parameters as shown in Figure 2. There was a significant correlation between LE positive dipstick and pyuria of ≥100 ($P = 0.000004$).

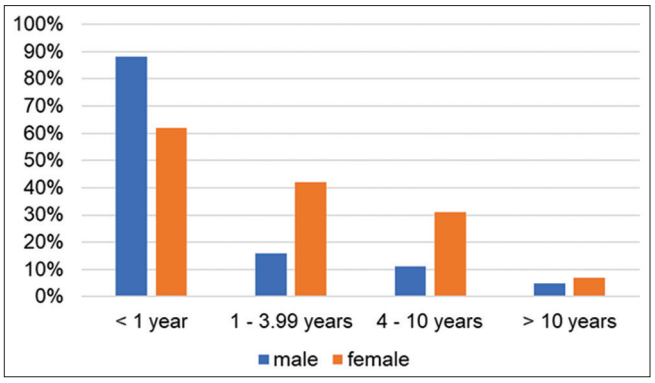

Figure 1: Age and sex distribution of urinary tract infection

Of the 262-positive UC, the predominant isolated pathogen was *Escherichia coli* (89.7%). The other isolated organisms are represented in Table 2.

Discussion

Quantitative (UC) is the gold standard for the diagnosis of UTI. The significance of bacterial growth from a urine sample depends largely on the method by which urine is obtained and the number of colonies grown. The UC from a bagged urine specimen is only helpful if negative.[5] This retrospective study was done to evaluate the sensitivity of dipstick urinalysis and microscopy in diagnosing UTI before UC results become available. In our setting, positive urine dipstick and microscopy leads to the commencement of empirical antibiotics, especially in febrile infants. It takes approximately 30 min for the urine microscopy result to be available. This has been thought to greatly reduce the rate of false UTI diagnosis based on dipstick alone.

Congruent results of LE and nitrite (both positive or both negative) help to rule in or rule out a UTI, but the common scenario in which LE is positive, but nitrite is negative creates diagnostic uncertainty.

Of note, urinary nitrite is not a sensitive marker for UTI in children, particularly infants, because of their frequent bladder emptying.[1] Most urinary pathogens except Enterococci can reduce nitrate to nitrite; thus, nitrite in the urine indicates bacteriuria. The nitrite dipstick test may be falsely negative if the urine is held for too short a time in the bladder; usually <4 h.[5,6] This may be the reason for the low sensitivity (53%) in our study. On the other hand, its sensitivity in girls at least 3 years of age has been as high as 98%.[1,8-10] The presence of nitrite has a positive predictive value of 94%.[11] In addition, positive dipstick

Figure 2: Age distribution of positive screening parameters

Table 1: Sensitivity of parameters used for screening urinary tract infection

Parameters	Sensitivity	95% CI
LE	0.86	0.82-0.91
Nitrite	0.53	0.46-0.62
Blood	0.74	0.68-0.80
LE or nitrite	0.90	0.86-0.94
LE or blood	0.93	0.90-0.96
Both LE and nitrite	0.49	0.40-0.58
LE or blood or nitrite	0.97	0.95-0.99

CI=Confidence interval, LE=Leucocyte esterase

Table 2: Distribution of causative organisms of urinary tract infection (*n*=262)

Organism	*n*=262
Escherichia coli	235
Enterococcus	7
Proteus	6
Staphylococci	4
Pseudomonas	4
Citrobacter	2
Morganella morganii	2
Haemophilus parainfluenzae	2

nitrite is highly specific for bacteriuria (96.6%–97.5%) with a low sensitivity of 0%–44% for 10^3–10^5 CFU/mL bacteriuria.[12,13]

A positive (LE) test correlates well with pyuria. However, a positive result is not very specific for UTI as there are many other conditions causing pyuria. Such conditions include acute febrile illnesses, urinary calculi, sexually transmitted infections, and intrinsic renal disorders.[14] Three pediatric meta-analyses and one large study reported LE sensitivities of 72%–83%.[10,15-17] In our study, LE sensitivity (85.9%) was similar. Also in our study, positive LE was strongly linked to pyuria ($P < 0.001$). It is, therefore, reasonable to propose that a positive LE is indirectly a strong predictor for UTI.

In a systematic review of several studies, nitrites and LE were shown to have good sensitivity and specificity for the detection of UTI in older children but were less reliable in infants.[3] Ramlakhan *et al*. differed as they found dipstick urinalysis useful in the diagnosis of UTI in children below 2 years of age.[18] However, a more recent study of infants between 1 and 90 days of age showed that when microscopy is added to the dipstick urinalysis, the negative predictive value is 99.2%, but would result on average 8 false positives for every missed episode of true UTI.[19]

Pyuria appears to be a sensitive and reliable marker in diagnosing UTI. However, the definition of pyuria is not clear in the literature, multiple studies, and a few meta-analyses found the cutoff of 5 WBC per HPF being used, the sensitivity and specificity being 74% and 86% respectively.[16,17,20] In our study, the cutoff was placed at 100 WBC per mm^3 based on local guidelines. The sensitivity was high in this study despite the high cutoff value; up to 94%. A pediatric study including young infants showed that a WBC count of ≥10 per mm^3 had a sensitivity of 91% and a specificity of 96% for predicting a positive culture of ≥50,000 CFU/mL.[21] another study including young infants compared the enhanced method with automated urinalysis and found similar sensitivity and specificity for detecting pyuria associated with a bacterial culture of ≥50,000 CFU/mL.[15]

The sensitivity of urine dipstick increased to 96.6% when any of the three (blood, LE, and nitrite) parameters were positive. Dipstick has shown to perform well in children ≥2 years old as a screening test for UTI.[3] Pediatric UTIs are treated with two purposes: to eliminate infection thus, preventing systemic illness and to prevent or reduce possible long-term complications such as renal scarring and hypertension.[7] Using dipstick at the GP (general practitioner) settings or in the ED will be useful in deciding if the urine should be sent for culture. NICE guidelines state that if both LE and nitrite are negative, the child should not be regarded as having UTI. Antibiotic treatment should not be started, and a urine sample should not be sent for culture.[22]

Limitation of this study includes its retrospective nature. The study did not entail the comparison of negative UC and positive dipstick urinalysis with microscopy, thus specificity could not be calculated. A prospective study will evaluate the specificity of dipstick urinalysis/microscopy and consequent predictive values.

Conclusions

Dipstick urinalysis alone may not be a completely adequate screening tool for UTI. However, analysis of results of urine microscopy in the light of a positive dipstick urinalysis would be useful in making a reasonably prompt decision on UTI treatment.

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Conflicts of interest

There are no conflicts of interest.

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