Urinary Tract Infections in Infants: Etiology and Associated Urological Anomalies

Deena Mohammed, MBBS, CABP, MSc* Hasan Mohamed Ali Isa, MBBCh, CABP** Ayat Abdul Nasser, MD***

Background: Urinary tract infection (UTI) is common in infants; it might be associated with underlying renal anomalies. Early detection and treatment are important to prevent morbidities and improve patients' outcomes.

Objective: To evaluate the most common underlying organisms and the associated urological anomalies in infants with UTIs.

Design: A Retrospective Study.

Setting: Pediatrics Department, Salmaniya Medical Complex, Bahrain.

Methods: All medical records of infants below one year of age with confirmed UTI admitted between June 2015 and June 2017 were reviewed.

Results: One hundred twenty-five infants with UTI were included in the study, 85 (68%) were males. Median age was 29 days (range 2 to 329). Fever, 74 (59.2%), and neonatal jaundice, 46 (33.6%), were the most common clinical presentation. The most common pathogens were Escherichia coli in 69 (55.2%) followed by Klebsiella pneumonia in 44 (35.2%) patients. Extended-spectrum beta-lactamase organisms were found in 44 (35.2%) patients. Recurrent UTI were documented in 15 (12%) patients. Eighty-three (66.4%) patients had renal ultrasound; 29 (23.2%) had urological anomalies. Hydronephrosis was found in 19 (15.2%) patients; 11 (8.8%) had bilateral hydronephrosis and seven (5.6%) had unilateral hydronephrosis. Vesicoureteric reflux (VUR) was seen in 15 (12%) patients; 10 (8%) had bilateral VUR.

Conclusions: Escherichia coli remain the most common causative organism for UTIs in infants. Approximately one-third of infants with UTIs had urological anomalies. .

Bahrain Med Bull 2019; 41(1): 25 - 28

Urinary tract infection (UTI) is common in children and it has a high incidence in infants[1-4]. If the infantile UTI is associated with fever, there could be underlying renal anomalies[1]. Infants have a high probability of developing severe UTI involving the upper tracts and subsequently renal scarring and chronic kidney disease[2,4]. Investigating infants with UTI is a common practice among clinicians[5]. Early detection and treatment are of great significance to prevent morbidities and improve patients' outcome.

Many studies have been published from neighboring countries and worldwide regarding the causative organisms and the prevalence of renal anomalies among infants admitted with UTI[1-3,6-11]. To the best of our knowledge, no study in this regard has been published from Bahrain.

The aim of this study is to evaluate the most common underlying organisms and to identify the associated urological anomalies in infants with UTI.

METHOD

All infants with UTIs admitted between June 2015 and June 2017 were included in the study. Electronic files of infants from birth to one year of age who had the diagnosis of UTI were reviewed. Data documented: age, gender, nationality, birth weight, clinical presentation, the method of urine collection (suprapubic aspiration or catheterization) and laboratory results. Only urine samples which were obtained by a transurethral bladder catheterization or suprapubic aspiration were included in the analysis. We excluded urine samples collected by the bag or showed mixed organisms which indicate contaminations. UTI was defined as "the presence of 10,000 to 50,000 colony-forming units (CFU) per mL"[12]. Results of all renal radiological imaging including ultrasound, micturating cystourethrogram (MCUG) or nuclear scans were reviewed.

SPSS version 21 was used for statistical analysis. Frequencies and percentages of all categorical variables were calculated.

* Consultant Pediatric Nephrologist
Pediatric Department
Salmaniya Medical Complex
** Assistant professor, Arabian Gulf University
Pediatric Gastroenterology Consultant, Pediatric Department
*** Intern
Salmaniya Medical Complex
Kingdom of Bahrain
E-mail: dr.deena@hotmail.com

Continuous variables were checked for normal distribution. Continuous variables were presented as mean and standard deviation for normally distributed variables or as median and range for non-normally distributed variables.

RESULT

One hundred twenty-five infants were admitted with UTIs. Personal characteristics and clinical data of infants are shown in Table 1. Eighty-five (68%) infants were males and forty (32%) were females. Median age at presentation was 30 days (2-329 days). Fever was the most common clinical presentation seen in seventy-four (59.2%) patients, followed by neonatal jaundice in forty-six (36.8%). The most commonly identified pathogen was Escherichia Coli (E. coli) 69 (55.2%) followed by 44 (35.2%) Klebsiella pneumonia. E. coli organisms and Klebsiella pneumonia organisms were extended-spectrum beta-lactamase (ESBL)-producing, see table 2.

Recurrent UTI was documented in 15 (12%) patients. Hydronephrosis was the most common urological abnormality which was found in 19 (15.2%). Vesicoureteric reflux (VUR) was seen in 15 (12%) patients. Secondary VUR was seen in five (4%) patients. Among those with secondary VUR, posterior urethral valve (PUV) was involved in four (3.2%) and neurogenic bladder was causal factor in one (0.8%) patient, see table 3.

Table 1: Clinical Characteristics of 125 Infants Presented with Urinary Tract Infection

Clinical characteristics	N	%
Nationality		
Bahraini	102	81.6
Other	23	18.4
Total	**125**	
Gender		
Male	85	68
Female	40	32
Total	**125**	
Age at presentation, days, median (range)	30 (2-1723)	-
Clinical presentation		
Fever	74	59.2
Jaundice	46	36.8
Poor feeding	10	8.0
Vomiting	10	8.0
Irritability	10	8.0
Hypoactivity	9	7.2
Smelly urine	8	6.4
Abdominal pain	4	3.2
Constipation	3	2.4
Reason for admission		
To rule out sepsis	52	41.6
Neonatal jaundice	42	33.6
To rule out UTIÎ	22	17.6
Fever	6	4.8
ALTE†	1	0.8
Abdominal distension	1	0.8
For duplex ultrasound kidney	1	0.8
Recurrent UTIÎ	15	12

ÎUTI: urinary tract infection
†ALTE: apparent life-threatening event

Table 2: Urine Microscopy and Urine Culture

Investigation	Number of Patients	%
Urine microscopy		
Pyuria	32	25.6
Microscopic hematuria	11	8.8
Nitrate	7	5.6
Leucocyte esterase	36	28.8
Hemoglobinuria	39	31.2
Missing data	7	5.6
Total number of urine microscopy	**118**	**94.4**
Urine culture		
Escherichia Coli (ESBL*)	69	55.2
Klebsiella (ESBL*)	44	35.2
Enterococcus	8	6.4
Pseudomonas aeruginosa (MDR †)	5	4
Enterobacter	4	3.2
Candida species	2	1.6
Others	8	6.4
Total number of urine cultures†	**140**	**112**

*ESBL: extended-spectrum beta-lactamases

†MDR: multidrug resistant

Stenotrophomonas maltophilia and enterobacter each in two patients; proteus mirabilis, staphylococcus epidermidis, streptococcus agalactiea, serratia species each in one patient.
†fifteen patients had more than one urine culture.

Table 3: Renal Ultrasound and Micturating Cystourethrogram

Radiological findings	Number of Patients	%
Renal Ultrasound		
Normal	54	43.2
Abnormal finding	29	23.2
Hydronephrosis	19	15.2
Bilateral	11	8.8
Left	7	5.6
Right	1	0.8
Altered parenchymal echogenicity	3	2.4
Simple renal cyst	3	2.4
Nephrocalcinosis	1	0.8
Duplex kidney system	2	1.6
Dysplastic kidney	1	0.8
Total ultrasounds done	**83**	**66.4**
MCUG* (40)		
Normal	25	20
†VUR	15	12
†Bilateral VUR	10	8
†Left VUR	3	2.4
Right VUR	2	1.6
MCUG not done	85	68
Total	**125**	**100**

*MCUG: Micturating cystourethrogram
†VUR: vesicoureteral reflux

Table 4: The Causative Organisms and the Associated Urological Anomalies among Infants and Children with UTI in Different Countries

Country	Bahrain §	Saudi Arabia	Iran	Kuwait	India
Author, year	Mohamed et al, 2018	Garout et al, 2015	Ghorashi et al, 2011	Hussain et al, 2015	Kaur et al, 2014
Study period	2015-2017	2013-2014	2003-2008	2011-2012	2011-2013
Age (Y)	≤ 1	≤ 5	0-10	0-12	≤ 1
Total N	125	153	100	149	2017
Male N (%)	85 (68)	85 (55)	21 (21)	79 (53)	144 (70.1)
E. coli N (%)	69 (5)	63 (41.2)	77 (77)	103 (69.1)	79 (45.4)
Klebsiella pneumonia N (%)	44 (32)	30 (19.6)	10 (10)	18 (12.1)	29 (16.7)
Urological anomalies N (%)	29 (35)	53 (34)	34 (34)	17 (12.5)	ND
VUR* N (%)	15 (37.5)	29 (60.4)	14 (33.3)	9 (15)	ND
ESBL† N (%)	44 (32)	ND**	ND	ND	45.1

VUR: Vesicoureteric reflux, †ESBL: extended-spectrum beta-lactamase, §the present study, **ND: not done.

DISCUSSION

The clinical presentations of UTI and pyelonephritis in children are variable depending on the age. Infants usually have non-specific or ambiguous symptoms such as labile temperature, poor feeding, slow weight gain, reduced activity and irritability[8].

Fever was the most common non-specific chief complaint among infants with UTI (59.2%); Ghorashi et al found that 36% of the hospitalized infants and children with UTI had fever as the main presenting chief complaint[13]. However, Hussain et al found that fever was the most reported symptom (93.3%)[14]. In addition, it's not uncommon for the very young children (less than two months) with UTI to be initially admitted with the clinical impression of sepsis or for the workup of prolonged neonatal jaundice[15]. Neonatal jaundice might be the first sign of UTI in infants[15]. In our study, 33.6% of infants with UTI presented with neonatal jaundice.

In this study, male predominance (68%) was found; similarly, Kaur et al reported male predominance (70.1%)[9]. Tse et al from China reported male to female ratio of 2.9:1 in infants less than 6 months of age[5]. However, a meta-analysis by Shaikh et al showed that uncircumcised males less than three months or females less than 12 months of age had the highest baseline prevalence of UTI[1].

In this study, E. coli was the most common pathogen causing UTI in infants accounting for 50% of patients, followed by Klebsiella pneumonia (32%), which was similar to other studies: Garout et al found that E. coli was responsible for 42.9% of the UTIs, followed by Klebsiella pneumonia in 20.2%[3]. Kaur et al found that E. coli was responsible for 45.4% of UTI cases followed by Klebsiella in 16.7%[9]. However, Ghorashi et al and Hussain et al showed higher rate of E. coli infections where 77% and 69.1% were reported, respectively[13,14]. Moreover, Klebsiella pneumonia was reported only in 10% and 12.1% in Ghorashi et al and Hussain et al which is lower than our study[13,14].

This study found a high rate of ESBL-producing organisms, 43.4% of the total E. coli and 31.8% of Klebsiella pneumonia infections; similarly, Kaur et al showed 45.1% of gram-negative bacilli in infants with UTI were ESBL[9]. Rising incidence of ESBL organisms is an emerging problem worldwide and is a major health threat[6]. It could be due to unjustified, widespread and inappropriate use of antibiotics[9]. Cheng et al compared the incidence of ESBL-producing E. coli between urban and rural areas but they found no difference; they attributed their finding to the easy access to healthcare facilities[6]. Recent studies identified different potential risk factors for ESBL-positive UTI including the presence of an underlying renal abnormality, clean intermittent catheterization (CIC) and the previous hospitalization necessitating the use of antibiotics[10,11].

In the present study, only 83 (65%) patients had renal ultrasound while MCUG was performed in 40 (32%) patients. However, over the past years, there has been a lot of controversy in the clinical practice guidelines for the diagnosis of the initial UTIs in children[16-18]. Previous guidelines were aimed for a drastic reduction of the imaging studies in order to reduce radiation exposure as well as health-related costs[16-18]. Nevertheless, internationally, there is no consensus on the optimal radiological investigations after the first febrile UTI[5,16-20].

In this study, the majority of infants with a single UTI did not have any renal anomalies detected by radiological imaging. Yet, 35% of patients had positive renal US findings. Similarly, 90% of infants with single UTI did not have anomalies in another study[3]. Out of 40 patients who underwent MCUG, VUR was detected in 15 patients. A study by Garout et al found that VUR was detected in 60.4% where the MCUG was conducted in 48 (31.3%), which is higher than our finding[3]. Another study found only 15% of VUR in children with UTI[14]. This might be explained by the expansion of their patients' age up to five years and/or the variability in demography and the underlying genetics between Saudi Arabia and other Arab countries[3].

This study had several limitations due to its retrospective nature. The small study population and missing data are the main limitations. We could not identify if males in our study were circumcised before or after the UTI episode. Despite its limitation, this study is the first effort that shed light on the prevalence of anatomical abnormalities identified in infants hospitalized with UTIs from Bahrain.

CONCLUSION

E. coli is the most common causative organism in infants who presented with UTI in Bahrain. A high rate of ESBL-producing organisms is alarming. Approximately one-third of infants with UTI had urological anomalies. Further studies tackling sensitivity patterns and antibiotic coverage are needed.

Author Contribution: All authors share equal effort contribution towards (1) substantial contributions to conception and design, acquisition, analysis and interpretation of data; (2) drafting the article and revising it critically for important intellectual content; and (3) final approval of the manuscript version to be published. Yes.

Potential Conflict of Interest: None.

Competing Interest: None.

Sponsorship: None.

Acceptance Date: 7 January 2019.

Ethical Approval: Approved by the Ethical Medical Committee of Secondary Care, Salmaniya Medical Complex, Bahrain.

REFERENCES

1. Shaikh N, Morone NE, Bost JE, et al. Prevalence of Urinary Tract Infection in Childhood: A Meta-Analysis. Pediatr Infect Dis J 2008; 27(4): 302-308.
2. Nowell L, Moran C, Smith PB, et al. Prevalence of Renal Anomalies after Urinary Tract Infections in Hospitalized Infants Less Than 2 Months of Age. J Perinatol 2010; 30(4):281-5.
3. Garout W, Kurdi H, Shilli A, et al. Urinary Tract Infection in Children Younger Than 5 Years. Etiology and Associated Urological Anomalies. Saudi Med J 2015; 36(4):497-501.
4. Peru H, Bakkaloglu SA, Soylemezoglu O, et al. The Relationship between Urinary Tract Infections and Vesicoureteral Reflux in Turkish Children. Int Urol Nephrol 2009; 41:947-951.
5. Tse NK, Yuen SL, Chiu M, et al. Imaging Studies for First Urinary Tract Infection in Infants Less Than 6 Months Old: Can They Be More Selective? Pediatr Nephrol 2009; 24:1699-1703.
6. Cheng MF, Chen WL, Huang IF, et al. Urinary Tract Infection in Infants caused by Extended-Spectrum Beta-Lactamase-Producing Escherichia coli: Comparison between Urban and Rural Hospitals. Pediatr Nephrol 2016; 31: 1305-1312.
7. Swerkersson S, Jodal U, Ahren C, et al. Urinary Tract Infection in Infants: The Significance of Low Bacterial Count. Pediatr Nephrol 2016; 31(2):239-45.
8. Morello W, Scola C, Alberici I, et al. Acute Pyelonephritis in Children. Educational Review. Pediatr Nephrol 2016; 31:1253–1265.
9. Kaur N, Sharma S, Malhotra S, et al. Urinary Tract Infection: Etiology and Antimicrobial Resistance Pattern in Infants from a Tertiary Care Hospital in Northern India. J Clin Diagn Res. 2014; 8(10): DC01-DC03.
10. Uyar Aksu N, Ekinci Z, Dündar D, et al. Childhood Urinary Tract Infection Caused by Extended-Spectrum β-Lactamase-Producing Bacteria: Risk Factors and Empiric Therapy. Pediatr Int. 2017; 59(2):176-180.
11. Kim YH, Yang EM, Kim CJ. Urinary Tract Infection Caused by Community-Acquired Extended-Spectrum β-Lactamase-Producing Bacteria in Infants. J Pediatr (Rio J) 2017; 93(3):260-266.
12. Roberts KB, Downs SM, Finnell SM, et al. Urinary Tract Infection: Clinical Practice Guideline for Diagnosis and Management of the Initial UTI in Febrile Infants and Children 2 to 24 Months. Pediatrics 2011; 128(3):595-610.
13. Ghorashi Z, Ghorashi S, Soltani-Ahari H, et al. Demographic Features and Antibiotic Resistance among Children Hospitalized for Urinary Tract Infection in Northwest Iran. Infect Drug Resist 2011; 4:171-176.
14. Husain E, Al-Saleem T, Marwan Y, et al. Management of Pediatric Urinary Tract Infections in Kuwait, Current Practices and Practicality of New Guidelines. Kuwait Med J 2015; 47(1): 139-143.
15. Omar C, Hamza S, Bassem AM, et al. Urinary Tract Infection and Indirect Hyperbilirubinemia in Newborns. N Am J Med Sci 2011; 3(12): 544-547.
16. Mori R, Lakhanpaul M, Verrier-Jones K. Diagnosis and Management of Urinary Tract Infection in Children: Summary of NICE Guidance. BMJ 2007; 335(7616):395-7.
17. Kari JA, Tullus K. Controversy in Urinary Tract Infection Management in Children: A Review of New Data and Subsequent Changes in Guidelines. J Trop Pediatr 2013; 59(6):465-9.
18. Montini G, Zucchetta P, Tomasi L, et al. Value of Imaging Studies after a First Febrile Urinary Tract Infection in Young Children: Data from Italian Renal Infection Study. Pediatrics 2009; 123(2):e239-46.
19. Tombesia M, Alconcherb L, Lucarellib L, et al. Algorithms Imaging Tests Comparison following the First Febrile Urinary Tract Infection in Children. Arch Argent Pediatr 2017; 115(4):370-373.
20. Wiswell TE, Miller GM, Gelston HM Jr, et al. Effect of Circumcision Status on Periurethral Bacterial Flora during the First Year of Life. J Pediatr 1988; 113:442–6.