Original Article

Association Between Urine pH and Urinary Tract Infection in Children - A Hospital Based Cross Sectional Study

Antony J*, Ashvind L**, Edinbrow***, Sujatha Sridharan****, Suresh P*****, Umadevi L******

*Associate Professor, **Assistant professor, ***Postgraduate, ****Professor, Department of Paediatrics, Chettinad Hospital & Research Institute, Chennai, India.

Dr. J. Antony presently working as Associate Professor, Department of Paediatrics, obtained his M.B.B.S degree from the Rajah Muthiah Medical College, Annamalai University, Chidambaram, Tamilnadu in 2005 and his M.D Degree in Paediatrics from Sri Ramachandra Medical College and Research Institute, Chennai, Tamilnadu in 2009. He joined the present institution as Assistant Professor in 2009 and his area of interest is Allergy and Asthma in Paediatrics and is currently running the Asthma and Allergy clinic in the Department.

Corresponding author - Dr. Antony. J (antonjenifer@gmail.com)

Abstract

Objective: To assess the association between urinary pH and urinary tract infection (UTI), in children presenting with fever and symptoms of UTI.

Materials & Methods: Hospital based Cross sectional study was done. All children ≤ 18 yrs of age, admitted with fever and suspected urinary tract infection between September 2015 to February 2016 were included in the study with a sample size of 107 cases.

Results: The epidemiological indices - sensitivity, specificity and predictive values of the rapid screening tests (urine dipstick test) were calculated individually for urine pH and compared with a positive urine culture as the validating standard. Association between urine pH and UTI were analysed with Chi-Square test and Odds ratio. A ROC (Receiver operating characteristic) curve is plotted to illustrate the sensitivity and specificity.

Conclusions: Acidic urine pH can be taken as a good predictor of UTI in children presenting with fever and UTI symptoms with high sensitivity and specificity.

Key Words: UTI, urinary PH, urine analysis.

Introduction

Urinary tract infection (UTI) is one of the most common infections in children. It occurs in 3-10% of girls and 1-3% of boys[1]. Children are either asymptomatic or present with atypical signs and symptoms. The diagnosis and management of urinary tract infection (UTI) in young children is clinically challenging. The various tests used for the diagnosis of UTI are urine analysis, urine dipstick, esterase and urine culture. Urine culture is considered as gold standard for the diagnosis of UTI. Many studies have proved that there is a strong association between urine pH and UTI both in adults and children[2]. Urinary pH has a strong therapeutic implication in the treatment of UTI[3]. Alkalinization of urine is done as a treatment for UTI. The need for the study is that there are very few studies on Indian children and this study will have very strong diagnostic and therapeutic implication.

Aim:

To assess the association between urinary pH and urinary tract infection, in children presenting with febrile illness and symptoms of UTI.

Materials & Methods:

This is a hospital based cross sectional study with a sample size of 107 cases. This study was conducted in paediatric OPD, at Chettinad hospital and research institute, Chennai.

Study period: Over a 6 month period, between September 2015 to February 2016.

Inclusion criteria:

All children aged less than 18yrs admitted with fever and complaints suggestive of urinary tract infection were included in the study.

Exclusion criteria:

Children with concurrent infections, those on diuretics and those catheterized were excluded from the study.

A clean–catch midstream urine specimen, from these children was subjected to the standard urine analysis along with urine culture. As per routine clinical practice, the urine specimens were sent to the hospital lab in sterile containers. Urine pH was assessed using Uro-dip reagent strips (Urodip10A). Institutional ethical committee clearance was obtained. Descriptive analysis of demographic and clinical parameters were compiled into frequency and percentages. Association between urine pH and UTI were analysed by chi square test and odds ratio. A ROC (Receiver operating characteristic) curve was plotted to illustrate the sensitivity and specificity. The epidemiological indices - sensitivity, specificity and predictive values of the rapid screening tests (urine dipstick test) were calculated individually for urine PH and compared with a positive urine culture as the validating standard. The statistical analysis were made by IBM SPSS version 21.

Results:

A total of 107 children admitted to the hospital with suspected UTI were enrolled in the study, out of which 37 children were diagnosed to have UTI. Among them 17 were males and 20 were females. Among children with UTI 17 were males and 20 were females. Among children with UTI 27 % of the children were in <1 year age group, 45% in 1-5 year age group, 18 % in a 6-10 year age group and the remaining 10 % in 10 – 18 year age group as shown in **Fig 1**. The symptoms with which the children presented to the department are shown in **Fig 2.** Among 37 children with UTI, the commonest organism grown in urine culture is E coli (N=27, 72.9 %) followed by Proteus (N= 7, 19 %) and Enterococci (N=3, 8.1%) as shown in **Table 1**. The association between urine pH and suspected UTI (N=107) were analyzed. In urine culture positive children (N = 37) 77.8% of cases had acidic urine (N= 28) and 12.7 % of cases with neutral urine (N= 9). Among the children who did not have UTI, 22.2% of cases had acidic urine (N = 8) and 87.3% of cases had neutral urine (N= 62). The Chi-Square value was 44.754 and Odds ratio was 24.111 with p value <0.001 as shown in **Table 2.** The association between urine mean pH and suspected UTI (N=107) were analyzed, the mean urine pH was 6.10 in children with UTI (N=37) and 6.70 in children without UTI (N=70) with p value <0.001 as shown in **Table 3**. A ROC (Receiver operating characteristic) curve is plotted which illustrated 88.6% sensitivity and 75.7% specificity as shown in **Fig 3**.
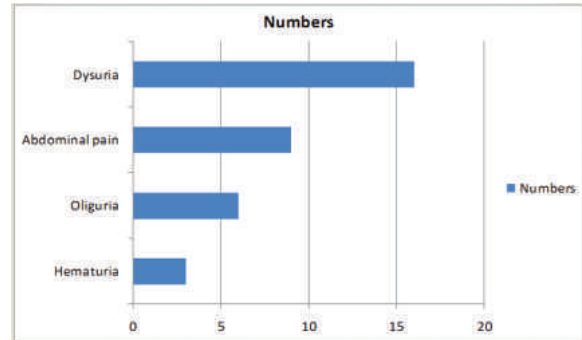

Fig 2 - Common presentation of UTI
Common Presentation N=37

Urine Culture	Frequency	Percentage
E coli	27	72.9
Proteus	7	19
Enterococci	3	8.1

Table 1 - Organism isolated in Urine Culture
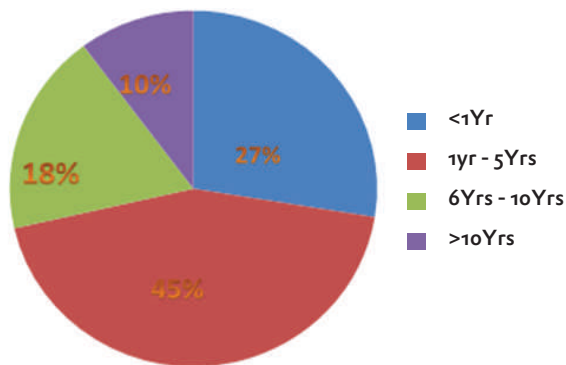Urine Culture And Sensitivity (N=37) - Organism

Fig 1 - Age distribution of UTI cases.
Age Distribution of Study Population (N=37)

Urine PH	Final Diagnosis		Chi Square Value	Odds Ratio	P Value	95% CI Value	
	UTI	Non UTI				Lower	Upper
Acidic	28 77.8%	8 22.2%	44.754	24.111	<0.001	8.423	69.021
Neutral	9 12.7%	62 87.3%					

Table 2 - Association between Urine pH and UTI
Association Between Urine PH and UTI (N=107)

Diagnosis	Mean Urine PH	Mean Difference	P Value	95% CI Value	
				Lower	Upper
UTI (N=37)	6.10	0.591	<0.001	0.44	0.74
NO UTI (N=70)	6.70				

Table 3 - Association between Urine pH and UTI
Association between Urine mean pH and UTI (N=107)

Fig 3 - ROC Analysis

Area under the curve: 0.858 (0.78 to 0.93)
P Value <.001

The proposed cut-off pH:6.25
Sensitivity: 88.6%
Specificity: 75.7%

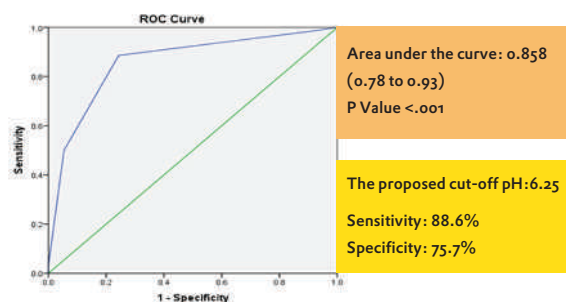## Discussion:

UTI should be suspected in infants or children presenting with unexplained fever beyond three days[4-6]. In the study group of 107 febrile children 37 had culture proven UTI and 70 were culture negative. Studies by Whiting P, Westwood M et al showed that the incidence of UTI are common in female children aged less than 5years[7]. This study shows incidence of UTI is more common in females (54%) than males(45%). This study shows that 1 to 5 years being the predominant age group with UTI (55%). In this study, the commonest presentation was dysuria (43.2%, N=16) associated with fever. A study by Klinth JE et al has demonstrated that urinary pH plays a strong role in adhesion of *E.coli* to urinary tract epithelium[8]. In this study of 37 culture proven UTI, the commonest organism was found to be *E.coli*(72.9%).Studies by Mookerjee BK et al, Erdogan-Yildirim Z et al and Roasio N et al have demonstrated strong association between urine pH and UTI[11-9]. Among the N=37 culture proven UTI, 77.8%(N=28) were acidic pH with 12.7%(N=9) neutral pH. Among the N=70 non UTI,22.2%(N=8) were acidic and 87.3%(N=62) were of neutral pH. Antibiotic therapy of Amikacin or a third generation cephalosporin (cefotaxime or ceftriaxone) was given[12].Once the child showed clinical improvement, with resolution of fever and toxicity, antibiotics were administered orally based on the culture sensitivity. The current study reveals very high area under ROC curve (0.858, 95% CI 0.78 to 0.93) indicating that urine pH can be a good predictor of UTI.

Conclusion:

Acidic urine pH can be taken as a good predictor of UTI in children presenting with febrile illness with high sensitivity and specificity. Commonest organism in UTI in children being *Eschericia coli*.

References

1) Wei C, Yu I, Lin H. Occurrence of infection among children with nephrotic syndrome during hospitalisation. Nephrology. 2012;17(8):681-88.

2) Conway PH, Cnaan A, ZaoupisT, Henry BV, Grundmeier RW, Keren R. Recurrent Urinary tract infections in children: risk factors and association with prophylactic antimicrobials. JAMA. 2007;298(2):179-86.

3) Nicolle LE, Strausbaugh LJ, Garibaldi RA. Infections and antibiotic resistance in nursing homes. Clin Microbial Rev. 1996;9:1-17

4) Roberts KB. Urinary tract infection: clinical practice guideline for the diagnosis and management of the initial UTI in febrile infants and children 2 to 24 months. Pediatrics. 2011;128(3):595-610.

5) Finnell SM, Carroll AE, Downs SM. Technical report-Diagnosis and management of an initial UTI in febrile infants and young children. Pediatrics.2011;128(3):e749-70.

6) Mori R, Yonemoto N, Fitzgerald A, Tullus K, Verrier-Jones K, Lakhanpaul M. Diagnostic performance of urine dipstick testing in children with suspected UTI: a systematic review of relationship with age and comparison with microscopy.Actapaediatrica(Oslo, Norway: 1992). 2010;99(4):581-4.

7) Whiting P, Westwood M, Watt I, Cooper J, Kleijnen J. Rapid tests and urine sampling techniques for the diagnosis of urinary tract infection (UTI) in children under five years: a systematic review. BMCpediatrics. 2005;5(1):4.

8) Klinth JE, Castelain M, Uhlin BE, Axner O. The influence of pH on the specific adhesion of piliatedEscherichia coli. PloS one. 2012;7(6):e38548.

9) Mookerjee BK, Allen AC, Dossetor JB. Validity of net renal hydrogen ion excretion in the presence of urinary tract infection. The Journal of laboratory and clinical medicine. 1968;71(4):582-85

10) Erdogan-Yildirim Z, Burian A, Manafi M, Zeitlinger M. Impact of pH on bacterial growth and activity of recent fluoroquinolones in pooled urine. Research in microbiology. 2011;162(3):249-52.

11) Roasio N. Influence of changes in ph in diseases of the urinary tract.Beneficial results obtained with an acidifying drug with a base of phosphoric-ethylic esters. Minerva urologica. 1963;15:159-66.

12) Revised Statement on Management of Urinary Tract Infections. Indian society of pediatric nephrology. Correspondence to:
Dr M Vijayakumar,
Department of Pediatric Nephrology,
Mehta Children's Hospitals, 2012;7(6):e38548.