Original Article

Clinical Characteristics of Febrile Urinary Tract Infection and Application of Thai Guideline Imaging Recommendations Compared between Children Aged 2 Months to 2 Years and Children Aged 2 to 5 Years

Darin Siripiriyakul MD[1], Kraisoon Lomjansook MD[1], Anirut Pattaragarn MD[1], Nuntawan Piyaphanee MD[1]

[1] Division of Nephrology, Department of Pediatrics, Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok, Thailand

Background: In 2014, the Thai Pediatric Nephrology Association (TPNA) launched a guideline for febrile urinary tract infection (UTI) in children aged two months to five years. Renal and bladder ultrasound (RBUS) is recommended for first febrile UTI, and voiding cystourethrography (VCUG) is recommended in patients with at least one of eight proposed risk factors.

Objective: To compare characteristics of febrile urinary tract infection (UTI), compliance with the imaging study recommendation regarding to the TPNA guide, and kidney, ureter, and bladder (KUB) abnormality detections between children aged two months to two years and older than two years to five years.

Materials and Methods: The present study was a retrospective study, reviewed children aged two months to five years presenting with first or recurrent episode of febrile UTI between 2014 and 2019 at Siriraj Hospital. Clinical parameters during febrile UTI, indications to perform VCUG, and kidney, ureter, and bladder (KUB) abnormality detections were compared between the younger group and the older group. RBUS and VCUG undergone according to the recommendation were accounted for the compliance.

Results: The mean age of 259 younger and of 51 older age children was 8.2±5.6 and 40.0±10.9 months, respectively. Female gender (p=0.01), complaint of constipation (p=0.03), abnormal bladder emptying (p<0.01), and renal impairment (p=0.03) were more frequent in the older than the younger. Overall imaging study compliance was 73.9% and the KUB abnormality detection was 16.5%. High-grade vesicoureteral reflux (VUR) was more common than low-grade VUR. The rates of compliance (p=0.45) and KUB abnormality detections (p=0.54) between the younger and older children were not different.

Conclusion: Female gender, and bladder and bowel dysfunction were associated to febrile UTI in older children. The TPNA febrile UTI guideline imaging recommendation was shown to be applicable in both younger and older children.

Keywords: Clinical characteristics; Febrile urinary tract infection; Thai guideline imaging recommendations; Renal and bladder ultrasound; Voiding cystourethrography

Received 15 September 2021 | Revised 9 November 2021 | Accepted 15 November 2021

J Med Assoc Thai 2021;104(12):1977-83

Website: http://www.jmatonline.com

Febrile urinary tract infection (UTI) is a common infection in young children significantly associated with congenital abnormalities of kidney and urinary tract (CAKUT)[1-3], especially vesicoureteral reflux (VUR). Renal and bladder ultrasound (RBUS) has low sensitivity, but high specificity for abnormal finding on VCUG[4,5]. Published guidelines for febrile UTI in infants and young children are from high-income countries, and most included children aged up to two to three years. RBUS is recommended for all febrile UTI, and voiding cystourethrography (VCUG) is recommended in the patients who had recurrent UTI, abnormal RBUS, or other atypical features[6-9]. With shortcomings in antenatal care or prenatal ultrasonography[10,11] including underdiagnosis of UTI in the rural areas, the guidelines may be different in low- and middle-income countries compared to those published in high-income countries.

In 2014, the Thai Pediatric Nephrology Association (TPNA) launched a guideline for febrile UTI in Thai children aged two months to five years[12]. The guideline includes the diagnosis of febrile UTI,

Correspondence to:

Piyaphanee N.

Division of Nephrology, Department of Pediatrics, Faculty of Medicine Siriraj Hospital, Mahidol University, 2 Wanglang Road, Bangkoknoi, Bangkok 10700, Thailand.

Phone: +66-2-4195660, **Fax**: +66-2-4195960

Email: nuntawan.piy@mahidol.edu

How to cite this article:

Siripiriyakul D, Lomjansook K, Pattaragarn A, Piyaphanee N. Clinical Characteristics of Febrile Urinary Tract Infection and Application of Thai Guideline Imaging Recommendations Compared between Children Aged 2 Months to 2 Years and Children Aged 2 to 5 Years. J Med Assoc Thai 2021;104:1977-83.

doi.org/10.35755/jmedassocthai.2021.12.13196

treatment, imaging study, antibiotic prophylaxis, evaluation of bladder and bowel dysfunction (BBD), and indication for referral to a specialist. To detect kidney, ureter, and bladder (KUB) abnormality, RBUS is recommended as the first-line imaging study, and VCUG is recommended if the patient had one or more of eight proposed risk factors, including recurrent UTI, abnormal RBUS, identified pathogen(s) other than *Escherichia coli* (*E. coli*), abnormal bladder emptying, UTI with septicemia, renal impairment, first-degree relative of VUR, and suspicion of family non-compliance. If VCUG was indicated, antibiotic prophylaxis would be offered until VCUG could be performed.

The aim of the present study was to investigate the clinical characteristics of febrile UTI, the compliance with TPNA guideline imaging study recommendations and KUB abnormality detections compared between children aged two months to two years and children aged two to five years.

Materials and Methods

The authors conducted a retrospective study in children aged two months to two years and children aged two to five years who were diagnosed with febrile UTI between January 2014 and December 2019 at Siriraj Hospital, which is a large tertiary medical center located in Bangkok, Thailand. The present study was approved by the Siriraj Institutional Review Board of the Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok, Thailand (COA no. Si 556/2019). The need to obtain written informed consent was waived due to the retrospective nature of the study.

The authors included children who presented at the present study center with their first or a recurrent episode of febrile UTI with no known spinal dysraphism and never underwent imaging study prior to experiencing UTI. Febrile UTI was defined as temperature of 38°C or higher, urinary finding of positive nitrite or leucocyte esterase, or white blood cell (WBC) of more than 5 cells/high-power field (HPF), and bacterial growth of 10,000 colony-forming units (CFU)/mL in catheterization urine or 100,000 CFU/mL in clean-catch midstream void urine, or if there was any growth of a single uropathogen in a suprapubic aspiration culture.

Demographic and clinical parameters collected were age, gender, concomitant presentations, such as constipation, phimosis or labial adhesion, renal function, methods of urine collection and culture results, hospitalization, antimicrobial treatment, and prescription and type of prophylactic antibiotics. To evaluate compliance with TPNA imaging study recommendations, the following indications for performing VCUG were collected and recorded: recurrent UTI, first-degree relative of VUR, abnormal bladder emptying, renal function impairment as estimated glomerular filtration rate (eGFR) of less than 60 mL/minute/1.73m², identified pathogen(s) other than *E. coli*, coexisting septicemia and UTI, abnormal RBUS, and suspicion of family non-compliance. The results of RBUS and VCUG were also collected and reviewed. Diagnosis of KUB abnormality, further episode of UTI, presence of renal scarring as determined by dimercaptosuccinic acid (DMSA) scan performed later than six months after the UTI episode, and surgical treatment were also obtained and analyzed.

Recurrent UTI was defined as two or more episodes of febrile UTI. Abnormal bladder emptying was characterized by the lower urinary tract symptoms of straining, weak stream, or dysuria[13]. Estimated GFR was calculated using the creatinine-based new Schwartz's equation[14]. Septicemia was defined as positive hemoculture. Abnormal RBUS included abnormal renal parenchyma, pelvicalyceal or ureteric dilatation, ureterocele, or abnormal bladder findings. Suspicion of family non-compliance was defined as any family-associated factor that could adversely impact the patient, including, but not limited to, failure to attend scheduled follow-up, medication non-adherence, inappropriate or inadequate hygiene practices, failure to observe for or report symptoms, and delayed seeking of medical care and treatment. VUR was diagnosed and graded according to the International Reflux Study in Children criteria[15]. High-grade VUR was diagnosed when reflux was graded III-V.

Statistical analysis

Patient demographic and clinical characteristics were summarized using descriptive statistics and the Kolmogorov-Smirnov test for normality testing. Normally distributed continuous data were compared using Student's t-test, and the results were presented as mean plus/minus standard deviation (SD). Categorical data were compared using chi-square test or Fisher's exact test, and the results were given as number and percentage. Statistical analysis was performed using PASW Statistics, version 18.0 (SPSS Inc., Chicago, IL, USA), and a p-value of less than 0.05 was considered to be statistically significant.

Table 1. Demographic and clinical characteristics of febrile UTI compared between children aged 2 months to 2 years and children aged 2 years to 5 years

Characteristics	2 months to 2 years (n=259); n (%)	>2 years to 5 years (n=51); n (%)	p-value
Age (months); mean±SD	8.2±5.6	40.0±10.9	<0.01
Sex: female	113 (43.6)	32 (62.7)	0.01
Concomitant presentation			
Constipation	4 (1.5)	4 (7.8)	0.03
Phimosis (% in males)	67 (45.9)	8 (42.1)	0.31
Labial adhesion (% in females)	9 (8.0)	3 (9.4)	
Renal function measurement	165 (63.7)	32 (62.7)	
eGFR (mL/minute/1.73m^2), mean±SD	112.4±36.8	99.0±40.0	0.08
Urine collection by urethral catheterization	256 (98.8)	33 (64.7)	<0.01
Organism			0.80
Escherichia coli	193 (74.5)	43 (84.3)	
Non-*Escherichia coli*	66 (25.5)	8 (15.7)	
Hospitalization	216 (83.4)	38 (74.5)	0.16
Antimicrobial treatment			
Third-generation cephalosporin	193 (74.5)	36 (70.6)	0.11
Antimicrobial prophylaxis	85 (32.8)	15 (29.4)	0.74
Bactrim	71 (83.5)	12 (80.0)	
Amoxycillin	9 (10.6)	2 (13.3)	

UTI=urinary tract infection; SD=standard deviation; eGFR=estimated glomerular filtration rate

A p<0.05 indicates statistical significance

Results

Three hundred ten children were included and categorized into two groups consisting of children aged two months to two years with 259 infants (83.5%), and children aged of two to five years with 51 infants (16.5%) (Table 1). The mean age of the younger group and the older group were 8.2±5.6 months and 40.0±10.9 months, respectively. In the older group, female gender was significantly predominant (p=0.01), and the proportion of patients with constipation (p=0.03) was significantly higher than in the younger group. In the younger group, urethral catherization was significantly more often used for urine collection for culture (p<0.01). There were no significant differences in the prevalence of phimosis/labial adhesion, renal function, types of pathogens, hospitalization, or types of antimicrobial therapy, or antimicrobial prophylaxis between the younger and older groups.

One hundred forty (45.2%) patients had one or more proposed risk factors indicating the need to perform VCUG (Table 2). Older children presented with abnormal bladder emptying significantly more frequently (p<0.01). Renal impairment with eGFR lower than 60 mL/minute/1.73m² was found only in the older group (p=0.03). There were no significant differences in the prevalence of recurrent UTI, abnormal RBUS, non-*E. coli* UTI, or coexisting septicemia, and UTI between groups. First-degree relative of VUR and suspicion of family non-compliance were not found in either group.

RBUS was performed in 282 (91.0%) patients, however, only 81 (57.9%) of 140 patients with one or more risk factors indicating the need for VCUG underwent VCUG. Four patients with no risk factors underwent VCUG. The patients who did not comply for RBUS (n=28), performed VCUG without the indication (n=4), and not perform VCUG even with the indication (n=49). Therefore, overall compliance with the recommendation to perform RBUS and to perform or not perform VCUG was 73.9% (n=229). The rates of compliance with the imaging study recommendations were consistent among the six years of the study period (p=0.60) (Figure 1). Overall KUB abnormality was found in 51 (16.5%) patients. Nineteen (6.1%) children had VUR accounting for 27 renal units. Of those, 16 (84.2%) children had VUR with 21 renal units revealing high grade with eight grade III, nine grade IV, and four grade V.

Table 2. The proposed risk factors that indicate the need to perform VCUG compared between children aged 2 months to 2 years and children aged 2 years to 5 years

Risk factors	2 months to 2 years (n=259); n (%)	>2 years to 5 years (n=51); n (%)	p-value
Recurrent UTI	26 (10.0)	8 (15.7)	0.23
Abnormal RBUS	44/234 (18.8)	8/48 (16.7)	0.84
Non-*Escherichia coli* pathogen	66 (25.5)	8 (15.7)	0.15
Abnormal bladder emptying	5 (1.9)	10 (19.6)	<0.01
Septicemia (hemoculture positive)	9 (3.5)	4 (7.8)	0.24
Impaired renal function*	0 (0.0)	2 (3.9)	0.03
First-degree relative of VUR	0 (0.0)	0 (0.0)	-
Suspicion of family non-compliance	0 (0.0)	0 (0.0)	-

VCUG=voiding cystourethrography; UTI=urinary tract infection; RBUS=renal and bladder ultrasound; VUR=vesicoureteral reflux

* Defined as estimated glomerular filtration rate (eGFR) of <60 mL/minute/1.73m^2

A p<0.05 indicates statistical significance

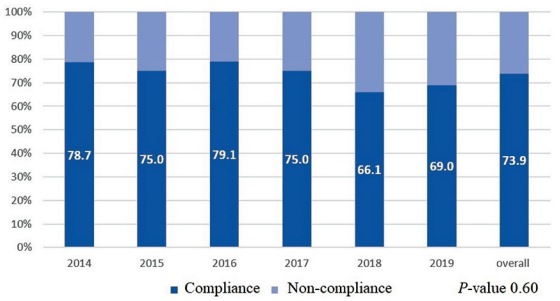

Figure 1. Compliance versus non-compliance with of Thai Pediatric Nephrology Association (TPNA) febrile urinary tract infection (UTI) imaging guideline for Thai children aged 2 months to 5 years between 2014 and 2019.

The rates of compliance with the imaging study recommendations, abnormal finding on RBUS, or VCUG, were not significantly different between the younger and older age groups (Table 3). There were also no significant differences in the prevalence of KUB abnormality, further episode of UTI, renal scarring, or the need for surgical treatment.

Discussion

The present retrospective study demonstrated the younger had approximately five times higher prevalence of febrile UTI than the older children. Female gender, constipation, abnormal bladder emptying, and renal impairment with eGFR of less than 60 mL/minute/1.73m² were associated to febrile UTI in older children. At a rate of compliance with TPNA guideline recommendations of about 75%, the prevalence of KUB abnormality was 16.5%, VUR, mostly high-grade VUR, was the most common CAKUT.

BBD is a significant risk factor of recurrent UTI, especially in concomitant with VUR[16]. High-grade VUR, recurrent UTI, and VUR in older age children were reported by studies to be significant risk factors for renal scarring and chronic kidney disease[17-21]. The present study also showed that the older group was associated with BBD, while the rates of VUR and high-grade VUR were not different between the younger and older age groups.

Physician compliance with the current febrile UTI guidelines can be a challenge, and the true rates of compliance are not known. Overall compliance with the National Institute for Health & Care Excellence (NICE) imaging guideline in children with confirmed UTI was reported to be only 45%[22]. In the present study, overall compliance was higher than the previous study. The compliance with the TPNA RBUS recommendation was higher than the compliance with the TPNA VCUG recommendation. Regular education of UTI in the authors' institute may have helped to maintain the rates of compliance during the study period. However, overall TPNA guideline compliances were not significantly different between younger and older age children.

Prevalence of CAKUT including VUR in the present study was lower than the previous studies in the last decade, which ranged from 35.4% to 45.4%[2,3]. The decrease in the compliance to perform imaging study may be attributed to the lower prevalence of CAKUT and VUR. Furthermore, regarding the application of criteria used to determine indication for imaging study, including the TPNA guidance for febrile UTI in young children[12] and other current recommendations[6-9], the true prevalence of CAKUT was not determined. Some types of CAKUT could

Table 3. TPNA guideline compliance, imaging study findings, KUB abnormality detection and outcomes compared between children aged 2 months to 2 years and children aged 2 years to 5 years

Variables	2 months to 2 years (n=259); n (%)	>2 years to 5 years (n=51); n (%)	p-value
Compliance with TPNA guideline imaging recommendation	189 (73.0)	40 (78.4)	0.45
Performed RBUS	234 (90.3)	48 (94.1)	0.88
Abnormal RBUS	44 (18.8)	8 (16.7)	0.84
Parenchymal	5	0	
Pelvis/calyceal dilatation	34	8	
Ureter	3	0	
Bladder	2	0	
Performed VCUG	69 (26.6)	16 (31.4)	0.19
Abnormal VCUG	18 (27.7)	8 (50.0)	0.13
VUR	13	6	
Abnormal bladder	5	2	
KUB abnormality	41 (15.4)	10 (21.6)	0.54
Primary VUR	13	6	
High-grade	11	5	
Low-grade	2	1	
Isolated hydronephrosis	17	4	
Extrarenal pelvis	2	0	
Ureteropelvic junction obstruction	2	0	
Ureterovesical junction obstruction	1	0	
Renal parenchymal disease	2	0	
Atrophic kidney	1	0	
Renal calculi	1	0	
Renal cyst	1	0	
Detrusor sphincter dyssynergia	1	0	
Further episode of UTI	16 (6.2)	5 (9.8)	0.34
Performed DMSA	14 (5.4)	3 (5.9)	1.00
Renal scar	10	2	
Surgical treatment	11 (4.2)	2 (5.9)	0.59
Ureteral reimplantation	5	2	
Pyeloplasty	2	0	
Ureteral stent	1	0	
Circumcision	3	1	

TPNA=Thai Pediatric Nephrology Association; KUB=kidney, ureter, and bladder; RBUS=renal and bladder ultrasound; VCUG=voiding cystourethrography; VUR=vesicoureteral reflux; UTI=urinary tract infection; DMSA=dimercaptosuccinic acid scan

A $p<0.05$ indicates statistical significance

be missed, especially VUR, if VCUG was not performed[23-26]. Nevertheless, in the present study, there was no significant difference in the rates of KUB abnormality detection between the younger and older age groups.

The present study demonstrated the Thai Guideline imaging recommendations is applicable in patients aged two months to two years and older than two years to five years. The TPNA recommends RBUS in all children with febrile UTI aged up to five years, and further VCUG if those children had one or more of the proposed eight risk factors. Using the proposed risk factors as indications for the need to perform VCUG, high-grade VUR was found more often than low-grade VUR. The ability to detect high-grade VUR was also found in the previous study by Boonyatarp et al[27]. However, the potential exists that high-grade VUR could be missed, so children with

first febrile UTI should be followed-up later. VCUG should be performed in cases of recurrent febrile UTI.

High-grade VUR is more clinically significant than low-grade VUR, which has the potential for spontaneous resolution[28,29]. Therefore, most guidelines are based on significantly associated factors to identify patients at risk, and then those patients are scheduled to undergo VCUG. In the present study, the prevalence of CAKUT was low, which means that some children having VUR may have been missed, and the VUR detected was mostly high grade. This finding may suggest that the application of the risk factors included in the TPNA guideline to indicate the need for VCUG can identify high-grade VUR, but that low-grade VUR could be missed.

The limitation of the present study were retrospective design and single center. The first-degree relative of VUR and suspicion of family non-compliance, as the risk factors, could not be evaluated in the study. Furthermore, the performance of the proposed eight risk factors for high-grade VUR to indicate the need to perform VCUG should be further validated. In addition, physicians should be educated and encouraged to comply with the TPNA febrile UTI guideline, which will improve CAKUT and VUR identification in young children.

Conclusion

The children aged two months to two years had approximately five times higher prevalence of febrile UTI than the children aged two years to five years. Female gender, and bladder and bowel dysfunction were associated to febrile UTI in older children. The TPNA febrile UTI guideline imaging recommendation was shown to be applicable in both younger and older children including the compliance and KUB abnormality detections.

What is already known on this topic?

Febrile UTI in young children is common and associated to CAKUT. The TPNA febrile UTI guideline recommends RBUS as the first-line imaging study, and then VCUG, if the patient had one or more of the eight proposed risk factors.

What this study adds?

The TPNA febrile UTI guideline imaging recommendation is applicable in term of the compliance and the KUB abnormality detection, especially high-grade VUR, in both children aged two months to two years and in children aged two to five years.

Acknowledgement

The authors gratefully acknowledge Ms. Kanokwan Sommai for assistance with statistical analyses.

Conflicts of interest

All authors declare no personal or professional conflicts of interest relating to any aspect of this study.

References

1. Craig JC, Williams GJ, Jones M, Codarini M, Macaskill P, Hayen A, et al. The accuracy of clinical symptoms and signs for the diagnosis of serious bacterial infection in young febrile children: prospective cohort study of 15 781 febrile illnesses. BMJ 2010;340:c1594.
2. Ismaili K, Wissing KM, Lolin K, Le PQ, Christophe C, Lepage P, et al. Characteristics of first urinary tract infection with fever in children: a prospective clinical and imaging study. Pediatr Infect Dis J 2011;30:371-4.
3. Sitthisarunkul N, Uthairat M, Dissaneewate P, McNeil E, Vachvanichsanong P. Characteristics and findings of childhood urinary tract infection in the last decade. Urol Int 2019;102:456-61.
4. Nelson CP, Johnson EK, Logvinenko T, Chow JS. Ultrasound as a screening test for genitourinary anomalies in children with UTI. Pediatrics 2014;133:e394-403.
5. Boonyatarp M. Diagnostic performance of renal ultrasound to detect vesicoureteral reflux in children with first febrile UTI. Lampang Med J 2015;36:74-83.
6. National Institute for Health and Clinical Excellence. Urinary tract infection in under 16s: diagnosis and management [CG54]. Clinical guideline [Internet]. 2007 [cited 2020 Dec 20]. Available from: https://www.nice.org.uk/guidance/cg54.
7. 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;128:595-610.
8. Ammenti A, Cataldi L, Chimenz R, Fanos V, La Manna A, Marra G, et al. Febrile urinary tract infections in young children: recommendations for the diagnosis, treatment and follow-up. Acta Paediatr 2012;101:451-7.
9. Stein R, Dogan HS, Hoebeke P, Kočvara R, Nijman RJ, Radmayr C, et al. Urinary tract infections in children: EAU/ESPU guidelines. Eur Urol 2015;67:546-58.
10. World Health Organization, Department of Reproductive Health and Research. Antenatal care in developing countries. Promises, achievements and missed opportunities-an analysis of trends, levels and differentials, 1990-2001. Geneva: WHO/UNICEF; 2003.
11. Siddique AB, Perkins J, Mazumder T, Haider MR, Banik G, Tahsina T, et al. Antenatal care in rural Bangladesh: Gaps in adequate coverage and content.

PLoS One 2018;13:e0205149.
12. Thai Pediatric Nephrology Association. Clinical practice for diagnosis and management of urinary tract infection in infants and children 2 months to 5 years [Internet]. 2014 [cited 2020 Dec 22]. Available from: http://www.thaipediatrics.org/Media/media-20161208143440.pdf.
13. Austin PF, Bauer SB, Bower W, Chase J, Franco I, Hoebeke P, et al. The standardization of terminology of lower urinary tract function in children and adolescents: Update report from the standardization committee of the International Children's Continence Society. Neurourol Urodyn 2016;35:471-81.
14. Schwartz GJ, Work DF. Measurement and estimation of GFR in children and adolescents. Clin J Am Soc Nephrol 2009;4:1832-43.
15. Lebowitz RL, Olbing H, Parkkulainen KV, Smellie JM, Tamminen-Möbius TE. International system of radiographic grading of vesicoureteric reflux. International Reflux Study in Children. Pediatr Radiol 1985;15:105-9.
16. Keren R, Shaikh N, Pohl H, Gravens-Mueller L, Ivanova A, Zaoutis L, et al. Risk factors for recurrent urinary tract infection and renal scarring. Pediatrics 2015;136:e13-21.
17. Vachvanichsanong P, Dissaneewate P, Thongmak S, Lim A. Primary vesicoureteral reflux mediated renal scarring after urinary tract infection in Thai children. Nephrology (Carlton) 2008;13:38-42.
18. Shaikh N, Ewing AL, Bhatnagar S, Hoberman A. Risk of renal scarring in children with a first urinary tract infection: a systematic review. Pediatrics 2010;126:1084-91.
19. Mattoo TK, Chesney RW, Greenfield SP, Hoberman A, Keren R, Mathews R, et al. Renal scarring in the randomized intervention for children with vesicoureteral reflux (RIVUR) Trial. Clin J Am Soc Nephrol 2016;11:54-61.
20. Chen MJ, Cheng HL, Chiou YY. Risk factors for renal scarring and deterioration of renal function in primary vesico-ureteral reflux children: a long-term follow-up retrospective cohort study. PLoS One 2013;8:e57954.
21. Peters C, Rushton HG. Vesicoureteral reflux associated renal damage: congenital reflux nephropathy and acquired renal scarring. J Urol 2010;184:265-73.
22. Platt C, Larcombe J, Dudley J, McNulty C, Banerjee J, Gyoffry G, et al. Implementation of NICE guidance on urinary tract infections in children in primary and secondary care. Acta Paediatr 2015;104:630-7.
23. La Scola C, De Mutiis C, Hewitt IK, Puccio G, Toffolo A, Zucchetta P, et al. Different guidelines for imaging after first UTI in febrile infants: yield, cost, and radiation. Pediatrics 2013;131:e665-71.
24. Suson KD, Mathews R. Evaluation of children with urinary tract infection--impact of the 2011 AAP guidelines on the diagnosis of vesicoureteral reflux using a historical series. J Pediatr Urol 2014;10:182-5.
25. Ristola MT, Hurme T. Consequences of following the new American Academy of Pediatrics guidelines for imaging children with urinary tract infection. Scand J Urol 2015;49:419-23.
26. Narchi H, Marah M, Khan AA, Al-Amri A, Al-Shibli A. Renal tract abnormalities missed in a historical cohort of young children with UTI if the NICE and AAP imaging guidelines were applied. J Pediatr Urol 2015;11:252.e1-7.
27. Sorapipatcharoen K, Pruangprasert P. Any undiagnosed vesicoureteral reflux following the adoption of Thai Pediatric Nephrology Association endorsed clinical practice guideline 2014 on urinary tract infection in children aged 2 months to 5 years. J Med Assoc Thai 2019;102 Suppl 6:25-8.
28. Arant BS Jr. Medical management of mild and moderate vesicoureteral reflux: followup studies of infants and young children. A preliminary report of the Southwest Pediatric Nephrology Study Group. J Urol 1992;148:1683-7.
29. Tamminen-Möbius T, Brunier E, Ebel KD, Lebowitz R, Olbing H, Seppänen U, et al. Cessation of vesicoureteral reflux for 5 years in infants and children allocated to medical treatment. The International Reflux Study in Children. J Urol 1992;148:1662-6.