

# The relationship between infecting organisms and underlying structural anomalies in children with urinary tract infections

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## Abstract

**Introduction:** Urinary tract infections (UTIs) are a common cause of morbidity in childhood with potential for renal scarring and reflux nephropathy which can lead to hypertension and end-stage renal failure.

**Aim:** The aim of this study was to investigate the relationship between the infecting organism and any underlying anomalies of the urinary tract which may predispose to the development of infections and which may alter the management of children with UTIs.

**Methods and results:** A total of 72 cases of UTI were recorded retrospectively (in- and outpatients), with ages ranging from 3 days to 48 months (mean 9.5, median 5 months). Fifty seven (79%) of patients had their first reported urinary tract infection under the age of 1 year. Fifty eight (80.6%) were *E. coli* infections. These presented at an older age than non-*E. coli* infections. Investigations were abnormal in 31 (43%) cases. The mean age for first infection in patients with abnormal investigations was 7.7 months (median 2 months), younger than those with no renal tract abnormalities. Organisms other than *E. coli* were rarely found when no significant abnormalities were detected with investigation by US and MCUG and this was a statistically significant difference ( $p < 0.001$ ). Renal scarring was identified in 10 (13.9%) patients.

**Discussion:** This study confirms that non-*E. coli* UTI is associated with underlying renal pathology and that early infections with any organism are more likely to be associated with underlying abnormalities. We also outline an algorithm based on the recent NICE 2007 guidelines which will be adopted by the Paediatric Department, Mater Dei Hospital for the investigation of UTI.

## Introduction

Urinary tract infections (UTI) are not uncommon in children at all ages.<sup>1</sup> They are particularly important in infants and children under four years of age due to the association with vesico-ureteric reflux (VUR) and renal scarring. Prior to the

## Key words

Urinary Tract Infections, diagnosis, epidemiology, microbiology, therapy

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**Table 1:** Infective organisms cultured

	<i>n</i>	Percentage
<i>E. coli</i>	58	80.6
<i>Pseudomonas</i>	6	8.3
<i>Proteus</i>	3	4.2
<i>Klebsiella</i>	3	4.2
Mixed	2	2.8
Total non <i>E. coli</i>	14	19.4
<b>Grand total</b>	<b>72</b>	

**Table 2:** Infecting organism and abnormalities found on investigation

	<b>Normal investigations*</b>	<b>Abnormal investigations*</b>
<b><i>E. coli</i></b>	39	19
<b>Non-<i>E. coli</i></b>	2	12

\*Ultrasound and micturating cystourethrogram

era of aggressive investigation of UTI and the treatment of underlying pathology, renal scarring was a common occurrence, frequently resulting in reflux nephropathy with associated eventual hypertension and renal failure. A more proactive and aggressive management strategy in early childhood has resulted in a dramatic reduction of long term complications. Ultrasonographic examination (US) of the urinary tract is the initial investigation of choice in patients with UTI. Micturating cystourethrography of the bladder (MCUG) is performed at a later stage to exclude the presence of VUR, while isotope studies such as dimercaptosuccinic acid (DMSA) scans determine whether renal scarring has occurred.<sup>1,2</sup> Delay in investigating children, especially infants less than a year of age, may result in re-infection with increased risk of scarring. Known risk factors for renal scarring are younger age at infection, underlying anatomical malformations of the genito-urinary system, especially VUR, delayed treatment, and a causative pathogen other than *Escherichia coli* (*E. coli*).<sup>2,3</sup>

The aim of this study was to investigate the relationship of the infecting organism to underlying renal tract anomalies and to relate this to current UTI investigation guidelines.

### Patients and methods

All children < 4 years of age with a bacteriological diagnosis of urinary tract infection presenting to the children's ward and children's outpatient clinic from Jan 2006 to July 2007 were retrospectively included in the study. Patients only were

included in the study if a positive culture was associated with UTI symptomatology and positive urinalysis and microscopy results (presence of nitrites and white blood cells).

The infecting organism was identified and recorded and the outcome of the US of the renal tract, the MCUG and the DMSA scan were recorded. Any associated relationship between the infecting organism and any underlying renal tract anomalies were identified. Infecting organisms were divided into those caused by *E. coli* and others of the non-*E. coli* group.

For the purpose of this audit, the following definitions were used. An abnormal US of the renal tract was defined as an ultrasound study that showed any structural or anatomical abnormality of the renal tract. An abnormal MCUG indicated any degree of vesico-ureteric reflux, whether unilateral or bilateral. An abnormal DMSA scan was defined as any degree of renal scarring whether unilateral or bilateral.

Data was entered and analysed in an Excel spreadsheet. T-tests (2-tailed) were used to analyse means while Chi tests (with Yates' continuity correction) were used to compare numbers. A *p* value of <0.05 was taken to be statistically significant.

### Results

A total of 72 cases of UTI were recorded. Thirty three were male and 39 were female. The ages ranged from 3 days to 48 months with a mean age of 9.5 months (median 5 months). Fifty seven (79%) patients had their first reported urinary tract infection under the age of 1 year (figure 1).

The infecting organism reported in 58 (80.6%) patients was a member of the *E. coli* group while non-*E. coli* organisms were reported in 14 (19.4%) cases. These included *Pseudomonas*, *Proteus mirabilis*, and *Klebsiella* (Table 1). There were no gender differences by infecting organism.

The mean age at first infection with *E. coli* was 10.1 months (median 5 months) while non-*E. coli*/mixed infections occurred at a mean age of 6.5 months (median 4 months). This was not a statistically significant difference (*p*=0.17).

Investigations carried out were abnormal in 31 (43%) and normal in 41 (57%) cases. Renal anomalies included duplex kidney and/or duplex ureters and ureterocoele. No ectopic or horseshoe shaped kidneys were identified in this study.

**Table 3:** Organisms isolated in scarred and unscarred kidneys

<b>DMSA</b>	<b><i>E. coli</i></b>	<b><i>Pseudomonas</i></b>	<b><i>Proteus</i></b>	<b><i>Klebsiella</i></b>	<b>Mixed</b>	<b>Total</b>
<b>Normal (n)</b>	51	5	3	2	1	62
<b>Scarred (n)</b>	7	1	0	1	1	10
<b>Normal (%)</b>	82.3	8.1	4.8	3.2	1.6	
<b>Scarred (%)</b>	70.0	10.0	0	10.0	10.0	

The mean age for the first infection in patients with abnormal investigations was 7.7 months (median 2 months) compared to 10.8 months (median 6 months) for patients without reflux, US abnormalities or renal scarring. However, this was not a statistically significant difference ( $p=0.2$ ).

The relationship of infecting organism with abnormalities found in investigations is shown in Table 2. *E. coli* UTIs were

significantly associated with normal investigations (US and MCUG), whereas renal tract anomalies were more likely in those with UTIs due to other organisms (Table 2:  $\chi^2=10.8$ ,  $p<0.001$ ).

Renal scarring by DMSA was identified in 10 (13.9%) patients and *E. coli* was the commonest organism isolated in both scarred and unscarred kidneys (Table 3).

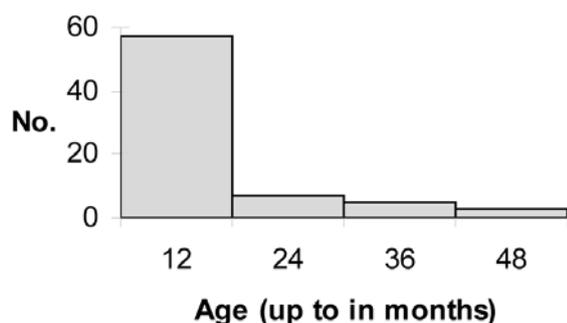
## Discussion

The results of this study indicate that non-*E. coli* UTI is associated with underlying renal pathology and that infections at a relatively younger age with any organism are more likely to be associated with underlying abnormalities.

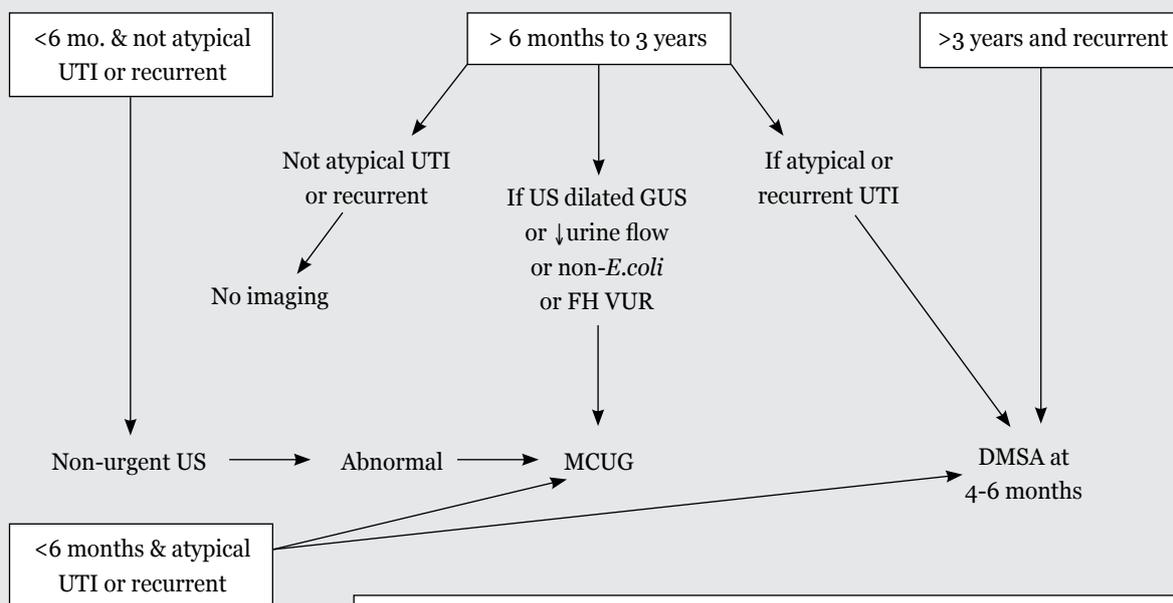
Although renal scarring is known to be associated with UTI under the age of one year, no association could be shown in our patients as the total number of patients with scarring was too small. Moreover, 2 patients with renal scarring first presented at 2 and 4 years of age respectively. Both had severe, persistent reflux requiring surgical treatment and the possibility of infections earlier in life could not be excluded.

The choice of antibiotic administration and duration of

**Figure 1:** Histogram of infections by age at initial presentation



## Management of UTI (NICE 2007)



**All atypical**, all ages (very ill, ↓urine, abdo mass, ↑creatinine, septicaemia, no response in 48h of Rx, non *E.coli*): **do urgent US**

**All recurrent**, all ages: **do non-urgent US**

**Surveillance C&S:** not routinely indicated.

**Prophylaxis:** only while investigated and continue only if abnormal findings.

treatment are dependent on the presence or otherwise of any underlying anomalies. Parenteral administration and a full 10-day course of treatment are indicated if the initial ultrasound examination shows underlying malformation/s or a dilated urinary system (which may indirectly indicate the existence of VUR or urinary obstruction). It is common practice to treat the infection and investigate at a later stage. Individual variations in the type of investigations carried out also exists. Figure 2 summarises the recent NICE (National Institute for Clinical Excellence) guidelines for the management of UTI, and this is the set of guidelines that will be adopted by the Paediatric Department.<sup>4</sup>

The findings of this study are clearly reflected in the NICE guidelines, with younger and/or toxic patients being investigated more urgently and more intensively particularly if the infecting organism is non *E. coli*, as such patients are more likely to have renal pathology that may predispose to renal scarring.

In patients with recurrent non-*E. coli* UTIs, special care should be taken for antibiotic sensitivities and referral to a urologist for possible surgical intervention.

In conclusion, UTI is a common infection in childhood and warrants prompt treatment and investigation especially in infants and younger children. Aggressive management has been shown to prevent the long-term complications associated with urinary tract infections.<sup>5</sup>

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