Prevalence of urinary tract infection in children of preschool age

ROSEMARY BOOTHMAN, M. LAIDLAW, and I. D. G. RICHARDS

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Boothman, R., Laidlaw, M., and Richards, I. D. G. (1974). Archives of Disease in Childhood, 49, 917. Prevalence of urinary tract infection in children of preschool age. 1000 children between the ages of 3 months and 5 years were screened for urinary tract infection using a dipslide technique. Significant or doubtful cultures were obtained in 13%, the rate being highest (47%) in children below the age of one year. Higher rates were obtained in girls (16%) than in boys (11%). After serial dipslide and urine examinations, 9 children were considered to have a urinary tract infection. 2 had radiological abnormalities.

In view of the uncertainty regarding the effect of treatment on the long-term prognosis of children with asymptomatic bacteriuria, it is suggested that the results of controlled studies should be awaited before any recommendation is made concerning the urinary screening of this age group.

In childhood the prevalence of urinary tract infection is second only to infection of the respiratory tract (Kass, 1956; Riley, 1964) and, while there is no evidence to suggest that untreated bacteriuria in the adult produces progressive kidney damage (Asscher, 1970), the sequelae of untreated infection in children may be more serious. British Medical Journal (1963) suggested that persistent urinary tract infection in childhood often leads to chronic atrophic pyelonephritis and renal failure.

The prevalence of urinary tract infection in childhood has been studied in the neonate and in schoolchildren (see Table 1) but little attention seems to have been paid to children of preschool age. This paper records the findings of a study in which 1000 Glasgow children between the ages of 3 months and 5 years were screened for urinary tract infection using a dipslide technique.

To distinguish between bacteriuria due to contamination before or after the collection of urine and bacteriuria due to the presence of bacteria in the bladder urine, Kass (1956) introduced the concept of 'significant bacteriuria'. The term applies to the presence of more than 100,000 organisms/ml urine, and it is now widely believed that this demarcation between infection and contamination holds true with few exceptions (Asscher, 1970).

Methods

The children studied were between the ages of 3 months and 5 years, any with known handicapping conditions being excluded. In order to obtain a reasonably representative cross-section of the population, three groups were examined.

1. Children attending local authority child health clinics (335).
2. Children attending day nurseries (628).
3. A small group of children visited at home in the course of a study of child development (37).

Urine was voided into a sterile disposable gallipot without preliminary cleaning; it was used to inoculate an Oxoid dipslide which was then incubated overnight at 37 °C in the City Laboratory. The slides were all read by one observer (ML) against the standards published by the manufacturers, the results being recorded as follows.

Significant = more than 100,000 organisms/ml.
Doubtful = 10,000 to 100,000 organisms/ml.
Negative = less than 10,000 organisms/ml.

In the cases reported as having significant bacteriuria or a doubtful growth, a further dipslide was obtained for culture and the urine itself was examined microscopically and cultured. No special cleaning up procedure was used except in the case of 2 babies and 2 older children who were not 'socially clean'. For every child in the study the nursery school staff, clinic health visitors, or parents were asked about symptoms suggestive of urinary tract infection.

The following rules were adopted at the beginning of the study. (1) After a significant culture, whenever...
possible 3 negative cultures were sought before a child was discharged from the study. (2) After a doubtful culture, one negative culture was required before a child was discharged. (3) A diagnosis of urinary tract infection was made when 3 dipslide cultures were significant, or if there were persisting significant and doubtful cultures. Children with the infection were referred to the Renal Unit at the Royal Hospital for Sick Children, Glasgow, for further investigation.

In order to ensure that the method was technically reliable and that the results were being correctly recorded two control studies were undertaken. In the first, urine specimens from 220 children were examined by standard laboratory methods and the results compared with the dipslides. In the second, 230 duplicate slides were sent to the Bacteriology Department of the Royal Hospital for Sick Children for culture and examination.

Results

Validation of the method. The comparison of dipslide and urine cultures from 220 children is shown in Table II. Negative results were recorded for 154 dipslides; 4 of the related urine cultures were reported as significant and 2 as doubtful. Repeat urine cultures from these 6 children were negative and the initial false positive results are attributable to a delay of several hours between voiding and plating out the specimens. 35 dipslides were reported as positive; 7 of the related urine cultures were recorded as negative and repeat cultures were also negative.

The comparison of dipslide cultures in the study and control laboratories is shown in Table III. 187 slides were reported as negative in the study laboratory; none of the duplicates from these children was reported as significant by the control laboratory and only 3 as doubtful. 19 were reported as significant by the study laboratory; 17 of the duplicate slides were reported by the control laboratory as positive and two as doubtful.

Main results. Dipslide cultures from 545 boys and 455 girls were examined. The results of the initial cultures are shown in Table IV. Overall, 13 % had significant or doubtful cultures but the rate varied with the child's age, the highest rate (47%) being in children below the age of one year. The rate then decreased to 4 % in children aged 4 years. With the exception of 4-year-old children, girls had a higher rate of significant or doubtful cultures than boys. Overall, 16 % of girls had significant or doubtful cultures and 11 % of boys; this difference is significant (P < 0.05), but none of the age-specific sex differences is significant.

Details of the children with urinary tract infection

<table>
<thead>
<tr>
<th>Dipslide</th>
<th>No.</th>
<th>Urine</th>
<th>Significant</th>
<th>Doubtful</th>
<th>Negative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Significant</td>
<td>35</td>
<td>28</td>
<td>0</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>Doubtful</td>
<td>31</td>
<td>2</td>
<td>0</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Negative</td>
<td>154</td>
<td>4</td>
<td>2</td>
<td>148</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>220</td>
<td>34</td>
<td>25</td>
<td>161</td>
<td></td>
</tr>
</tbody>
</table>
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TABLE III
Comparison of dipslide cultures in the study and control laboratories

<table>
<thead>
<tr>
<th>Study Laboratory</th>
<th>No.</th>
<th>Control Laboratory</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Significant</td>
</tr>
<tr>
<td>Significant</td>
<td>19</td>
<td>17</td>
</tr>
<tr>
<td>Doubtful</td>
<td>24</td>
<td>1</td>
</tr>
<tr>
<td>Negative</td>
<td>187</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>230</td>
<td>18</td>
</tr>
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</table>

TABLE IV
Sex and age distribution of initial dipslide cultures and cases of urinary tract infection

<table>
<thead>
<tr>
<th>Age (yr) and sex of children</th>
<th>3/12</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4+</th>
<th>All ages</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>F</td>
<td>M</td>
<td>F</td>
<td>M</td>
<td>F</td>
</tr>
<tr>
<td>Dipslide culture</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Significant</td>
<td>4</td>
<td>9</td>
<td>11</td>
<td>11</td>
<td>6</td>
<td>11</td>
</tr>
<tr>
<td>Doubtful</td>
<td>1</td>
<td>3</td>
<td>9</td>
<td>12</td>
<td>15</td>
<td>11</td>
</tr>
<tr>
<td>Negative</td>
<td>10</td>
<td>9</td>
<td>46</td>
<td>38</td>
<td>185</td>
<td>146</td>
</tr>
<tr>
<td>Total</td>
<td>15</td>
<td>21</td>
<td>66</td>
<td>61</td>
<td>206</td>
<td>168</td>
</tr>
<tr>
<td>Percentage</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>significant or doubtfull</td>
<td>33</td>
<td>57</td>
<td>30</td>
<td>38</td>
<td>10</td>
<td>13</td>
</tr>
<tr>
<td>Cases of UTI</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number</td>
<td>47</td>
<td>34</td>
<td>11</td>
<td>8</td>
<td>4</td>
<td>13</td>
</tr>
<tr>
<td>Percentage</td>
<td>2</td>
<td>0</td>
<td>4</td>
<td>1</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>5.6</td>
<td>3.9</td>
<td>0.5</td>
<td>0.0</td>
<td>0.0</td>
<td>0.9</td>
</tr>
</tbody>
</table>

are shown in Table V. The initial dipslide had been significant in 8 and doubtful in one. At the Renal Clinic, serial urine examinations failed to confirm infection in Cases 4, 6, 7, and 9. It is thought that Case 3 was infected and that the changing urine pattern was due to administration of antibiotics for a chest infection; 2 further children (Cases 1 and 8) were given antibiotics by their general practitioners because of suspected urinary tract infection. 3 children had symptoms—feeding problems (Case 1), frequency, dysuria, and abdominal pain (Case 8), and nocturnal enuresis (Case 9). The intravenous pyelogram was normal in these 3 children. Cases 1 and 8 were admitted to hospital for treatment of urinary tract infection and Case 4 for isotope renography. A duplex kidney was found in one child (Case 2) and impaired renal function, described as 'difficult to interpret', in another (Case 4).

Discussion
The dipslide technique, introduced by Guttmann and Naylor (1967), has been shown to be a useful and reliable quantitative method in screening for bacteriuria (Arneil, McAllister, and Kay, 1970, 1973; Arneil, 1972, 1973; Savage et al., 1973). The control studies conducted as part of our investigation confirm the reliability of this method. 13% of the initial dipslides gave significant or doubtful cultures. The rate decreased with age, and this trend may be associated with the greater difficulty of obtaining uncontaminated specimens in the earlier years. It is estimated that if equal numbers had been screened in each age group, the rate would have been approximately 20%.

Although we attempted to follow closely the rules laid down at the start of the survey, in a small number of instances we were unable to obtain 3 negative cultures before discharging a patient after a significant result, or to obtain a negative after a doubtful culture. Reasons for this include parental anxiety and difficulty in tracing some children. We believe that few, if any, cases of urinary tract infection were missed as a result of incomplete follow-up. Whether any cases of the intermittent bacteriuria of early pyelonephritis (Gower et al., 1968) are overlooked in a study such as this can be determined only by an investigation in which serial dipslide cultures are made over several months.

The prevalence of urinary tract infection in this
study (9/1000) falls between the rate recorded in previous studies of neonates and schoolchildren (Table I). However, it should be realized that the number of children at different ages in our study varied greatly, and we estimate that there were equal numbers in each group, the overall prevalence would be 2.2%.

Of the 9 children with urinary tract infection, 6 were boys and all were aged less than 3 years. This higher prevalence among boys is in contrast to the female excess of significant or doubtful cultures obtained from the initial dipslides. A higher frequency of infection in male neonates than in females has often been recorded (e.g. Craig, 1935; Neumann and Pryles, 1962; Stansfeld, 1966; Bergström, 1972; Littlewood, 1972) and has been attributed to a greater prevalence of congenital abnormalities of the urinary tract in males (Hutchison, 1965) and to the mode of infection thought usually to be blood-borne (Littlewood, 1972). In contrast, the prevalence of bacteriuria in schoolchildren shows a marked excess among girls, and Kunin (1968) has reported that the prevalence rises steadily with age with an annual acquisition rate of 0.32%. Mair (1973) found that 40% of children with so called 'asymptomatic bacteriuria' in fact had symptoms of urinary tract infection. In our study, one child (Case 8) had such symptoms at the time of the investigation and another child (Case 1) had feeding problems; the remainder were symptom free.

Radiographic abnormalities of the urinary tract are often found in children with bacteriuria (Kunin et al., 1960, 1962; Meadow et al., 1969; Asscher et al., 1973; Mair, 1973; Savage et al., 1973). Vesicoureteric reflex is a commonly reported defect and Smellie and Normand (1968) have shown that in such children an uncontrolled urinary tract infection leads to impaired kidney growth and the development of renal scarring; reduction of the infection results in improved kidney growth and prevents further scarring. In our study only 2 of the 9 children investigated radiographically were found to have renal abnormalities; one had a congenital lesion and another had impaired renal function of unknown cause. This low prevalence of kidney defects may be due to the early age at which these children were examined; it could be that renal scarring and impaired growth are detected radiographically only after a longer exposure to infection.

It has been estimated by Kunin (1968) that 5% of girls leaving school have had a urinary tract infection, while Arneil (1973) and Savage et al. (1973) suggest that the Scottish figure is likely to be higher than this. Many of these children have x-ray abnormalities of the urinary tract, and Kunin (1971) and Arneil (1973) have both called for the general introduction of screening of schoolgirls for urinary tract infection. Meadow et al. (1969) emphasized the need for careful long-term studies before recommending screening on a national scale, and the outcome of studies such as that of Asscher et al. (1973) is awaited with interest.

Our investigations indicate that urinary screening...
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V

<table>
<thead>
<tr>
<th>Micturating cystogram</th>
<th>Remarks</th>
<th>Urine at renal clinic</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>Feeding problems; antibiotics prescribed by GP after first dipslide</td>
<td>Esch. coli</td>
<td>Nitrofurantoin</td>
</tr>
<tr>
<td>Normal</td>
<td>Atrioseptal defect</td>
<td>Proteus</td>
<td>Sulphadimidine</td>
</tr>
<tr>
<td>Normal</td>
<td>Isotope renogram showed impaired function of right kidney</td>
<td>Esch. coli</td>
<td>Nitrofurantoin</td>
</tr>
<tr>
<td>Normal</td>
<td>Frequency, dysuria, abdominal pain; antibiotics prescribed by GP</td>
<td>Normal</td>
<td>Nil</td>
</tr>
<tr>
<td></td>
<td>Nocturnal enuresis</td>
<td>Protein</td>
<td>Sulphadimidine</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Normal</td>
<td>Nil</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Normal</td>
<td>Nil</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Esch. coli</td>
<td>Nalidixic acid</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Normal</td>
<td>Nil</td>
</tr>
</tbody>
</table>

in children of preschool age would give a low yield of cases of infection; their detection would lead to the identification of only a small number of congenital anatomical anomalies of the urinary tract. It is uncertain how the long-term prognosis is affected by treatment and we believe that the results of controlled studies are required before any recommendation can be made regarding the screening of this age group.

We thank all who participated in this study, the children and their parents, and the day nursery and clinic staffs who collected the specimens; Dr. T. McAllister and his staff for examining the duplicate dipslides and the technical staff of the City Laboratory; Professor G. C. Arneil and Dr. Anna Murphy for investigating the children with urinary tract infection, Professor J. H. Hutchison for helpful advice, and Miss M. Tinning for clerical assistance.

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References


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