HK J Paediatr (new series) 2005;**10**:180-188

Auditing the Management of Childhood Urinary Tract Infections in a Regional Hospital

SP ***Wu,*** SN ***Wong***

Abstract

Aim: A clinical audit on urinary tract infection (UTI) management to identify deviations from published local guidelines and any areas of improvement. ***Method:*** Retrospective review of 2 cohorts of children below 2 years old admitted to paediatric wards of a regional hospital. Data were extracted according to structured questionnaires. The first cohort included children admitted for fever without foci of infection, and data were collected to evaluate the adequacy of screening for UTI. The second cohort included children with a diagnostic label of UTI. The diagnostic criteria, treatment and follow-up imaging tests were evaluated. ***Results:*** Part I: 97 children were recruited. UTI was screened in 87.6% (23.7% by both dipsticks and bedside microscopy and 63.9% by dipsticks only). After an initial positive screening by dipsticks and/or bedside microscopy, only 44.4% had appropriately definitive tests by culture of a proper urine specimen (bladder tap/catheter/clean catch urine) whereas half of the cases had repeated bag urine screening. For patients who needed antibiotics immediately due to ill conditions on admission, proper urine was collected for culture in only 60%. Part II: 76 patients were recruited. UTI diagnosis was based on positive culture from a proper urine specimen in 92.1%, but of the 5 cases managed by doctors in Accident & Emergency Department or private practice, 4 (80%) were based on bag urine culture. All patients received appropriate antibiotics (mainly cefuroxime) covering the causative organisms (mainly *Escherichia coli*). Radiological investigations were arranged in >90% of patients, to look for urological abnormalities, vesicoureteric reflux or scarring, but there was a long waiting time (mean 2 months for ultrasound and 4-5 months for micturating cystourethrogram). Lastly, the documentation of clinical assessment and parental education were found to be less than adequate. ***Conclusion:*** Though UTI was properly managed in most cases, areas of improvements were identified. The diagnosis might be missed by 1) not screening patients' urine in 12% of cases; 2) not doing both dipsticks and microscopy in 63.9% of cases; 3) not doing urine culture before empirical antibiotics therapy in 40% of such situations. UTI diagnosis might have been delayed by just repeating bag urine screening when it was already positive. Furthermore, UTI recurrences might be prevented by properly looking for clues of urological abnormalities and educating parents, and shortening the waiting time for urological imaging studies.

Key words Chinese children; Clinical audit; Clinical guidelines; Urinary tract infection

Department of Paediatrics & Adolescent Medicine, Queen Elizabeth Hospital, 30 Gascoigne Road, Kowloon, Hong Kong, China

SP **Wu** （胡瑞萍） *MBBS, FHKAM(Paed)*

Department of Paediatrics & Adolescent Medicine, Tuen Mun Hospital, Tsing Chung Koon Road, Tuen Mun, N.T., Hong Kong, China

SN **Wong** （黃錫年） *MBBS, FHKAM(Paed)*

Correspondence to: Dr SN **Wong**

Received August 25, 2004

Introduction

Urinary tract infection (UTI) is a common childhood infection affecting about 5% of febrile children.[1] Previous surveys have documented wide variations in the diagnosis and treatment of UTI.[2] Suggested guidelines on its management have been published in North America[3] and Europe.[4,5] A local guideline on management of UTI in children below 2 years of age was introduced in 2002 among the public hospitals. It has been disseminated via the Hospital Authority intranet, the Hong Kong Journal of

Paediatrics[6,7] and through the coordinators in each paediatric units. To assess the extent of implementation of the guidelines, we performed a clinical audit in a regional hospital, with the aim of identifying any deviations in the management practices from guideline recommendations and any opportunities of improving the quality of care to these patients.

Patients and Methods

The study was a retrospective review of the case notes of patients in the paediatric department of a regional hospital. Data were extracted by the authors according to two structured questionnaires.

Part I of the study aimed at evaluating the proper method to diagnose or exclude UTI in at risk children. Consecutive patients below 2 years of age admitted with fever (>38°C) without obvious foci of infection during the period 1st January to 31st January 2003 were studied. In accordance with previous Guidelines, patients with a clinical diagnosis of pharyngitis, upper respiratory infection or mild gastroenteritis without watery or blood stained stool were not considered as foci of infection and were included.[6] The following audit points were evaluated:

Audit point 1.1: All children below 2 years old with documented fever but no foci of infection should be investigated for UTI.

Audit point 1.2: Urine should be collected by a convenient method for dipsticks (for nitrite and leucocyte esterase) and microscopy of the fresh urine by house-officers (for leucocytes). If any of these were positive (any "+" in dipsticks or >5 leucocytes per ml), a proper sample (clean-catch urine/ catheter urine/bladder tap urine) should be collected for culture.

Audit point 1.3: Antibiotic therapy should be commenced if urinalysis of the properly collected sample also yielded positive results, while culture results are awaited.

Audit point 1.4: If it was judged that immediate commencement of antibiotics were required, urine should be collected properly by bladder tap or catheterisation or clean-catch technique prior to antibiotics therapy.

Part II of the study aimed at evaluation of basis of diagnosis and subsequent management of patients with proven UTI. We recruited all patients aged less than 2 years who received the diagnosis of UTI for the first time in the same department during the period of 1st January to 31st December 2003. Patients with known history of underlying urological abnormalities before UTI diagnosis were excluded. The referred cases from other hospitals solely for investigations without subsequent follow-up at our clinic were also excluded. The following audit points were selected for review:

Audit point 2.1: The diagnosis of UTI should be proven by a positive bacterial culture from a properly collected urine sample (see Table 1).

Audit point 2.2: The choice of antibiotic therapy should be based on local antibiotics susceptibility patterns. Treatment should be given for at least 7 days. Switch to oral antibiotics and outpatient treatment was possible once fever has subsided.

Audit point 2.3: Clinical assessment should include inquiry into bowel and bladder habits, documenting signs of chronic renal failure, hypertension, palpable kidneys and bladder, lumbosacral spinal abnormalities, weak urine stream (in boys), and serum creatinine level. In children with any abnormalities, the schedule for follow up investigations should be accelerated.

Audit point 2.4: Patients with UTI who do not show the expected clinical response to antibiotics therapy should have urine re-cultured. The co-existence of septicaemia and meningitis should be considered, and

Table 1 Diagnostic criteria for proven UTI[6]

Method of collection	Colony counts per ml (pure growth)
Suprapubic tap	Gram-negative bacilli: any number Gram-positive cocci: > a few thousand
Transurethral catheterisation	$>10^4$
Clean voided urine in boys	$>10^4$
Clean voided urine in girls	$>10^5$

ultrasound kidneys should be performed on an urgent basis.

Audit point 2.5: It is important that the family be educated to recognise the symptoms and signs of recurrent UTI, and be advised to seek immediate medical care when UTI is suspected.

Audit point 2.6: It is strongly recommended to do ultrasound scan of the urinary tract and an imaging study for VUR. DMSA renal scan may help in the following situations: a) A DMSA scan may be needed as soon as possible if the diagnosis of pyelonephritis is strongly suspected but urine culture is not confirmatory. b) A late DMSA scan after 6-12 months can assess permanent renal scarring.

Audit point 2.7: A prophylactic antibiotic should be given to cover the period while waiting for investigations. It can be stopped if significant vesicoureteric reflux and obstructive uropathy are ruled out.

Results: Part 1

Of the 144 patients admitted for fever during the study period, 46 patients had definite foci of fever. One patient's record could not be retrieved. Hence 97 patients were recruited. There were 37 girls (38%) and 60 boys (62%), with ages ranging from 0.1 to 2 years (mean 1.5 years, median 1 year). Six (6.2%) had a final diagnosis of UTI. The clinical presentation of the recruited patients was summarised in Table 2.

Table 2 Clinical presentation of 97 patients with fever and no obvious foci of infection

Clinical presentation	No. of patients (%)
Fever	97 (100)
Respiratory symptom	68 (70.1)
Non-specific symptom (malaise, decreased feeding, irritability)	38 (38.2)
Vomiting	34 (35.1)
Febrile convulsion	21 (21.6)
Diarrhoea	17 (17.5)
Skin rash	4 (4.1)
Foul smell urine	1 (1)
History of recent vaccination	1 (1)

Audit point 1.1: Among the 97 recruited patient, only 85 (87.6%) had urine collected and examined for UTI by dipsticks for nitrite and leukocyte esterase, microscopy or culture.

Audit point 1.2: As shown in Figure 1, first urine samples were collected by bag and clean catch technique in 83 and 2 patients respectively. However, only 23 (27.1%) had both dipsticks and bedside microscopy performed, while 62 (72.9%) had dipsticks test only.

Eighteen patients (out of 85) had positive results (by dipsticks and/or microscopy). This led to urine collection for culture by bladder tap or catheterisation in 7 patients (38.9%) and by clean-catch urine in 1 patient (5.6%). Urinalysis of bag urine were repeated in the remaining 9 patients (50%). The repeat urinalysis was positive in 3 patients, which led to bladder tap or catheter urine collection for culture. In 1 patient, the positive urinalysis result was not followed up.

Audit point 1.3: Of the 10 patients who had urine collected by suprapubic tap, catheterisation or clean catch technique, 3 had positive urinalysis/ microscopy result on the proper urine samples. All of these 3 patients were treated with antibiotics while awaiting culture results.

Audit point 1.4: Antibiotics had to be commenced immediately in 10 patients with poor clinical condition, and only 6 (60%) had properly collected urine specimens (by suprapubic tap or transurethral catheterisation) for definitive diagnosis of UTI before treatment. Urine was not saved for culture in 4 cases.

Results: Part 2

During the period 1st January to 31st December 2003, 79 children below 2 years of age were coded to have a diagnosis of the first episode of UTI. Three hospital records could not be retrieved and hence 76 patients were recruited for evaluation. There were 20 girls and 56 boys with ages ranging from 0.03 to 1.77 years (median 0.31 years). Their clinical presentations were summarised in Table 3.

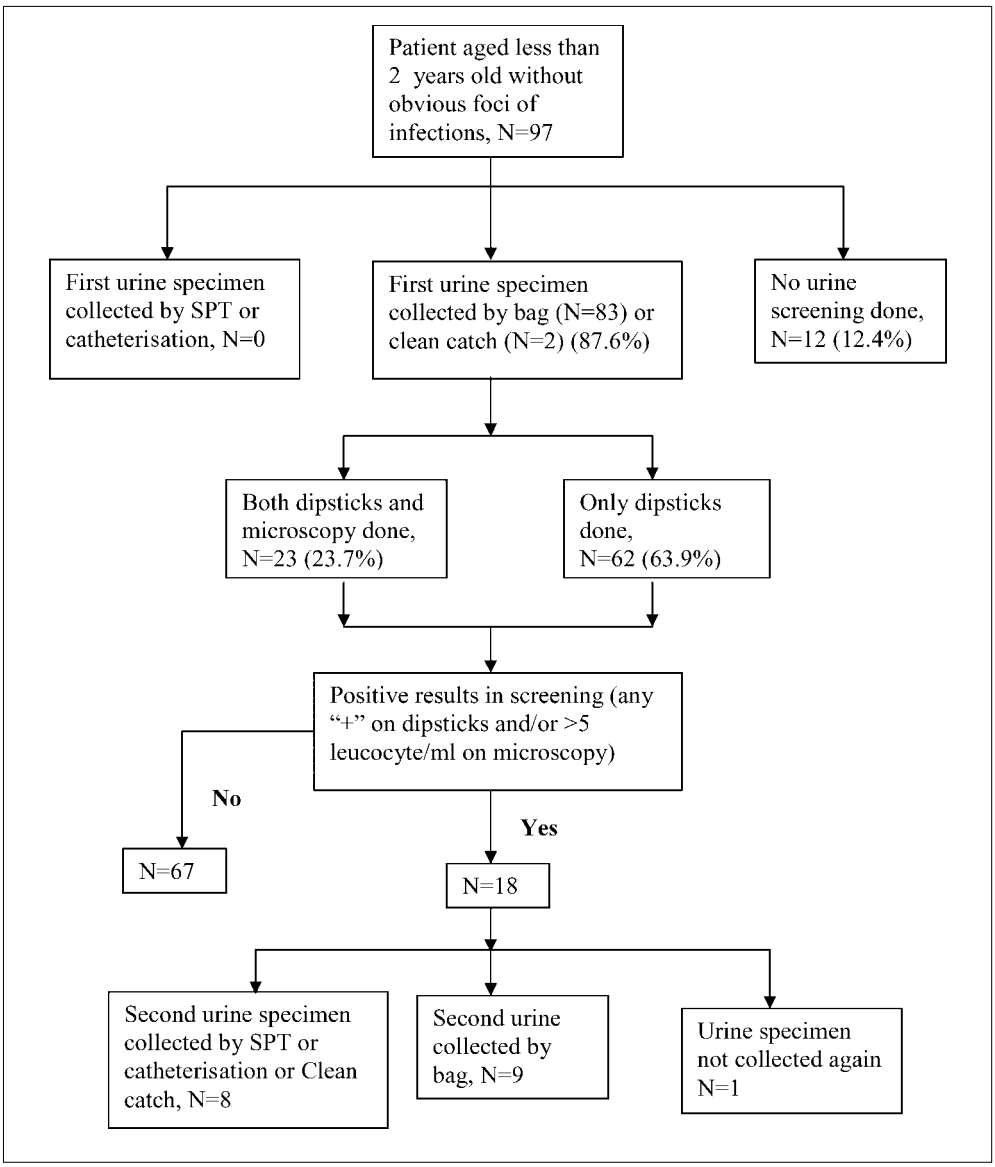

Figure 1 Screening for UTI in 97 children with fever and no foci of infection.

Audit point 2.1: In this group of 76 children, UTI was diagnosed by positive culture of bladder tap urine in 12 (15.8%) patients, catheter urine in 49 (64.5%), clean-catch urine in 9 (11.8%). One patient had negative bacterial growth in catheter urine saved after commencement of antibiotics and UTI was subsequently confirmed by DMSA scan. Five patients were initially "diagnosed" by positive bacterial growth in bag urine samples. Three of these 5 patients were confirmed to have UTI by acute DMSA scan while in the remaining 2 patients, DMSA scan showed normal findings hence UTI could not be confirmed or excluded (Figure 2). Hence the diagnostic procedures were unsatisfactory in 6 patients.

Five patients were diagnosed and treated by doctors in private practice or in the Accident and Emergency Department before referral. Their diagnosis was based on positive cultures in the bag urine samples in 4 patients (80%) and clean-catch urine in the remaining one.

Table 3 Clinical presentations of 76 patents diagnosed to have first time diagnosis of UTI

Clinical presentation	No. of patients (%)
Fever	69 (90.8)
Non-specific symptom (malaise, decreased feeding, irritability)	45 (59.2)
Respiratory symptom	30 (39.5)
Vomiting	19 (25)
Diarrhoea	12 (15.8)
Chills and rigors	4 (5.3)
Foul smell urine	4 (5.3)
Turbid urine	3 (3.9)
Referred case from private doctor/AED	3 (3.9)
Febrile convulsion	2 (2.6)
Skin rash	1 (1.3)
Weight loss, dehydration	1 (1.3)
Afebrile convulsion	1 (1.3)
Urinary frequency	1 (1.3)

Audit point 2.2: UTI was caused by *Escherichia coli* in 90% of our cases and 6.3% of the cultured *Escherichia coli* was ESBL positive. The remaining causative organisms were *Klebsiella*, enterococcus and enterobacter. One hundred percent of the ESBL-negative *Escherichia coli* were sensitive to cefuroxime sodium but only 17.4% was sensitive to cefuroxime axetil while the remaining was of intermediate sensitivity.

All patients except two (who had a retrospective diagnosis of UTI based on DMSA scan findings) were treated with antibiotics, most commonly with cefuroxime (see Table 4). Seventy patients (92.1%) were given intravenous antibiotics initially and 44 (57.9%) of these patient had their antibiotics changed to oral route when fever subsided. The

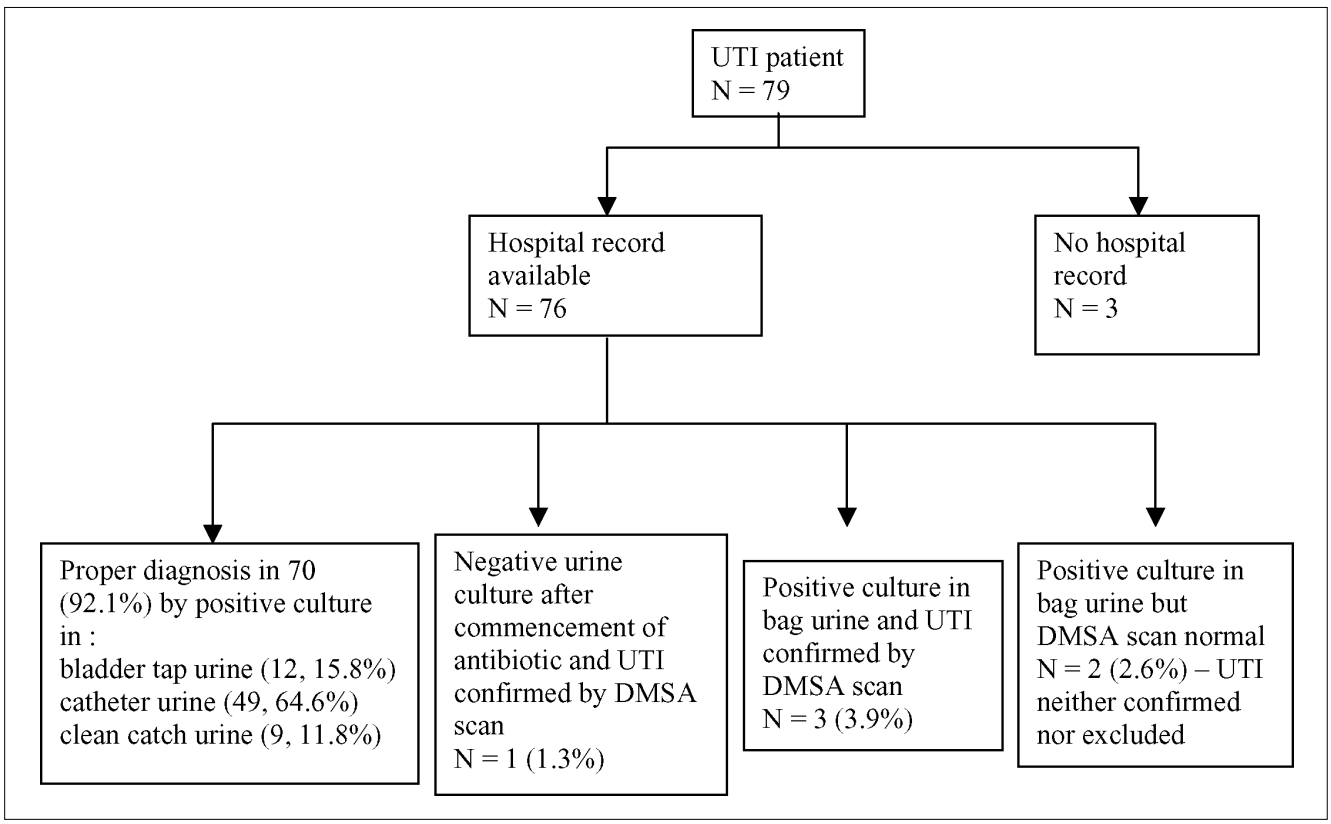

Figure 2 Methods of diagnosis of UTI in 76 children.

Table 4 Choices of antibiotics to treat UTI in 76 children

Antibiotics	No. of patients (%)
Cefuroxime	52 (68.4)
Third generation cephalosporin	4 (5.3)
Gentamicin/netromycin	2 (2.6)
Septrin	3 (3.9)
Nitrofurantoin	4 (5.3)
Meropenum	1 (1.3)
Others	8 (10.5)
No treatment	2 (2.6)

7 patients who were treated with septrin or nitrofurantoin were initially given intravenous cefuroxime until fever subsided. Sixty-nine patients (90.8%) were given treatment for 7 or more days. Duration of treatment was unknown in one referred case. Three patients were given 6 days of treatment and 1 treated for 3 days only. This patient was treated for 3 days because urinary tract infection was not highly suspected initially and parents refused further management when positive urine culture result came back.

Audit point 2.3: The documented clinical findings were summarised in Table 5. There were inadequate documentation of signs of palpable kidneys, bladder, growth percentiles, spinal abnormalities and history of urine stream.

Audit point 2.4: Fever did not subside after 48 hours of antibiotics treatment in 7 patients only and all of them had urine re-cultured but only 3 of them had early renal ultrasound scan performed on day 3, 4, and 12 of the illness. This was mainly related to the waiting list of urgent ultrasound scan requests in the hospital.

Table 5 Clinical assessment documented in records of 76 patients with first time diagnosis of UTI

Clinical assessment	No. of patients (%)
Serum creatinine level measurement	72 (94.7)
Blood pressure measurement	70 (92.1)
Inquiry into bowel habits	66 (86.8)
Palpate the kidneys	41 (53.9)
Inquiry into bladder habits	38 (50)
Chart growth percentile	8 (10.5)
Palpate the bladder	4 (5.3)
Lumbosacral spine examination	6 (7.9)
Inquiry into weak urine stream (in boys)	1 (1.8)

Audit point 2.5: Education of the family about signs and symptoms of UTI and explanation of investigation and/or prophylactic antibiotics were well-documented in only 8 (10.5%) and 22 (28.9%) patients respectively. Pamphlets of urinary tract infection were documented to have been given in 9 cases (11.8%).

Audit point 2.6: Follow-up renal ultrasound scans were performed in 72 patients (94.7%) and it was refused by the parents of 2 patients. However, the mean (median) time of getting the ultrasound done was 57.2 days (43.5 days) with the longest being 232 days.

Follow-up micturating cysto-urethrogram MCUG were arranged in 71 patients (93.4%) but they were refused by parents in 3 cases. Again it took a mean of 138.8 days (median 145 days, range 18-285 days) for MCUG to be performed.

Follow-up DMSA scans were arranged in 68 (89.5%) patients. DMSA scans were not arranged in 6 (7.9%) cases and refused by the parents in 2 (2.6%) cases. The scans were performed at a mean (median) of 132.6 days (136 days) from UTI diagnosis (range 1-383 days). This wide range was probably because of different purposes of doing the scans - early for confirming UTI and late for assessing scarring.

Audit point 2.7: Seventy-one (93.4%) patients were given prophylactic antibiotics before vesicoureteric reflux (VUR) was excluded. Prophylactic antibiotics were refused by the parents in 2 cases and were not given in one case with an uncertain diagnosis of UTI. The most popular choice of prophylactic antibiotic was trimethoprim which contributed to 90.8% of the total cases. The remaining cases used co-trimoxazole (2.6%) or nitrofurantoin (2.6%).

Discussion

This is the first report of a clinical audit to assess the compliance to the local guidelines on the management of childhood UTI in a regional hospital since the guidelines were introduced two years ago. It is also part of our continuous effort to improve the quality of care to these patients through the audit cycle: i.e. compiling an agreed standard of practice, ensuring its dissemination and implementation, auditing any deviations in actual clinical practice, and hence identifying significant areas for improvement.

The findings of this audit showed that, in accordance with established guidelines, UTI was properly looked for in most young febrile children. The incidence of UTI in our sample was 6.2%. This was comparable to previous studies overseas.[1,8] Almost all UTI children received appropriate antibiotics treatment and were given prophylactic antibiotics pending investigations, and almost all children received appropriate imaging investigations to look for urological abnormalities and vesicoureteric reflux. These findings were comparable to those in a survey on 32 hospitals in the United Kingdom reported by Verrier Jones in 2000 (see Table 6).[2]

Table 6 Comparison with the UK audit

	UK audit result, 2000	**HK audit result, 2004**
Screening of UTI in "at risk" children aged less than 2	81% ("at risk" children defined as those with symptoms that were likely be associated with UTI, obvious cases of asthma, upper respiratory tract infections, surgical admissions and other cases in which it was considered unreasonable to expect investigation to exclude UTI were excluded)	87.6% ("at risk" children defined as those with fever without obvious focus, obvious cases of asthma, acute bronchiolitis, croup, severe gastroenteritis, pneumonia with definite pneumonic changes in chest X-ray, surgical cause of fever were excluded)
Method of urine collection for UTI screening	Bag urine : 32% Mid stream urine : 22% Clean catch : 11% Urine pad : 4% SPT : 4% Catheter : 0% Not specified : 27%	Bag urine : 97.6% Clean catch : 2.4%
Urine screening method	None performed : 19% Nitrite test only : 10% Microscopy only : 3% Culture only : 3% Culture and microscopy : 65% Nitrite and culture : 1%	None performed : 12.4% Dipsticks for nitrite and leukocyte only : 63.9% Dipsticks for nitrite and leukocyte and bedside microscopy : 23.7%
A positive screening test in bag urine should be confirmed by proper urine specimen	A second urine sample were collected in 57% cases of which 36% were by SPT or catheter	A second urine sample were collected in 94.4% cases of which 38.9% were by SPT or catheter
Prophylactic antibiotics should be given before significant VUR and obstructive uropathy are rule out	79% of children received prophylactic antibiotics while awaiting the imaging investigations	93.4% of children received prophylactic antibiotics while awaiting the imaging investigations
Urological investigation	Ultrasound : 93% MCUG : 72% DMSA scan : 58%	Ultrasound : 94.7% MCUG : 93.4% DMSA scan : 89.5%
Information for parents	65% hospitals returned written information for parents	Pamphlets were documented to be given : 11.8%

However, the audit also revealed a number of noteworthy areas of deficiencies. Firstly only 87.6% of febrile children were screened for UTI. This was similar to a United Kingdom survey in which 81% of 746 infants at risk had urine examination for UTI.[2] Another study from office paediatricians in the USA showed that only 57% of 3066 infants had urine examined for UTI.[9] Though our results were comparable to these overseas surveys, it could be further improved.

Secondly the screening method was considered inadequate, namely by dipsticks only, in about 60% of children. This may be related to the uncertain time of collecting the bag urine samples from infants. When a fresh urine sample was available, dipsticks could be done immediately by the ward nurses, whereas urine microscopy had to be done by the on-call doctors who might be busy with other duties. Another possible reason was the widely held misconception that we can screen for UTI by dipsticks alone and only when it is positive that we should confirm UTI by urine microscopy. It must be pointed out that the sensitivity and specificity of urine dipsticks alone for leukocyte esterase and nitrite were 88-93% and 72-93% respectively. By combining urine microscopy and dipsticks tests one can increase the sensitivity to 99.8% with specificity of 70%.[1,6] In other words, we would have missed 7-12% of genuine UTI cases if only dipsticks were done alone. In contrast, the UK survey showed that 64% of patients had urine collected by bag or clean-catch and sent for both urinalysis and culture.[2] Though the sensitivity of this approach was high, the false positive rate of bag urine culture was also unacceptably high.[1]

Thirdly, when the screening tests were positive, urine was collected properly (by bladder tap, catheter or clean-catch) in only 40% whereas the same tests on bag urine were repeated a second time in the rest. Provided the urinalysis was performed properly, repeating it twice may just lead to a delay in diagnosing UTI and starting treatment with undesirable consequences.[10,11]

Fourthly, when antibiotics had to be given immediately to ill patients on admission, only 60% had properly collected urine for culture to confirm or exclude UTI as a cause. In the remaining 40% of patients, the chance of clarifying the diagnosis was missed as antibiotics will render the urine culture negative once treatment was started.

Fifthly, the few patients who had been diagnosed and treated by colleagues in Accident and Emergency departments or private practice had improper documentation by bag urine cultures only. This may indicate the lack of awareness of the current guidelines by doctors in other specialties, or the difficulty of obtaining urine by bladder tap or catheterisation in a non-inpatient setting. However we were unable to audit the UTI management in these settings as other departments or private doctors were involved.

In addition, the documentation of clinical signs and patient education were inadequate. As shown in Table 3, the presence or absence of many important physical findings was documented in <50% of charts. These abnormal findings may signify serious underlying renal abnormalities and call for accelerated investigations and surgical treatment.[4] Failure to perform these simple clinical assessments may lead to serious consequence.

Similarly education of parents were documented in a minority of cases. The overall recurrence rate of symptomatic UTI was 15%.[12] and the risk of renal scarring increases with the number of recurrent febrile UTI.[13] Therefore adequate education to parents to ensure their early detection of recurrences is important to prevent late complications. Besides, adequate explanation about the reasons for doing follow-up investigation and giving prophylactic antibiotics are important to ensure compliance. Use of pamphlets is a good alternative to convey adequate and correct information to parents. However, pamphlets were document to be given in only 12% cases. However because of the retrospective nature of an audit, these results may be related to lack of documentation rather than a genuine failure of communication to parents.

Lastly, the long wait for follow up investigations (mean of 2 months for ultrasound scan and 4-5 months for MCUG) were considered unsatisfactory. It may delay the detection of renal abnormalities and their appropriate treatment. For those without VUR, prophylactic antibiotics had to be continued unnecessarily till the investigations were performed.

We should be aware that this clinical audit is retrospective with the usual limitations of any retrospective data collection. We covered only inpatients in the paediatric department, and may have missed those children managed in the Accident and Emergency Department and private clinics. We did not audit the detection of UTI in situations other than the febrile child. Because of the small sample size, we cannot audit the diagnosis of UTI in neonates and use of DMSA scan for diagnosis in highly suspicious cases of UTI which cannot be confirmed by urine culture. Lastly the findings of this audit have to be interpreted bearing in mind that clinical guidelines are for guidance only, and its recommendations are based on levels of evidence. Flexibility and deviations from the recommendations are

possible in the clinical practice with proper documentation of the valid reasons behind such deviations.

In conclusion, this audit reveals some significant deviations from established guidelines on UTI management in young children. Areas needing improvement include ensuring urinalysis in ALL febrile children, adding urine microscopy to dipsticks tests, saving a catheter urine sample for culture when empirical antibiotics need to be given, and detailed documentation of clinical assessment and parental education before discharge of these patients. The findings in this survey can also serve as a baseline for comparison with future audits or with similar audits in other departments on the same topic.

References

1. Downs SM. Technical report: urinary tract infections in febrile infants and young children. The Urinary Tract Subcommittee of the American Academy of Pediatrics Committee on Quality Improvement. Pediatrics 1999;103:e54.
2. Verrier Jones K, Hockley B, Scrivener R, Pollock JI, on behalf of Royal College of Paediatrics and Child Health. Summary of diagnosis and management of urinary tract infections in children under two years: Assessment of practice against published guidelines. Royal College of Paediatrics and Child Health, 2000.
3. Practice parameter: the diagnosis, treatment, and evaluation of the initial urinary tract infection in febrile infants and young children. American Academy of Pediatrics. Committee on Quality Improvement. Subcommittee on Urinary Tract Infection. Pediatrics 1999;103(4 Pt 1):843-52.
4. Jodal U, Lindberg U. Guidelines for management of children with urinary tract infection and vesico-ureteric reflux. Recommendations from a Swedish state-of-the-art conference. Swedish Medical Research Council. Acta Paediatr Suppl 1999; 88:87-9.
5. Guidelines for the management of acute urinary tract infection in childhood. Report of a Working Group of the Research Unit, Royal College of Physicians. J R Coll Physicians Lond 1991;25: 36-42.
6. Wong SN, Chiu W, Ho S, et al. Clinical guideline on management of urinary tract infections in children below 2 years of age (part I): the diagnosis and initial management. HK J Paediatr (new series) 2002;7:205-13.
7. Wong SN, Chiu W, Ho S, et al. Clinical guideline on management of urinary tract infections in children below 2 years of age (part II): investigations following a documented infection. HK J Paediatr (new series) 2003;8:47-54.
8. Shaw KN, Gorelick M, McGowan KL, Yakscoe NM, Schwartz JS. Prevalence of urinary tract infection in febrile young children in the emergency department. Pediatrics 1998;102:e16.
9. Newman TB, Bernzweig JA, Takayama JI, Finch SA, Wasserman RC, Pantell RH. Urine testing and urinary tract infections in febrile infants seen in office settings: the Pediatric Research in Office Settings' Febrile Infant Study. Arch Pediatr Adolesc Med 2002;156:44-54.
10. Hiraoka M, Hashimoto G, Tsuchida S, Tsukahara H, Ohshima Y, Mayumi M. Early treatment of urinary infection prevents renal damage on cortical scintigraphy. Pediatr Nephrol 2003;18:115-8.
11. Smellie JM, Ransley PG, Normand IC, Prescod N, Edwards D. Development of new renal scars: a collaborative study. Br Med J (Clin Res Ed) 1985;290:1957-60.
12. Hansson S, Jodal U. Urinary Tract Infection. In: Barratt TM, Avner ED, Harmon WE, editors. Pediatric Nephrology. 4th ed. Baltimore: Lippincott Williams & Wilkins, 1999:835-50.
13. Jodal U. The natural history of bacteriuria in childhood. Infect Dis Clin North Am 1987;1:713-29.