Renal Concentrating Ability in 5-year-old Girls with Covert Bacteriuria

The renal concentrating mechanism may be impaired in pyelonephritis (Brod, 1956), and there have been a number of studies in adults with urinary tract infection. There are, however, few reports in children (Winberg, 1959; Aperia, Berg, and Broberger, 1970) and none in those with covert (asymptomatic) bacteriuria. During a survey of Dundee schoolgirl entrants with covert bacteriuria (Savage et al., 1969) renal concentrating ability was correlated with the radiological picture.

Patients and Methods

The 39 children were among those found in the survey to have significant bacteriuria which was defined as 3 consecutive specimens of urine with 100,000 or more viable organisms per ml urine.

The control group of 20 children were those admitted to the ward between the ages of 4 and 7 years, who had diseases which were not known to affect renal concentrating ability. In all the children parental permission to perform the concentration tests was first obtained.

The renal concentrating capacity was tested by depriving the child of all fluids from 1700 hours for a total of 20 hours so that apart from a dry breakfast, no other food or liquid was given during this period. Urine was passed in the early hours of the following morning and the osmolality determined in urine collected between 0600 and 0700 hours, 1000 and 1100 hours, and 1200 and 1400. The test was repeated on at least two occasions. The osmolality of the urine was either determined immediately, or stored at -20 °C until this could be done. Osmolality was measured either on an Osmet S automatic osmometer or on a Fiske osmometer.

Results

A control group was included because the published values for normal renal urinary concentration are very variable. In our controls the maximum osmolality, after 19 to 20 hours of fluid deprivation, was always greater than 950 mOsm/kg, and we have therefore taken this figure as the lower limit of normal. In some children studied on 3 or 4 consecutive days the renal concentrating ability increased over each 24-hour period, due presumably to increased priming of the renal medulla with salt and urea. Serial estimations during the period of water deprivation were made, since the last specimen passed is not necessarily that with the highest osmolality.

The results have been analysed in two groups, those children with vesicoureteric reflux (this includes all those with radiological pyelonephritis) and those without reflux.

Our relatively small numbers and high variability make analysis difficult, but the indications are that the osmolality rises throughout the day in the controls and 'no-reflux' group, but not in those children with reflux (Fig. 1). The mean maximum osmolality of the controls was $1070 \pm 93$ mOsm per kg ($\pm 1$ SD), in those children with infection but without reflux $1045 \pm 171$ mOsm per kg ($\pm 1$ SD), and in those with reflux $837 \pm 169$ mOsm per kg ($\pm 1$ SD) (Fig. 2). The two groups of children with urinary infection show significantly increased variation when compared with the controls as both include children with normal renal concentrating ability. Because of this variability the tests usually applied to means between groups are invalid. However, the variability in the two groups of children with infection is very similar; their means when tested show that of the reflux group to be significantly lower (1% level). Children with radiological evidence of vesicoureteric reflux and pyelonephritis have a mean of $735 \pm 93$ mOsm per kg ($\pm 1$ SD).

Children who had been treated and whose urine was free of infection were admitted to the ward for a 48-hour period for concentration tests to be repeated. In nearly every case the osmolality of the urine had increased, in some cases quite dramatically. These results are seen in Fig. 3.

Discussion

These results confirm the effect of urinary infection on the renal concentrating mechanism.
In this study the normal children of 5 to 7 years of age concentrated their urine to over 950 mOsm per kg after 19 to 20 hours of water deprivation, but in many of the children with urinary infection this level of urinary osmolality was not reached. This disability of the kidneys to concentrate the urine adequately is maximal when there is radiological evidence of parenchymal disease and is commonly present with vesicoureteric reflux. These findings are similar to those published by Ronald, Cutler, and Turck (1969) who demonstrated that, on ureteric catheterization, only patients with renal infection, as opposed to those with a vesical bacteriuria, had defects of renal concentration. Aperia et al. (1970) have shown that in children with urinary infection there is, with the failure to concentrate the urine satisfactorily, an associated impairment of the active sodium reabsorption in the loop of Henle. Since, anatomically, pyelonephritis is initially a disease of the renal medulla, the particular area where urinary concentration and sodium reabsorption occurs, and since in addition the latter function is the most energy-demanding process of the kidney (Kil, Aukland, and Refsum, 1961), it is not surprising that disease of this area causes this impairment of renal function. As clearing of bacteriuria improves the renal-concentrating ability there has presumably been an effective removal of bacteria from the renal parenchyma at the same time, the concentrating ability returning to normal despite continuing vesicoureteric reflux.

The theoretical application of these findings lies mainly in their ability to discriminate between those patients with upper and those with lower urinary tract infection, and Kaitz and London (1964) have suggested that screening for impaired concentrating ability might effectively detect subjects with silent pyelonephritis in various population groups. However, in children, concentration tests are difficult to complete satisfactorily, and we do not believe that they could be utilized in this way, though in hospitalized patients with urinary infection concentration tests might be useful as an adjunct to radiography in distinguishing renal involvement.

Clinically this impairment of renal urinary concentrating ability in the otherwise healthy child is probably of little significance. However, in the young infant, ill with urinary infection, or whose infection is associated with other disease, the inability of the kidney adequately to concentrate urine could prove serious, particularly when his fluid balance is in a precarious state.

**Summary**

Primary schoolgirl entrants found to have covert (asymptomatic) bacteriuria have been examined for their renal concentrating ability. These results have then been correlated with the intravenous pyelograms and micturating cystograms.
It was found that the kidneys’ concentrating ability is often impaired, particularly in children with radiological evidence of pyelonephritis or vesicoureteric reflux. This defect is reversible with effective chemotherapy.

In a previous publication we noted our appreciation to the many colleagues in Dundee without whose help this survey would not have been possible, and again it is a pleasure to thank them.

D.C.L.S. is in receipt of a Secretary of State for Scotland grant.

REFERENCES

D. C. L. SAVAGE,* MARGARET I. WILSON, and W. M. FEE
The Departments of Child Health and Bacteriology, University of Dundee, and Child Health Services, City of Dundee, Scotland.

*Correspondence to Dr. D. C. L. Savage, Department of Child Health, University of Dundee, 11 Dudhope Terrace, Dundee DD3 6HG.

Treatment of Infected Surface Lesions with Sulfamylon Acetate Cream

Established infection in large cutaneous lesions presents many problems apart from the obvious hazard of sepsicaemia; the presence of vast numbers of Gram-negative bacteria in infected burns tissue was reported by Lindberg and his colleagues (1965), and this serious complication is also common with large pressure sores and with exposed subcutaneous tissue after excision of neoplastic lesions. They listed the properties of an ideal medication for the treatment of infections involving extensive burned surface, suggesting that the agent should be active against Gram-negative and Gram-positive bacteria, be readily applicable and non-irritant to raw surfaces, and permit the free formation of granulation tissue. It should be stable in the presence of tissue exudates and serum and, if absorbed, be rapidly excreted or converted to a non-toxic derivative. Clinical studies by these workers suggested that sulfamylon acetate cream met their criteria, and subsequent laboratory investigations by Holt, Murphy, and O’Donnell (1968) confirmed that the drug had a broad antibacterial spectrum and other desirable properties. These observations suggested to us that sulfamylon acetate cream could play a valuable role in the control of infection of extensive skin lesions in children and permit successful grafting onto these areas, and we report below details of representative cases.

Methods
(1) Cultures from infected surfaces. Swabs moistened in broth were applied to selected sites and subsequently cultured aerobically and anaerobically on horse blood agar, gentian violet blood agar, MacConkey agar, Czapek-Dox agar for the isolation of Candida spp. and fungi, and in Robertson’s cooked meat broth. On occasions replica pad cultures (Holt, 1966) were made of some areas.

(2) Sensitivity tests. Bacterial sensitivity to sulfamylon acetate was tested by the methods reported elsewhere (Holt et al., 1968).

(3) Sulfamylon acetate cream. This contained 11%-2% w/w in a smooth, stable, hydrophilic cream base; it was spread daily on infected surfaces with sterilized flexible steel pastry spatulae, after removal of the previous cream layer. Though the manufacturer recommends layers of about 1-5 mm depth, a greater depth (3-5 mm) was found necessary in this series to ensure that the cream remained on the moist surface; Moncrief (1970) used even thicker layers (6 mm).

Case Histories
Case 1 (male child, age 23 months). Admitted with deep weeping burns of feet, lower limbs, buttocks, external genitalia, and lower abdomen caused by sitting in a bath to which scalding hot water had inadvertently been added. About 50% of the body surface was burned, mostly to full thickness depth. The burns were treated in the first instance by exposure. Skin and blood cultures during the first week were sterile, but by the third and fourth weeks cultures yielded a profuse growth of Pseudomonas aeruginosa with scanty Esch. coli and enterococci. The pseudomonas and Esch. coli were fully sensitive to sulfamylon acetate, requiring minimal inhibitory concentrations (MIC) below 1 mg/ml of the drug. The enterococci were less sensitive, requiring an MIC between 2 and 5 mg/ml.

Short Reports
Renal concentrating ability in 5-year-old girls with covert bacteriuria.
D C Savage, M T Wilson and W M Fee

Arch Dis Child 1972 47: 141-143
doi: 10.1136/adc.47.251.141