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Reliability of Urine Dipstick Analysis and Microscopy as a Predictor of Urinary Tract Infection

Manoj Sankar

Post Graduate in Pediatrics, Rajah Muthiah Medical College, Tamilnadu, India

Abstract: ***Urinary tract infection is one of the most commonly encountered genitourinary disease in pediatric practice. Diagnosis and management of urinary tract infection is a matter of concern in hospital settings and at community level. This study tries to establish the relevance of urine dipstick analysis and microscopy in detecting UTI. In this study a control group and a study group of equal number with similar complaints were taken and urine dipstick analysis studying 3 parameters i.e. leukocyte esterase, nitrite and albumin. Microscopy was done to check for bacteriuria, hematuria and pyuria. In predicting urinary tract infection, Nitrites and bacteriuria has a positive predictive value of 93.1% and a combined specificity of 95%.In predicting urinary tract infection, Leukocyte esterase and nitrites combined sensitivity of 82% and negative predictive value of 83%. In predicting urinary tract infection, Leukocyte esterase and pyuria has a combined sensitivity of 82%. Hematuria and albuminuria, as single pararmeters has poor sensitivity, specificity and predictive values. This study concludes that leucocyte esterase in combination with nitrite or pyuria is the best rapid diagnostic tool.***

Keywords: dipstick, urine microscopy

1. Introduction

Urinary tract infection is one of the most commonly encountered genitourinary disease in pediatric practice. Diagnosis and management of urinary tract infection is a matter of concern in hospital settings and at community level.(l) It accounts for significant morbidity due to potentially dangerous sequelae like renal scarring and hence warrants an early and accurate. diagnosis. (2)

The clinical diagnosis of urinary tract infection is difficult, due to non- specific or vague symptomatic spectrum seen in children. (3) Often, clinical diagnosis needs to be supported with confirmatory tests like urine culture, which guides in treatment of the infection.

Use of rapid diagnostic tests like urine dipstick and microscopy, over the recent past was found to be economical and effective in avoiding unnecessary sampling or urine cultures. These tests guides in selectively performing urine Culture based on urine analysis reports, unless there is a strong clinical suspicion or if the patient has received antibiotics.(4) These tests were also helpful in initiating an empirical treatment in children with strong suspicion of UTI, while the Urine culture reports are awaited.(5)Many studies have reported high specificity and sensitivity of dipstick tests, when used in combination with urine microcopy (6)(7)These tests aid in early therapeutic intervention, thereby preventing complications.

Although extensive pediatric studies have been done to evaluate the performance characteristics of these rapid diagnostic tests in rightly diagnosing a UTI, there is lack of sufficient studies and paucity of data on these in developing countries like India.
This study focuses on reliability of urine dipstick and microscopy in early detection of childhood urinary tract infection and the current status of urine analysis as an effective screening tool in an Indian set up. This study looks at the single as well as combination of parameters that provide maximum sensitivity and specificity, providing a better diagnostic criteria in detecting an underlying urinary infection.

2. Review of Literature

2.1 Epidemiology

UTI remains one of the commonest infection encountered in children, following gastrointestinal and respiratory focus. (13, 14, l5) It accounts for about 5% of febrile illness among pediatric patients and should be strongly considered as a cause for nil localizing pyrexia, especially in under 5 children. More than 75% of children in the above age group, diagnosed with febrile UTI were detected to have pyelonephritis aided by nuclear and imaging studies.(13)(18)(19)(20)

Although extensive studies have reported a wide and varied prevalence rates from 3.3 to 37.5%,a true incidence and prevalence of the disease, especially in developing countries still remains unclear because of the under reporting of UTI cases due to the wide range of non-specific presentations and difficulties in obtaining urine specimen for laboratory evaluation. It is not known how often UTI is the cause of illness in young children presenting in general practice-based primary care and which children should be targeted for urine sampling. It accounts for 0.7% of office visits to physician and 5-14 % of emergency consults by children annually. (16)Most of the studies which have evaluated UTI in children are observational and hence the data from such studies are unreliable and inconclusive. Prevalence of UTI is largely dependent on the demographic data, especially the age and sex of the patient.

One of the largest pooled data on the prevalence of UTI which utilized the MEDLINE and EM]3ASE databases was by Sheikh et al which concluded that the highest prevalence

of UTI was observed in males les than 3 months of age and females less than 12 months of age. (16)Among infants presenting with fever without any localizing examination findings, the prevalence of.UTI was found to be 7 % but ranged from 2.1-8.7% depending on the age and sex. Infants below 3 months had the highest prevalence with rates of 20.1% in Uncircumcised vs 2.4% in circumcised males with UTI.(16)

Ferrara P et al concluded that the prevalence rates differ according to age, Sex and status of circumcision and the highest prevalence was observed in uncircumcised febrile infants <50 months of age.(17)

Although a general higher preponderance is observed in females than males, males commonly present with UTI in the neonatal and infancy period. Among the males, there is a higher risk associated with uncircumcised children as compared to circumcised. Female children tend to have higher incidence of UTI beyond infancy and peaks at school age. This is attributed to the short urethra and translocation of fecal contaminants.

Leroy S and Garvaix A reports that 6% of the girls and 2% of boys are diagnosed with atleast 1 episode of UTI before the age of 7 years. Asymptomatic bacteriuria is usually seen in 1% of infants, 3% of preschool children and 1% of older children. (26)

Table 1: Prevalence of UTI according to different age groups (10)

Age group	Males	Females
< 1 year	0.2% - circumcised 0.7% - uncircumcised	0.1 – 0.4%
1-5 years	0.1 – 0.2%	1.4%
School age	0.04 – 0.2%	0.7 – 2.3%

Another study which reviewed prevalence of UTI according to age and sex distribution was by Bachur and Harper where highest prevalence was noted to be below 1 year of age among the males. Following infancy there was a shift to female preponderance as age progressed. (21)

Table 2: Prevalence of UTI in febrile children in various studies (18) (22) (23) (24) (25)

Different studies	Year	Prevalence of UTI
Hoberman et al	1993	5.3%
Schlager TA et al	2001	5.3%
Kaushal RK et al	2003	12.3%
Sheikh TA et al	2007	7%
Shaw KN and Gorelick et al	1999	5.4%

3. Clinical Features

Signs and symptoms of urinary infection depend on:
1. Age at presentation
2. Anatomical location of infection
3. Severity of infection

1. Age at presentation:
1. **Neonates and Infants**: Neonates and infants with UTI usually develop
UTI following septicemia.
1. Hypothermia
2. Hyperthermia
3. Failure to thrive
4. Vomiting
5. Diarrhoea
6. Irritabi1ity
7. Sepsis
8 Lethargy
9. Jaundice
10.Malodorous urine

2. Toddler
1. Vomiting
2. Diarrhoea
3. Abdominal pain
4. Abnormal voiding pattern
5. Malodorous urine
6. Inadequate weight gain

3. School age:
1. Dysuria
2. Abdominal pain
3. Dysfunctional / abnormal voiding pattern like secondary enuresis / incontinence
4. Constipation
5. Dribbling
6. Frequent micturition
7. Urgency
8. Malodorous urine

4. Adolescent
1. Dysuria
2. Abdominal discomfort
3. Burning micturition
4. Frequent micturition
5. Fever
6. Malodorous urine

There are various factors that are associated with increased occurrence of UTI like:-
1. Females(due to short urethra)
2. Uncircumcised male(prepucial colonization)
3. Vesicoureteric reflux
4. Toilet training
5. Obstructive uropathy
6. Instrumentation
7. Wiping of the genital tract from back to front
8. Tight undergarments
9. Constipation
10.Anatornical abnormalities of the genitourinary tract
11.Neuropathic bladder

4. Specific Physical Examination Findings in UTI

1) Abdominal palpation in suspected UTI may reveal renal masses, palpable or distended bladder or loaded fecal matter.
2) Examination of the spine and neurological evaluation is mandatory. External markers of neural tube defects must especially looked for.
3) Genitourinary examination must be done to look for related risk factors like phimosis and labial adhesions.

4) Height, weight and vitals including blood pressure must be measured as this gives clues to any underlying chronic renal compromise and obstructive uropathy.

4.1 Diagnosis

Since clinical diagnosis of UTI is difficult to rely upon due to the clarity of specific clinical features, laboratory evidence is required to confirm the infection.
Investigation modalities include
Supportive evidence
Specific investigations
Imaging for complications

1. Non-Specific Investigations:
An acute renal infection is evident by presence of neutrophilic leukocytosis in complete hemogram and elevated acute phase reactants like ESR and CRP. An elevated total counts >20,000-25,000 cells/cu.mm suggests an underlying renal abscess. A probable sepsis must also be considered in neonates and infants. Hence a blood culture must also be obtained prior to initiating antimicrobial therapy.

2. Specific Investigations

Urine Analysis
Although not gold standard, urine analysis, which includes dipstick and microscopy, is useful in predicting urinary tract infection in children, it offers to be a rapid diagnostic test, cost effective and reliable in ruling out negative samples.

There has been an inclination towards determining efficacy of urine dipstick and microscopy over the recent past. Although comparisons of parameters have been done in the past in numerous studies, only few studies have evaluated the wide range of prevalence in each scenario, on which reliability of test depends and thereby varies.

Bachur and Harper et al studied the performance characteristics of rapid and concluded that the sensitivity of urine analysis was 82% and specificity of 92%(21).

Gorelick and Shaw et al suggested that combination of leucocyte esterase and nitrites in children, along with gram stain was superior to microscopic pyuria in detecting UTI (l8).

A meta analysis was done by Huicho et al and colleagues, which included and reviewed a bigger number of articles, This study concluded that pyuri>10 cells/hpf and bacteriuria were better predictors in diagnosing UTI in children. Another meta-analysis done by Gabrielle J Williams was done to effectively analysis the sensitivity of urine analysis in detecting UTI in children, thereby selectively performing urine culture, reducing the laboratory work load and guide in starting an empirical therapy.

This study concluded that gram stain and microscopic detection of bacteria in the urine were best parameters which had good sensitivity and specificity (except for nitrites) as compared to all other parameters single and combination. The study also suggested that rapid diagnostic test was insufficient in identifying all childhood UTI cases.

Recent studies suggested that urine analysis is effective in 1ing out UTI in the setting of low clinical suspicion and in cases were culture report are not reliable due to prior antimicrobial use.

4.2 Dipstick Vs Microscopy

A recent study by Eric et al and colleagues compared the efficacy of dipstick and microscopy for screening UTI in 13,030 febrile infants which concluded that dipstick was the best screening and has equal performance ‘characteristic compared to microscopy and dipstick combined together.

4.3 Dipstick Analysis

Leukocyte Esterase:
Leukocyte esterase refers to enzymatic remnant of the white blood cells. It is predominantly found in granules of the azurophilic neutrophil. These grani1es possess proteins that exhibit esterolytic activity. This reacts with an impregnated reagent to produce a positive result of blue colour. Since the neutrophils are labile, leucocyte, esterase denotes enzymatic remnants of cells which are not visible microscopically.

A positive leukocyte esterase, thus denotes presence of significant number of neutrophils - either intact or lysed. Leukocyte esterase catalyzes hydrolysis reaction to produce respective alcohols and acid components.

False negative results can occur in:
1. Altered specific gravity, protein and glucose
2. Boric acid
3. Antibiotics like tetracycline, cephalexin, cephalothin
4. High ascorbic acid content

False positive results can occur in:
1. Contaminated urine with vaginal secretions
2. An alternative for cellular sources of esterase
3. In the presence of formalin and oxidizing agents .

4.4 Nitrites

Gram negative bacteria especially E.coli reduce dietary nitrates to nitrites. Atleast a minimum duration of 4 hours of urinary stasis is required for action of bacteria to breakdown nitrates.

Hence although nitrites are less sensitive in detecting UTI due o the above reasons, the presence of nitrites in a fresh urine sample is highly specific for an underlying UTI.

False positive results can also occur if there is delay in testing the sample Or in case of long standing samples.

The reagent impregnated on the nitrite dipstick is highly sensitive to air, so containers should be closed immediately after use. After one week of exposure, one third of strips gave false positive results. Non-nitrate—reducing organisms and patients who consume a low-nitrate in their diet may give a false-negative results.

Microscopic Examination

Importance of Microscopic examination of urine in detecting UTI is still a matter of controversy. A centrifuged urine specimen contains all the components which have accumulated during the filtration.

Cellular, elements are from two sources:

1. Desquamation/exfoliation of the epithelium lining the tubules and the urinary tract.
2. Cells which are of hematogenous origin like leucocytes and red blood cells.

4.5 PYURIA

Pyuria is the microscopic examination of urine sample for visible leucocytes which are seen per high power field. Among various components like casts, crystals, Rbcs etc, the most reliable parameter in detecting UTI by microscopic examination is pyuria. The number of pus cells/hpf depends on whether the urine specimen is centrifuged or uncentrifuged.In a centrifuged sample, pus cells of >5cells/hpf is considered as significant, whereas leucocytes of >10 cells/hpf is significant in an uncentrifuged specimen. False negative result may occur, if there is external contamination while collecting the specimen. Kagan Huysal and colleagues reported that among the various parameters studied both by dipstick and microscopic analysis, the evidence of pus cells or leucocytes detected in urine samples, indicated a probable inflammatory response in the urinary tract. The analysis showed that leukocyturia proved to be a better parameter as compared to bacteriuria. False negative results may occur during cell lysis. The presence of few or no pus cells is consistent with low likelihood of UTI.

4.6 Bacteriuria

Detection of bacteria in urine is yet another parameter which is measured to exclude urinary infection. Although there are many methods which are usedto study the bacteriuria, one of the reliable methods are using flow cylometry. False negative results may occur when cellular debri is falsely interpreted as bacteria. One must also remember that although cultures detect only the live bacteria, both live and killed bacteria are picked up by analyzers thereby increasing the chances for a falsely positive bacteriuria.

4.7 Hematurja and Albuminurja

Although either of' these parameters maybe tested positive in a UTI, a definite diagnosis based on the two parameters alone cannot be relied upon due to high chances of false positivity. A hematuria/ albuminuria may suggest an active renal involvement and may require further evaluation.

Table 3: AAP data on sensitivity and specificity of parameters of urine analysis (34)

Test	Sensitivity	Specificity
Leukocyte esterase	83(67-94)	78(64-92)
Nitrites	53(15-82)	98(90-100)
Either Leukocyte esterase/ nitrites positive	93(90-100)	72(58-91)
Microscopy(WBCs)	73(32-100)	81(45-98)
Microscopy(Bacteria)	8 1(1 6-99)	83(11-100)
Leukocyte esterase or nitrites or microscopy positive	99.8(99-100)	70(60-92)

4.8 Unine Culture

Urine culture has remained gold standard for the diagnosis of symptomatic urinary tract infection as well as for diagnosis of asymptomaticbacteriuria.

Urine culture gives us information about the organism grown, if the growth of uropathogen is significant to cause urinary infection and the likely susceptible antibiotics, It gives us an opportunity to revise or conform our diagnosis and alter the line of management if the current treatment involves use of resistant antibiotics.

The results of urinary culture must be however interpreted with caution because these maybe altered by:

1. Technique of urine collection
2. Prior use of antibiotic
3. Improper or faulty laboratory techniques

Technique of urine collection: An early morning of fresh sample is ideal although it is not always practically possible.

There are various methods of urine collection:

Bag method
Midstream clean catch
Suprapubic aspiration
Catheterized sample

The preferred method out of all the above methods is suprapubic aspiration among the invasive methods since there is increased risk of introduction of bacteria by catherization.

Among the non-invasive methods, mid stream clean catch urine is the preferred method of urine collection for culture. However this is not routinely erred as there is high risk of contamination with periurethral flora especially in males, since there is high risk of prepucial contamination.

Bag method is not reliable in detection of UTI due to the high risk of contamination in bagged specimens and thereby high rates of false positive results. However it is useful in ruling out negative sample its but not useful in documenting UTI in the absence of clinical supportive evidence.

4.9 Recommendations by Various Guidelines on Method of Urine Coluction

NICE guidelines suggests that non invasive method of urine collection is practically acceptable. Although midstream is the preferred method of urine collection, methods such as urine collection pads and bag method are also acceptable according to NICE guidelines. Invasive methods are used only if the non invasive method of urine collection fails. The preferred method of collection of urine for culture by AAP is suprapubic aspiration and catheterized methods.' Bag and midstream clean catch method is not recommended by AAP.

5. Materials and Methods

This study was conducted in Department of Pediatrics, Raja Muthiah Medical College and Hospital from October 2013 to August 2015. 100 patients with suspected urinary tract

infection, attending outpatient department or admitted in the hospital were, in the study.

Inclusion Criteria
Children aged lmonth to 12 years, suspected to have urinary tract infection.

Exclution Criteria
1. Patients who have received antibiotics within 48 hours of hospital visit.
2. Patients who are known case of congenital genitourinary abnormalities.
3. Patients with recurrent UTI.

Study Design

Prospective study of evaluation of screening test.

6. Methodology

Urine samples were obtained under strict aseptic precautions for both, urine analysis and urine culture in 2 different containers. The methods of urine collection adopted for the study were bag method, catheterized and mid stream clean catch sample. The samples for urine analysis and urine culture were sent to clinical pathology lab and microbiology lab respectively within 2 hours of collection. The decision to initiate an empirical treatment, pending the urine culture reports was left to the treating physician. Urine analysis was performed by trained lab technician and urine culture was done by a lab technician, under supervision of microbiologist. The results obtained from urine analysis, which included both urine dipstick and microscopy were compared with urine culture. 6 parameters such as leukocyte esterase, pyuria, nitrites, bacteriuria, hematuria and albumin were compared with urine culture.

The results were divided into two groups- culture proven UTI and the sterile culture groups. The true positive, true negative, false positive and false negative values were obtained and specificity, sensitivity, positive and negative predictive values were calculated for all the 6 parameters, single and in Combination in both the groups.

Microscopy

After testing the sample with Multistix dipstick test, the urine sample is placed in a plastic conical tube, which is labeled. The tube is covered with a tight fitting cover. The tube is placed in centrifuge along a second tube filled with water in equal amounts which acts as counter weight. Urine specimen is then centrifuged at relative centrifugal force of 400xg for 5- 1 0mm. After centrifuge has stopped, remove tube and pour off the supernatant, leaving sediment in the bottom of the tube. With a plastic pipette mix the remaining id and sediment. In cases where no sediments are visible, remove a few of the mixture from bottom of the tube. Place a drop of the sediment solution over a glass slide and place a cover slip. Examine the sediment using light microscope under low lOX power and 40X power, scanning several fields to obtain an estimate on the rage number of elements.

Principle:
The urine microscopy is a method of identifying and quantifying bacteria, cells and other materials in a sediment of centrifugedsample. This is for adequate identification of cellular elements in the urine sample andtract disease. The elements maybe organized or unorganized elements. Organized elements refer to RBCs, WBCs: Epithelial cells, Hyaline, cellular, granular fatty casts. Bacteria may' also be visible under direct microscopy. Microscopic hematuria, wbcs and bacteria are analysed in this study.

Interpretation and Standards Used

Pyuria: Since the sample was centrifuged, a lab cut off of >5cells/ hpf Was considered positive.
Hematuria: >5red blood cells/hpf was considered positive.
Albumin was interpreted as trace. I +, 2+, 3+ and 4+. Result >or = I + was considered positive.

Table 4: Interpretation of Albumin

Albumin	Interpretation
Trace	10-20mg/dl
1+	30mg/d1
2+	100mg/d1
3+	300mg/d1
4+	1-2g/d1

Nitrites was reported as positive or negative based on presence or absence. Leukocyte esterase was interpreted as negative, trace,l+,2+ and 3. Any L>O=1 + was considered positive.

Table 5: Interpretation at' Leukocyte esterase

Leukocyte esterase	Interpretation
Trace	<lOcells/cu.mm
1+	25cells/cu.mrn
2+	100
3+	500

Bacteria was interpreted as NiI,I+,2+,3+ and 4+.Result >or = 1+ was considered positive.

Urine Culture

Principle:
Une cultures are performed to detect the organism responsible for causing urinary tract infection. Normally the urinary tract is sterile above the level of urethra. However there is high risk of contamination with conventional method of urine collection especially non invasive methods like bag method. Hence cultures utilize a quantitative cut off or significant colony forming units to help differentiate between contamination, infection or colonization. However low counts maybe significant if patient is symptomatic.

Significant bacteriuria:
Urethral catherization> or equal to 5x I O4CFU/ml
Midstream clean catch or bag method > or equal to 1O5CFU/ml. Significant bacteriuria of a single pathogen was considered as a positive culture.

Statistical Tool Used
The data collected from the patients were formatted into Microsoft Excel sheets to generate master charts. Tables and

graphs. Diagramatic representation e used to depict significant clinical data from patients with culture proven UTI. The Sensitivity, specifcity, Nega1ive predictive value and positive predictive values were calculated using the standard formulas.

Sensitivity = True positive!(true positive H- false negative)
Specificity = True negative/(True negative + False positive)
Positive predictive value = True positive/ (true positive + False positive)
Negative predictive value = True negative/ (true negative + false negative)

SPSS software was used to analyze data. Correlation of parameters with 4t$ ag were assessed using chi- square pearson co-efficient test.

7. Results

100 (patients with suspected urinary tract infection were enrolled in the study. 50 patients with culture proven UTI and 50 patients with sterile urine cultures.

Individual Parameters in Each Group

1. Urine Analysis in Both Groups

Among the culture proven UTI group, urine analysis was positive in 43 cases and negative in 7 cases.

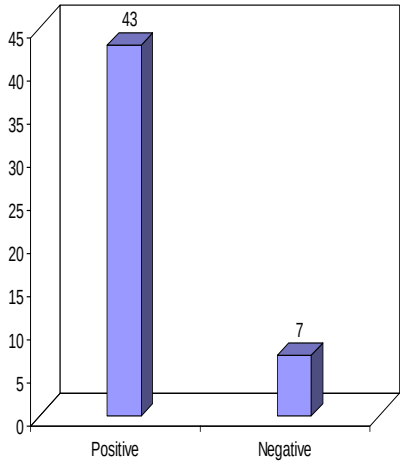

Figure 1

Urine analysis was positive in 17 cases and negative in 33 cases in the sterile culture group.

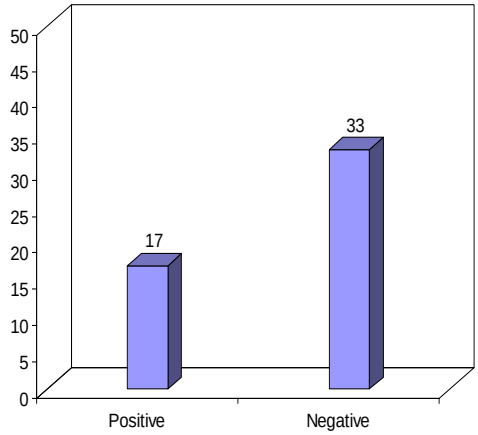

Figure 2

CHI-SQUARE TEST VALUE = 28.17 D.F.=1, P<0.001

The significant p-value confirms that the urine analysis was higher in the culture positive group as compared to the sterile culture group.

Sensitivity, Specificity, Negative Predictive Value and Positive Predictive Value

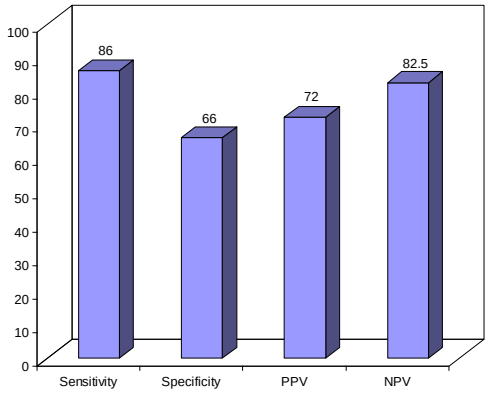

Figure 3:

Table 6

Urine analysis	Culture		Total
	Positive	Negative	
Positive	43	17	
Negative	7	33	
Total	50	50	100

Sensitivity = 43/(43+7)=86%
Specificity = 33/(33+17)=66%
Positive Predictive value = 43/(43+17)=72%
Negative Predictive value= 33/(33+7)=82.5% .

2. LEUKOCYTE ESTERASE

In the culture proven UTI, Leukocyte esterase was positive in 40 cases and negative in 10 cases.

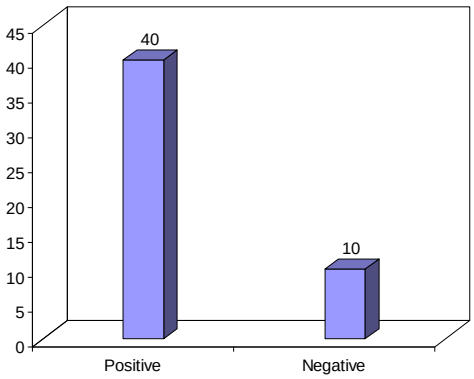

Figure 4

Leukocyte esterase was positive in 5 cases and negative in 45 cases in sterile culture group.

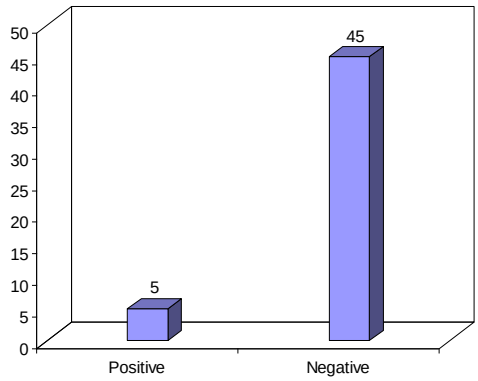

Figure 5

CHI-SQUARE TEST VALUE = 49.49 D.F.=1, P<0.001

The significant p-value confirms that the presence of Leukocyte Esterase was higher in the culture positive group as compared to the sterile culture group.

Sensitivity, Specificity, Negative Predictive Value and Positive Predictive Value

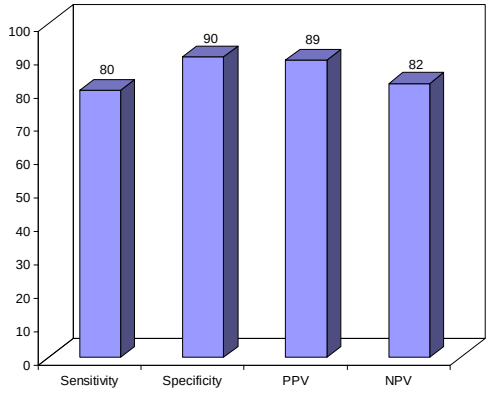

Figure 6

Table 7

Leukocyte Esterase	Culture		Total
	Positive	Negative	
Positive	40	5	
Negative	10	45	
Total	50	50	100

Sensitivity = 40/(40+10)=80%
Specificity = 45/(45+5)=90%
Positive Predictive value = 40/(40+5)=89%
Negative Predictive value= 45/(45+10)=82%

3. NITRITES

Among the culture proven UTI cases, nitrites were positive in 17 cases and negative in 33 cases.

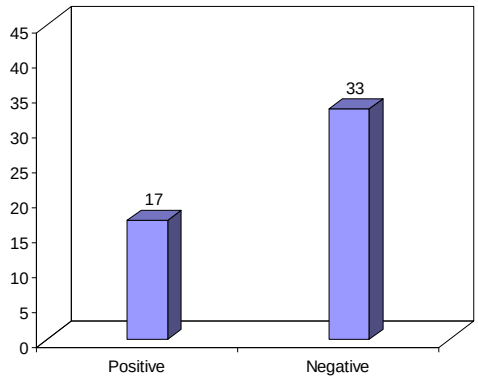

Figure 7

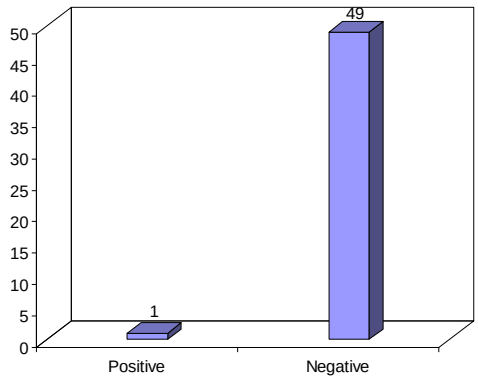

Figure 8

CHI-SQUARE TEST VALUE = 17.34 D.F.=1, P<0.001

The significant p-value infers that presence of nitrites has been higher among urine culture positive children compared to urine culture negative children.

Sensitivity, Specificity, Negative Predictive Value and Positive Predictive Value

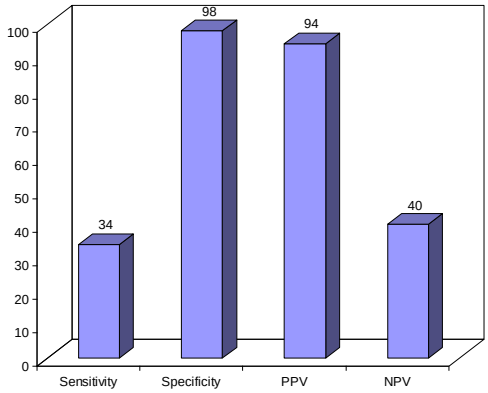

Figure 9

Table 8

Nitrites	Culture		Total
	Positive	Negative	
Positive	17	1	
Negative	33	49	
Total	50	50	100

Sensitivity = 17/(17+33)=34%

Specificity = 49/(49+1)=98%
Positive Predictive value = 17/(17+1)=94%
Negative Predictive value= 33/(33+49)=40%

4. PYURIA

Among the culture prove UTI cases, pyuria was positive in 37 cases and negative 13 cases.

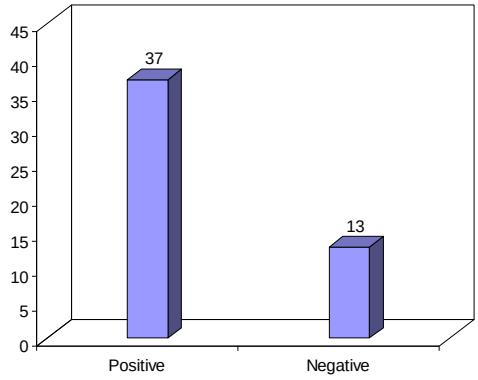

Figure 10

Among the sterile culture group, pyuria was positive in 3 and negative in 47 cases.

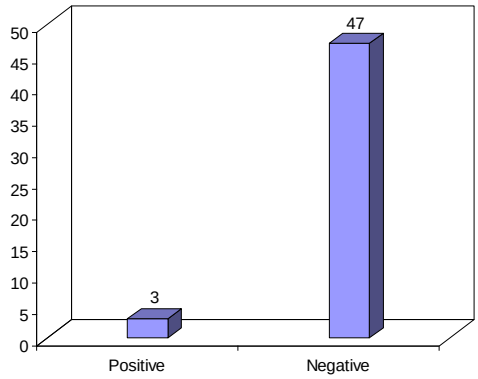

Figure 11

CHI-SQUARE TEST VALUE = 48.17 D.F.=1, P<0.001

Chi-square test was applied to look at pyuria in both culture positive and sterile culture group. P value suggest that pyuria was significantly higher in the culture positive group when compared to the sterile group.

Sensitivity, Specificity, Negative Predictive Value and Positive Predictive Value

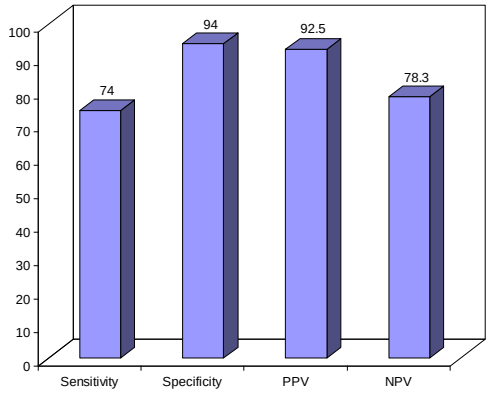

Figure 12

Table 9

Pyuria	Culture		Total
	Positive	Negative	
Positive	37	3	
Negative	13	47	
Total	50	50	100

Sensitivity = 37/(13+37)=74%
Specificity = 47/(47+3)=94%
Positive Predictive value = 37/(37+3)=92.5%
Negative Predictive value= 47/(47+13)=78.3%

5. BACTERIURIA

Among the culture proven UTI cases, bacteruria was present in 32 cases and absent in 18 cases.

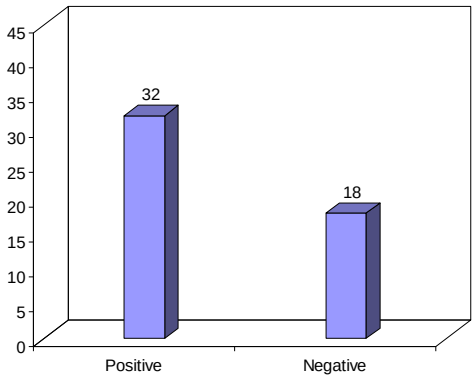

Figure 13

Among the sterile culture group, Bacteriuria was present in 2 cases and absent in 48 cases.

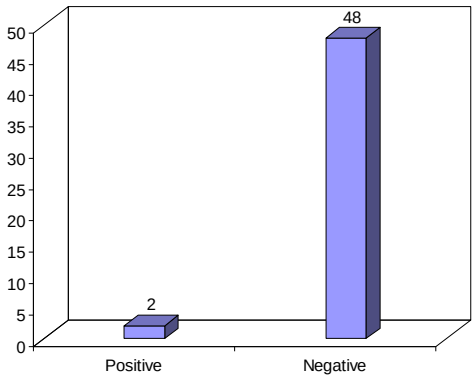

Figure 14

Table 10

Bacteriuria	Culture		Total
	Positive	Negative	
Positive	32	2	
Negative	18	48	
Total	50	50	100

Sensitivity = 32/(18+32)=64%
Specificity = 48/(48+2)=96%
Positive Predictive value = 32/(32+2)=94%
Negative Predictive value= 48/(48+18)=73%

CHI-SQUARE TEST VALUE = 40.11 D.F.=1, P<0.001

Chi-square analysis was done which showed that the bacteruria in the culture positive group was significantly higher than the culture negative group.

Sensitivity, Specificity, Negative Predictive Value and Positive Predictive Value

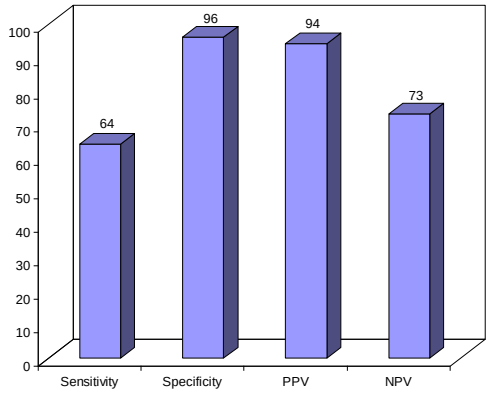

Figure 15

6. HEMATURIA

In the culture positive UTI cases, hematuria was present in 28 cases and absent in 22 cases.

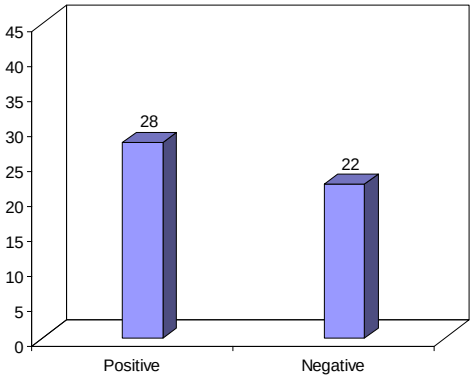

Figure 16

In the sterile group, hematuria was positive in 28 cases and negative in 22 cases.

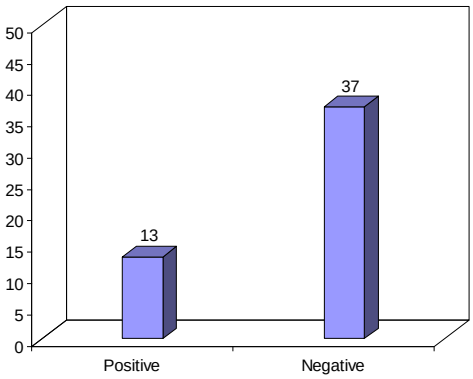

Figure 17:

Chi-square test value = 9.301, d.f=1, p<0.001

Chi-square analysis done showed significantly higher hematuria in culture positive UTI as compared to the sterile culture group.

Sensitivity, Specificity, Negative Predictive Value and Positive Predictive Value

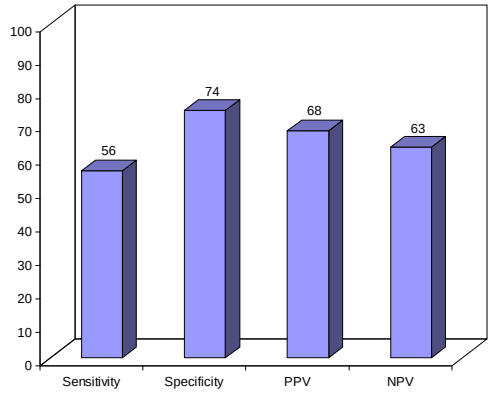

Figure 18

Table 11

Hematuria	*Culture*		*Total*
	Positive	*Negative*	
Positive	28	13	
Negative	22	37	
Total	50	50	100

Sensitivity = 28/(28+22)=56%
Specificity = 37/(37+13)=74%
Positive Predictive value = 28/(28+13)=68%
Negative Predictive value= 37/(37+22)=63%

ALBUMIN

In culture positive UTI cases, albumin was positive in 16 cases and negative in 34 cases.

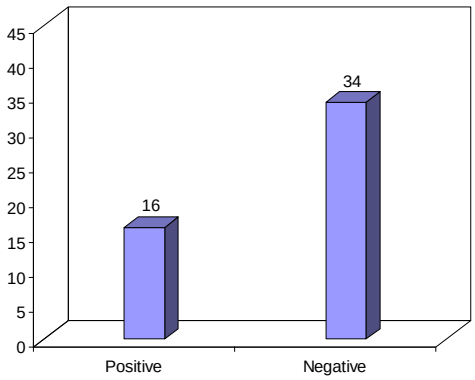

Figure 19

Albumin was positive in 7 cases and negative in 43 cases in sterile group.

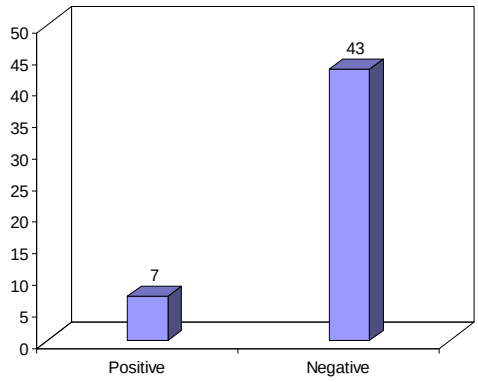

Figure 20

Chi-square test value = 4.574, d.f=1, p<0.001

Chi-square analysis showed that albuminuria was significantly higher in the culture positive group as compared to the sterile group.

Sensitivity, Specificity, Negative Predictive Value and Positive Predictive Value

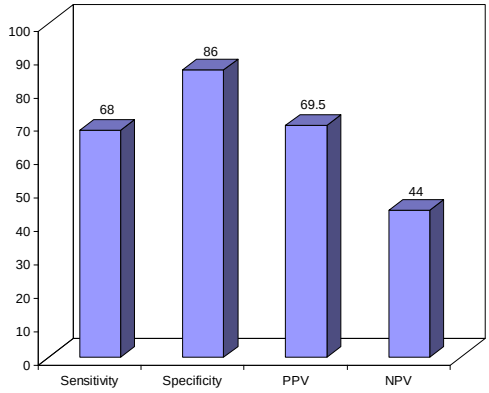

Figure 21

Table 12

Albumin	*Culture*		*Total*
	Positive	*Negative*	
Positive	16	7	
Negative	34	43	
Total	50	50	100

Sensitivity = 34/(34+16)=68%
Specificity = 43/(43+7)=86%
Positive Predictive value = 16/(16+7)=69.5%
Negative Predictive value= 34/(34+43)=44%

8. Data Analysis and Discussion

In the present study, sensitivity, specificity, negative and positive predictive values for leucocyte esterase, pyuria, hematuria, bacteriuria, nitrites and albuminuria were analyzed by comparing the test results with the gold standard norms (culture proven UTI cases and sterile culture cases).

This was done by identifying the true negative, true positive, false positive and false negative values for each variable and substituting it by the standard formula. Each parameter was compared in both the groups to see if these parameters were significantly higher in the culture proven UTI group as compared to the sterile culture group. Further combination of parameters were compared to find out the maximum sensitivity and specificity. Chi-square was computed. Graphical illustrations were also done.

Urine analysis (at least 1 parameter present) had a sensitivity of 86%.This was consistent with other studies. Lohr et al found sensitivity of urine analysis dipstick and microscopy to be 83% in children aged 1 month -16 yrs (35) Richard Bacher et al found sensitivity of urine analysis to be 82 % in children (21) Shaw et al reported sensitivity of combined urine dipstick and microscopy to be 83%(7).

It was observed that Leucocyte esterase had a sensitivity of 80% i.e among those who had the infection leucocyte esterase rightly detected UTI in 80%.Specificity was observed to be 90% i.e. leucocyte esterase had the ability to rightly rule out UTI in 90% of children. Positive predictive value was 89%, i.e. if the test was reported as positive, the likely chances that the patient has the infection was 89%.Negative Predictive value was 82% i.e. if a child was tested as negative the probability that the child does not have the infection was 82%.Sensitivity was consistent with studies by Gold smith et al(36), Perry et al (38), Muna et al(39) and Adeleke et al(40) where the leukocyte sensitivity ranged from 75-85% and specificity ranged from 85-95%. The study findings also were Consistent with the AAP norms.

It was observed that Nitrites had a senitivity of 34 %.i.e. nitrites had had a specificity of 98% i.e. it has the ability to rule out UTI in 98% cases. The positive predictive was observed to be 97% i.e. the chances that child has an actual urinary infection was 97% when tested positive. The negative predictive value was the ability of the test to rule out UTI when tested was 40% which was low.

Walter LJM et al(43), in his study stated that nitrites had a low sensitivity(45-60%) and a higher specificities (85-98%). Gabrielle J Williams et al(44), in his study observed the sensitivity and specificity of nitrites to range from 41-57% and 96-98% respectively. Standard norms laid by AAP for the sensitivity and specificity of nitrites ranged from 15-82% and 90-100% respectively which was on par with our study findings. Although specificity of nitrites in our study were consistent with the other studies, the expected sensitivity was a little low as compared to other studies. Thayyil et al found a sensitivity of 34.4% and specificity of 90.7% in a retrospective study.(4l) Positive predictive value were observed to be 29.8% and negative predictive value was found to be 92.4% by Thayyil et al.(41) Similar results were reported in a study by Lejeune et al where a sensitivity was 16.2% and specificity was 97.6%(42). Muna et al(39) reported a sensitivity of 27.3% and a specificity of 100%. Although specificity of nitrites in our study were consistent with the other studies, the expected sensitivity was either in the lower limit compared to other studies. This could be explained by the varied sample sizes used in different studies.

The sensitivity of pyuria to rightly diagnose UTI was observed to be 74% and specificity was 94% i.e. the ability

of the parameter to rightly ruling out UTI was found to be 94%. PPV i.e. when tested positive, the likely chances that the patient has UTI was 92.5%. NPV i.e. whentested negative the likely chances the patient doesn't have UTI was 76.1%.

The sensitivity and specificity norms laid by AAP for pyuria were 73 % and 45-98%. Findings were consistent with study by Hoberman et al where sensitivity and specificity for pyuria were 54 and 96% respectively. Although specificity was in par with studies done by Matthai J et al(4), Goldsmith et al(36) and Lohr et al(35), the expected sensitivity were above 80% which can be exp1ained by the large sample size adopted in the study.

The sensitivity of bacteria to rightly diagnose UTI was observed to be 64% and specificity was observed to be 96% i.e. the likely chances in ruling out UTI is 96%. PPV was observed to be 94% and NPV was observed to be 73% i.e. the chances of patient not having infection when tested negative was 73% and chances of patient having infection when tested positive was 94%.

Studies by Lohr et al(35), Hoberman et al(37) and Matthai J et(4) al had a higher sensitivity when compared to this study due to the larger sample size. Specificity, positive and negative predictive values were either consistent or higher when compared to these studies.

The sensitivity, specificity and predictive values of hematuria and albumin as single parameters were not significant. The combination of leukocyte esterase with pyuria and nitrites had the maximum sensitivity in this study.

These findings were consistent with studies by Frederick et al where combination of leukocyte esterase and nitrite or pyuria showed sensitivity and specificity of 86% and 8O% respectively. Nayak et al(5) in his study concluded that the sensitivity of leukocyte esterase and/ nitrites and/or pyuria were 75%. The drawbacks of this study were relatively small sample size and lack of standardization of urine collection due to practical difficulties.

9. Conclusion

1) In predicting urinary tract infection, Nitrites and bacteriuria has a positive predictive value of 93.1% and a combined specificity of 95%.
2) In predicting urinary tract infection, Leukocyte esterase and nitrites combined sensitivity of 82% and negative predictive value of 83%.
3) In predicting urinary tract infection, Leukocyte esterase and pyuria has a combined sensitivity of 82%.
4) Hematuria and albuminuria, as single pararmeters has poor sensitivity, specificity and predictive values.

10. Future Scope

From this study, we suggest that a combination of leukocyte esterase and nitrite or pyuria are reliable parameters in predicting urinary tract infection in children. This will help in early diagnosis and help bring down health care costs in developing nations.

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Author Profile

DR. J. Manoj Sankar completed his MBBS in 2012 under Tamil Nadu Dr.MGR medical university and is undergoing postgraduate training in Rajah Muthiah Medical College and Hospitals, Tamil Nadu India.