Urinary tract in schoolgirls with covert bacteriuria


From the Departments of Diagnostic Radiology, Child Health, and Medicine, Welsh National School of Medicine, Cardiff; and the Departments of Diagnostic Radiology, Medicine, and Surgery, United Oxford Hospitals, and Public Health Laboratory, Oxford

McLachlan, M. S. F., Meller, S. T., Verrier Jones, E. R., Asscher, A. W., Fletcher, E. W. L., Mayon-White, R. T., Ledingham, J. G. G., Smith, J. C., and Johnston, H. H. (1975). Archives of Disease in Childhood, 50, 253. Urinary tract in schoolgirls with covert bacteriuria. During screening of 16 800 primary schoolgirls, aged 4–12 years, in Cardiff and Oxford, significant bacteriuria was found in 294 (1.7%). Intravenous urography and micturating cystography were performed in 246 of these girls. The urinary tract was abnormal in 47%. Pyelonephritis with or without vesicoureteric reflux was present in 26% and reflux without renal abnormality in a further 16%. The prevalence of pyelonephritis and reflux was independent of age. With few exceptions kidneys without pyelonephritic scars appeared to be normal in size, even when ureteric reflux was present.

Covert bacteriuria, which describes significant bacteriuria (Kass, 1956) detected by a screening programme (Kunin, Deutscher, and Paquin, 1964), occurs in 1–2% of young schoolgirls (Kunin et al., 1964; Savage et al., 1969; Meadow, White, and Johnston, 1969). We present the radiological observations in the urinary tract in 246 schoolgirls aged 4–12 years with covert bacteriuria in Cardiff and Oxford. These observations will form a basis on which to assess change during the next 4 years.

Patients and methods

Techniques used to screen primary schoolgirls aged 4–12 years in Cardiff and Oxford for significant bacteriuria are described elsewhere (Asscher et al., 1973b). Of 16 800 girls tested, 294 (1.7%) showed significant bacteriuria, defined as more than 10⁹ organisms/ml urine (Kass, 1956) in at least two consecutive midstream specimens. Intravenous urography and micturating cystography were performed in 246 of these bacteriuric children; 180 were examined in Cardiff, 66 in Oxford. Both examinations were performed on the same afternoon, nearly always by the same teams of radiologist, radiographers, and nurses. Parents were advised to give their child a light breakfast on the morning of the examinations and to discourage her from drinking, and also to give her a laxative on the two evenings immediately before the examinations.

Micturating cystography was performed first. The child was placed on a tilting x-ray table. The bladder was catheterized (4.5–9 FG catheter) and drained. This urine was cultured at once. A control film of the bladder area was taken, using 70 mm film in Cardiff and a conventional x-ray in Oxford. Sterile sodium or meglumine diatrizoate containing approximately 150 mg iodine/ml was allowed to run into the bladder under gravity from a height of 100–120 cm. While the bladder filled it was screened intermittently at 0.25–0.5 mA and 60–80 kV. Any abnormality was x-rayed, particularly the upper extent of any ureteric reflux. When the child was ready to urinate, the table was tilted. In Cardiff, the table was placed vertical, the child was turned into the lateral or, more commonly, a steep oblique position, the catheter was removed and the child allowed to urinate into a funnel-mouthed container placed between her thighs. Micturation was intermittently recorded at 3 frames/s at 0.03 mA and 100–120 kV using 70 mm film (Kaude and Reed, 1969). In Oxford, the table was tilted 20° to the feet and micturation was recorded on a spot-film device with the child supine (Edwards, 1972). Again, the upper extent of any reflux was recorded. Intravenous urography was then performed. Technique in the two cities was identical. This consisted of a full-length control x-ray, x-rays of the renal area, 3 and 8 min after intravenous injection of 1.25 ml/kg bodyweight of sodium and meglumine diatrizoate (Urovison), and a full length x-ray at 12 min. Examinations were conducted on a

Received 24 September 1974.

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standard Bucky table with a tomographic attachment at 100 cm FFD, 60–90 mA, and 60–65 kV. Abdominal compression was not used. Examinations were monitored by a radiologist and further views obtained if necessary. Tomography was rarely required. Measures were taken to minimize radiation to the ovaries.

Renal length was measured, usually on the 3-min film. Pyelonephritis was defined according to Hodson (1968) and included kidneys showing a discrepancy in length of more than 15 mm in the absence of unilateral duplex (Stolpe, King, and White, 1967), even if no scarring was present. In cases of unilateral disease, the opposite kidney was considered to show compensatory hypertrophy if its length exceeded by more than 5 mm the distance between the superior border of the first lumbar vertebra and the inferior border of the fourth, including intervening discs (Stolpe et al., 1967).

Results

Of the 246 children 47% had an abnormal urinary tract (Fig. 1). Pyelonephritis with or without vesicoureteric reflux was observed in 26%; reflux without renal abnormality occurred in a further 16%. Catheter specimens of urine were negative in 20% of bacteriuric children. The prevalence of abnormality (42%) was similar in this subgroup. Fig. 2. indicates renal lengths in child-

![Graph showing renal lengths in children without scarred or duplex kidneys.](http://adc.bmj.com/)

**Fig. 2.**—Renal lengths in children without scarred or duplex kidneys. Kidneys drained by ureters without reflux ●; kidneys drained by ureters with reflux ○; mean renal length for normal children ———; ± 1SD (Hodson et al., 1962) ———.
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Renal lengths in children with scarred, nonduplex kidneys. Scarred kidneys \(\triangle\); contralateral unscarred kidneys drained by ureters without reflux \(\bullet\); contralateral unscarred kidneys drained by ureters with reflux \(\odot\); mean renal length for normal children \(-\); \(\pm\) 1SD (Hodson et al., 1962) \(-\).
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Discussion

The prevalence of covert bacteriuria (1.7%) in primary schoolgirls in Cardiff and Oxford resembles that observed elsewhere in this country (Savage et al., 1969; Meadow et al., 1969) and the United States (Kunin et al., 1964). We confirm the findings of Savage et al. (1973) that radiological examination of schoolgirls with covert bacteriuria detects abnormality of the urinary tract in nearly 50%. Like them, we showed vesicoureteric reflux in one-third and pyelonephritic scarring in one-quarter. The prevalence of abnormality is the same in children in whom urinary tract infection has declared itself (Smellie et al., 1964). We found bilateral abnormality in 22% of children with pyelonephritic kidneys. One-third of these kidneys showed extensive disease, being markedly shrunken or scarred in more than one site. The upper pole was most frequently involved, as Hodson (1968) observed. Like him, we occasionally saw scars with little or no calyceal deformity. The earliest lesion, in his view, is retarded growth of one kidney. However, we seldom noted unscarred kidneys which were asymmetrical in length and few showed compensatory hypertrophy. The length of the normal adult kidney is well correlated with its post-mortem weight (Griffiths, Cartwright, and McLachlan, 1975) and it is likely that the same is true in childhood (Hodson et al., 1962). Though it has been said (Smellie et al., 1964; Smellie, 1967) that sterility of the urine is necessary to prevent scarring and to allow kidneys to grow normally, we did not find that older children with bacteriuria had small kidneys or a greater prevalence of scarring, even if reflux was present. Serial studies (McRae, Shannon, and Utley, 1974) also suggest that moderate reflux does not restrict renal growth.

Our observations are consistent with those of Hodson (1968) that scarring usually appears in the first few years of life. Hodson's view (1969), endorsed by Bailey (1973), is that scarring is initiated by reflux of urine into the substance of the kidney. This has been noted in the immature kidney of infants (Rolleston et al., 1970), piglets (Hodson, 1974), and rats (M. Morgan and A. W. Asscher, in preparation). Our failure to observe intrarenal reflux may be due to the age of the child-

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**Fig. 4.—Prevalence of pyelonephritis in each age group.**

**Fig. 5.—Prevalence of pyelonephritis at each grade of vesicoureteric reflux (defined in text).**

**Fig. 6.—Grade and prevalence of reflux in each age group.**

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We agree with Maling and Hodson (1974) that its demonstration requires careful technique. The diagnosis of straightforward vesicoureteric reflux may not require elaborate radiological methods. Savage et al. (1973), whose simple technique of cystography consisted of 3 x-rays without fluoroscopic screening, observed reflux as often as we did. Occasionally, severe reflux may be suggested by ureteric striations visible at intravenous urography (Gwinn and Barnes, 1964; Silber and McAllister, 1970). Frequently the upper urinary tract appears normal (Hutch, Miller, and Hinman, 1963). We would have missed many examples of reflux had we followed a policy, proposed by Bailey (1973), of avoiding cystography in children over 5 years old with a normal excretion urogram. One child in 4 in whom reflux was gross enough to distend calyces showed no renal lesion at excretion urography. Though we noted no significant decrease in the prevalence of reflux with age, serial studies during long-term chemotherapy (Stephens, 1963; Smelie, 1967; Rolleston et al., 1970) have found that reflux tends to become less severe with time and may remit completely. It is likely that remission results from maturation of the vesicoureteric junction (Hutch, 1961b). This would explain the existence of dilated ureters or vesicoureteric diverticula, abnormalities associated with reflux (Hutch, 1961a; Stephens, 1963) in children in whom no reflux was shown. However, remission may not occur, even in adults. Williams et al. (1968) found reflux in 21% of women in whom bacteriuria had been detected during a previous pregnancy.

Studies of the point prevalence of abnormalities of the urinary tract can give only limited information on the effects of covert bacteriuria. Though we revealed much unsuspected disease, we consider that the value of screening schoolgirls for bacteriuria is still undecided. Our observation that many children, including those with an abnormal urinary tract, had sterile catheter specimens of urine emphasizes that bacteriuria is not a stable condition which can be detected in a single survey. Covert bacteriuria puts children at risk of developing frank urinary tract infections in later life (Kunin, 1971), but appears not to produce progressive renal disease in adult females (Asscher et al., 1973a). Further longitudinal studies are required to define any relation which may exist in childhood between bacteriuria and progressive renal damage. The results presented here form part of such a study and will be compared with later radiological observations. Our present measurements of unscarrred kidneys do not, in general, indicate failure of renal growth; the distribution of pyelonephritis with age suggests that scarring occurred before these children entered school. Attempts to prevent renal damage should probably be directed towards children of preschool age. The feasibility of screening children of this age for bacteriuria has recently been shown (Davies et al., 1974).

We acknowledge help received from nurses and radiographers in both cities, and are especially grateful to Mrs. J. Kidd, Mrs. M. Dawes, Mrs. D. Haddock, Mr. C. Latto, and Mr. and Mrs. E. Roberts. Invaluable help was also provided by Miss F. Mannings and Mrs. M. Morgan. Mr. G. Draper gave statistical advice. The study was conducted with the co-operation of Drs. Gillian Sleight and E. Smith. Financial help was received from the Dr. Clark Memorial Fund, Reading, and the Kidney Research Foundation for Wales.

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Arch Dis Child 1975 50: 253-258
doi: 10.1136/adc.50.4.253

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