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Urinary infection in children in general practice: a laboratory view

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SUMMARY

Children with urinary infection present at first to their general practitioners; paediatricians to whom they may be referred must assess the validity of the bacteriological diagnosis made at that time. With this in mind an analysis has been made of the laboratory findings in 2204 mid-stream urine specimens from 1586 children between the ages of two and 12 years examined at the request of their general practitioners during the course of one year.

The contamination rate was shown to be low; 8% of the specimens from boys and 19% of those from girls showed definite infection, and the ratio of infections in boys to girls was 1:4. There was a considerable difference in the infecting organisms in the sexes.

Analysis of the reasons for sending the specimens revealed that a high percentage of children who complained of urinary symptoms did not have infection. Of the children complaining of enuresis only there was a significantly greater incidence of infection in girls than in boys.

In the absence of any large studies of urinary infection in domiciliary practice, data from a laboratory which serves many practitioners can contribute to knowledge of the disease.

INTRODUCTION

During the past twenty years there has been increasing interest in urinary-tract infection in children. This has led to a greater understanding of the natural history of the disease and has also provided much evidence about related problems such as vesico-ureteric reflux and renal scarring. Despite many studies there is, as yet, an imperfect understanding of these conditions and of the relevance of bacterial infection to them. However, the finding of urinary infection is, at present, the only way in which children with these conditions are identified, and consequently the reliable diagnosis of bacteriuria is of paramount importance. Careful studies have established satisfactory techniques for detection of bacteriuria by means of screening programmes (Savage & Wilson, 1973; Asscher *et al.* 1973; Newcastle A.S.B. Research Group, 1975), but it must be borne in mind that the majority of children who undergo hospital investigations for urinary tract infection are originally diagnosed by their general practitioner. Confirmation of the diagnosis is made by urine culture at the time when the child has symptoms, and antibiotic therapy is almost invariably given; if the practitioner decides to refer the child for

investigation the mid-stream urine (M.S.U.) taken at the out-patient clinic may well be sterile. The only evidence, therefore, that the child has had urinary infection is the report of the M.S.U. collected according to the practitioner's instructions, conveyed to the local laboratory and examined at his request. Aware of the problems of contamination and delay in transport of specimens to laboratories, paediatricians may question the validity of the original diagnosis and place reliance only on the hospital findings. The danger of such an attitude is that recurrences are unlikely to occur conveniently on the days of hospital appointments and infection may therefore be missed.

In view of this problem we thought it would be useful to look critically at all urine specimens from children sent to our laboratory by general practitioners over the course of one year, in an effort to assess the validity of the findings and to determine to what extent the problems of initial contamination and bacterial growth during transport may detract from the reliability of the diagnosis. By providing M.S.U. collection instruction sheets, dip-inoculation spoons (Mackey & Sandys, 1965), collecting points at outlying hospitals where specimens can be refrigerated and facilities at the laboratory for patients to attend to pass a urine specimen we have attempted to minimize the problems of contamination and transport. We do not, however, believe that all practitioners who send specimens to the laboratory make use of these facilities, and the total number of specimens of which we have analysed the findings is likely to include many collected and transported under far from ideal conditions. In the course of this analysis, in addition to making some assessment of the contamination problem, we have also observed striking differences in the organisms causing infection in boys and in girls, some pointers to the relative incidence of infection in the sexes, and some information about presenting symptoms and bacteriological response to treatment.

METHODS

All urine specimens were cultured on CLED (cysteine lactose electrolyte deficient) agar using a fused platinum standard loop (0·005 ml.). Microscopy was carried out on the deposit after centrifugation at 2000 rev./min. for 5 min.

Definite infection was diagnosed by a finding of 10^8 organisms/l. in pure culture. Specimens yielding a pure growth of 10^7/l. or mixed growths of 10^7/l. or greater were classified as doubtful, and specimens yielding growths of less than 10^7/l. or no growth as negative. Pyuria was classified as gross (more than 10 leucocytes/high power field) or intermediate (2–10 leucocytes/h.p.f.). The presence of any red cells in the deposit was recorded as microscopic haematuria.

The reasons for sending the specimen were recorded from the practitioner's request form. These were classified as the presence of urinary symptoms (dysuria, frequency, macroscopic haematuria), enuresis only, non-urinary symptoms only and follow-up.

RESULTS

Number and source of specimens

During the year from May 1974 to April 1975, 2204 urine specimens were received from 1586 children between the ages of two and 12 years, 755 from 563 boys

Table 1. *Results of* 2204 *M.S.U. specimens from* 1586 *children,* 2–12 *years of age, examined at the request of their general practitioners, May* 1974 *to April* 1975

Result	Culture	Boys	Girls
Positive	10^8/l. pure culture	61 (8 %)	271 (19 %)
Doubtful	10^7/l. pure culture	50	69
	$\geqslant 10^7$/l. mixed culture	54 (13 %)	204 (19 %)
Negative	$< 10^7$/l.	69	93
	No growth	521 (79 %)	812 (62 %)
Totals		755	1449

Table 2. *Reasons for sending* 755 *specimens from* 563 *boys*

Classification of culture	Urinary symptoms	Enuresis only	Other symptoms only	Follow-up	No data	Total
Positive	39	3	7	12	0	61
Doubtful						
10^7/l. pure culture	19	2	6	22	1	50
$\geqslant 10^7$/l. mixed culture	21	9	6	18	0	54
Negative						
$< 10^7$/l.	27	13	9	20	0	69
No growth	193	127	96	96	9	521
Totals	299	154	124	168	10	755

and 1449 from 1023 girls. These specimens were examined at the request of 188 general practitioners, 90 % of the total number in the area served by the laboratory.

Classification of culture findings

Table 1 shows the findings for boys and for girls. Only 61 (8 %) of the 755 specimens from boys and 271 (19 %) of the 1449 specimens from girls showed definite infection. These infections were diagnosed in 56 boys and 231 girls, a ratio of 1:4 (Table 4). Cultures from 521 specimens from boys and 812 from girls yielded no bacterial growth.

Reason for sending the specimens

Only 28 forms gave no clinical data.

The reasons for sending the specimens from boys and from girls are shown in Tables 2 and 3 respectively. Of the 299 specimens sent from boys complaining of urinary symptoms only 39 (13 %) showed definite infection and a further 40 (13 %) gave a doubtful result; 220 (74 %) were negative on culture. Of the 623 specimens sent from girls complaining of urinary symptoms 170 (27 %) showed definite infection, and 131 (21 %) gave a doubtful result; 322 (52 %) were negative on culture. The difference between these findings in boys and in girls is highly

Table 3. *Reasons for sending* 1449 *specimens from* 1023 *girls*

Classification of culture	Urinary symptoms	Enuresis only	Other symptoms only	Follow-up	No data	Total
Positive	170	16	29	53	3	271
Doubtful						
10^7/l. pure culture	40	2	7	20	0	69
$\geqslant 10^7$/l. mixed culture	91	23	28	60	2	204
Negative						
$< 10^7$/l.	46	9	15	23	0	93
No growth	276	78	147	298	13	812
Totals	623	128	226	454	18	1449

significant ($\chi^2_2 = 41{\cdot}78$, $P = < 0{\cdot}001$). 154 specimens were sent from boys on account of enuresis only; 3 (2%) showed definite infection and 11 (7%) gave a doubtful result. Of the 128 specimens sent from girls for this reason 16 (12%) showed definite infection and 25 (19%) gave a doubtful result. The difference between this finding in the two sexes is highly significant ($\chi^2_2 = 25{\cdot}54$, $P = < 0{\cdot}001$).

Causative organisms

Table 4 shows the causative organisms in the definite infections, and in those classified as doubtful which yielded a pure growth of 10^7 organisms/l.; the organisms are listed separately for boys and girls. The numbers of children are given in brackets beneath the totals.

Microscopy

The association of pyuria and microscopic haematuria with infection is shown in Table 5.

Of the specimens yielding pure growths of 10^7/l. 23 (33%) of those from girls, and 3 (6%) of those from boys showed gross pyuria, 3 (4·5%) from girls and 3 (6%) from boys showed intermediate pyuria, and 8 (12%) from girls and 2 (4%) from boys showed microscopic haematuria.

The presence of any leucocytes or red cells in the deposit of those specimens yielding mixed growths or growths of less than 10^7/l. was analysed. Of the 123 male specimens in these categories 17 (14%), and of the 297 female specimens 66 (22%) had some cells in the deposit.

Of the 521 male and 812 female specimens which yielded no growth on culture only 20 male (4%) and 67 female (8%) had any cells in the deposit. In over half of these (11 male and 35 female) a definite explanation for the presence of the cells was obtained. These explanations included glomerulonephritis, known chronic pyelonephritis, recurrent proved urinary tract infection, neurogenic bladder, and recent circumcision.

Table 4. *Causative organisms in definite* (10^8/*l.*) *and possible* (10^7/*l. in pure culture*) *infections in* 99 *boys and* 297 *girls*

Organism	Boys		Girls	
	10^8	10^7	10^8	10^7
E. coli and other coliforms	28	15	241	55
Proteus spp.	28	29	13	5
Pseudomonas aeruginosa	0	0	0	2
Coagulase-negative staphylococci	2	0	9	2
Streptococcus faecalis	3	6	7	3
Group B streptococcus	0	0	0	1
Staphylococcus aureus	0	0	1	1
Totals				
Infections	61	50	271	69
Children	(56)	(43)	(231)	(66)

Table 5. *Incidence of pyuria and haematuria in specimens yielding* 10^8 *organisms/l. and* 10^7 *organisms/l. in pure culture*

	10^8/l.		10^7/l. (pure culture)	
	Boys (61 specimens)	Girls (271 specimens)	Boys (50 specimens)	Girls (69 specimens)
Pyuria				
Gross	29 (48%)	166 (61%)	3 (6%)	23 (33%)
Intermediate	1 (0·5%)	11 (4%)	3 (6%)	3 (4·5%)
Haematuria	9 (15%)	44 (16%)	2 (4%)	8 (12%)

Results of treatment

Specimens were received within 4 weeks of treatment of 179 definite infections and 47 infections in the 10^7/l. pure culture group. From the remaining children in these categories either no further specimens were received, or the follow-up specimen was received more than four weeks after the infection, or the request form did not state that the child had received antibacterial treatment. Of the 179 post-treatment specimens from children with definite infection 126 (70%) gave a negative culture, 26 (14·5%) gave a doubtful culture and 27 (15·5%) showed definite infection. Of the 47 post-treatment specimens from children in the 10^7/l. group 38 (81%) gave a negative culture, 6 (13%) gave a doubtful culture and 3 (6%) showed definite infection.

DISCUSSION

The figures in Table 1 suggest that the quality of specimens received from children is good and that the contamination rate is no higher than that of M.S.U.s received from the general population (Maskell, 1974). If, for reasons given later in the discussion, the specimens yielding a pure growth of 10^7/l. are regarded as positive rather than doubtful, as was done in the survey referred to (Maskell, 1974), the percentage of contaminated specimens decreases further to 6·5% from boys and 14% from girls.

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The method used for assessing the reasons for sending the specimens is obviously open to criticism; information on request forms is often incomplete. We are, however, fortunate that the practitioners whom we serve in this area fill in request forms carefully (only 28 forms gave no clinical data) and it seems justifiable to draw some conclusions. It is apparent that the presence of urinary symptoms, either in boys or in girls, is not diagnostic of bacterial infection; only 13 % of the boys and 27 % of the girls complaining of these symptoms had definite infection. It was found significantly less frequently in boys with urinary symptoms than in girls. Uncertainties such as the possibility of antibiotic therapy before collection of the specimen may well make these figures an underestimate, but it seems clear that a high proportion did not have infection and that the diagnosis cannot be made on clinical grounds alone. This finding is in agreement with those of several studies on adult females (Gallagher, Montgomerie & North, 1965; Mond, Percival, Williams & Brumfitt, 1965; Steensberg *et al.* 1969). The possibility that these symptoms were due to another infective cause such as a virus was considered. However, the cases were distributed evenly throughout the year which makes this, as the sole explanation, less likely. It is also interesting that infection was a rare finding in boys complaining of enuresis only, whereas in girls, from whom fewer specimens were sent for this reason, infection was found significantly more often. When the reasons for sending specimens were analysed for individual practitioners it was clear that the use made of the laboratory differed widely. For example, some practitioners sent no specimens from girls, but several from boys, suggesting that the diagnosis is made clinically in girls, but confirmed by culture in boys. Likewise some practitioners sent many specimens from children complaining of enuresis only whereas others sent none for this reason. The specimens sent for reasons other than urinary symptoms were received from only a minority of the practitioners, indicating that the diagnosis of urinary infection is not often considered in the absence of localizing symptoms.

The striking difference between the infecting organisms in boys and girls has also been noticed by Bergström (1972) and Mann (1972). In order to comply with accepted criteria we classified pure growths of 10^7/l. as of doubtful significance although we consider it likely that many of these children had significant urinary infection. Of the girls in this category 33 % had gross pyuria. In the case of the boys, data from another study (Maskell, Pead & Hallett, 1975) showed that swabs from the foreskin and meatal area seldom yielded pure growths; we suggest that pure growths in low counts may indicate the presence of infection in the urethra or possibly the prostatic ducts. The high incidence of *Proteus* spp. as the infecting organism in the 10^8/l. group of boys, and the preponderance of *Proteus* spp. over other organisms in the 10^7/l. group suggests that these organisms may have a particular affinity for the urethra or prostatic ducts in boys and may cause ascending infection from this site from time to time.

As expected, the overwhelming majority of infections were caused by coliform organisms and *Proteus* spp.; *Pseudomonas* was isolated from only two children and both were known to have abnormalities of the urinary tract. Of the 13 strains of coagulase-negative staphylococci, nine were isolated during a period when these

organisms were being typed in the laboratory by the Baird-Parker method (Baird-Parker, 1963): 5 strains belonged to the subgroups of staphylococcus II, V and VI; 3 strains were micrococcus subgroup 3; and 1 strain was micrococcus subgroup 7. Although coagulase-negative staphylococci are more commonly isolated in significant growth from young women (Mabeck, 1969; Maskell, 1974; Meers, 1974; Sellin *et al.* 1975) it is clear that they can occasionally cause infection in children.

The incidence of pyuria in relation to the finding of infection is similar to that reported in other studies. It is interesting that the presence of cells in the deposit in the absence of any growth on culture was rare, and that in over half the cases a definite explanation for their presence was found.

The observation that 70% of the post-treatment specimens received gave negative cultures indicates that the great majority of infections respond to short courses of antibacterial therapy. It is interesting that 38 of the children in the 10^7/l. pure culture group (81% of those from whom follow-up specimens were received) had sterile specimens after antibacterial therapy. This suggests that the organisms isolated were in the urinary tract rather than contaminants from extraneous sources, and further supports the view that a pure growth of 10^7/l. should be regarded as indicative of infection. As all such growths were reported as significant, and sensitivities given (unlike the specimens yielding mixed growths when the report was accompanied by a request for a carefully collected repeat specimen and no sensitivities were given) it seems likely that the follow-up specimens were collected and transported in the same way as the original specimens, and that, therefore, the negative culture after treatment was unlikely to be due to more careful technique.

It is accepted that the majority of patients with urinary tract infection are diagnosed and treated by general practitioners; it is likely that a better understanding of the natural history of the disease, and the way in which those at risk from complications may be identified must come from studies on patients seen in general practice. The number of patients seen by individual practitioners is usually too small to provide a meaningful amount of information; a laboratory which serves a large area, by making observations such as those recorded here can not only evaluate its own work but can also identify patients for investigation and contribute to a greater understanding of the disease.

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