URINARY WHITE CELL EXCRETION IN CHILDHOOD

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In recent years more attention has been paid to the
diagnosis of pyelonephritis, and this has made
accurate estimation of pyuria more necessary.
Houghton and Pears (1957), Hutt, Chalmers,
MacDonald, and de Wardener (1961), and Little
(1962) have all reported their experience in measuring
the rate of urinary white cell excretion. Their figures
are very largely derived from adults; the present
report is designed to provide a comparable set of
values during infancy and childhood. Such figures
have a direct relevance to the diagnosis of chronic
pyelonephritis, other renal diseases, and also to the
interpretation of the 'prednisolone provocative test'
(Little and de Wardener, 1962; Katz, Velasquez, and
Bourdo, 1962) when this is performed on a child.

Material and Methods

Carefully timed specimens of urine were collected by a
clean voiding technique from 141 children (85 male, 56
female) of varying ages. The problems inherent in
collecting timed specimens of urine from small infants
necessitate their presence in hospital, and in consequence
the urine specimens were collected from children already
in hospital convalescing from a variety of illnesses. Any
child who was febrile, who had had any disease remotely
likely to influence the cellular composition of the urine, or
who was receiving steroid, antibiotic, or salicylate therapy
was excluded from the study.

For continent children able to micturate on request
there is no problem about collecting a timed specimen of
urine, though with some it is preferable to allow them to
micturate spontaneously, carefully noting the times. In
consequence, though most specimens were collected over
an interval of two hours, there was a variation of 23 to
267 minutes.

Incontinent infants and toddlers present greater
difficulties; these were surmounted by using a special
machine which gave immediate audible warning of the
fact that an infant had micturated. The time of passing
the first specimen was noted and the specimen was
discarded. The next time micturition occurred the
specimen was collected, unless the time interval between
specimens was less than an hour, in which case more
specimens were collected and pooled together for exami-
nation, the total time being carefully noted. The dura-
tion of these specimens varied from 60 to 290 minutes.

The white cell excretion rate of each urine specimen was
determined by the method of Houghton and Pears (1957).
A few minor modifications in technique were made: 10 ml.
urine were centrifuged at 2,000 r.p.m. for 10 minutes and
the sediment resuspended in 0·5 ml. fluid (instead of 1 ml.)
thus concentrating the urine 20 times. This was found
generally to produce a more convenient concentration of
white cells for counting in a Fuchs-Rosenthal chamber.
An attempt was made to count only leucocytes and, to
facilitate this, 2 drops of 0·1% Nile-blue stain were
allowed to dry on the cover slip before use.

The height, weight, and age of each child were noted
and their body surface area calculated from nomograms.

Results

In Figs. 1-4 the urinary white cell excretion rates
are plotted against the age, height, weight, and
surface area of individual patients. There is clearly
a relation between white cell excretion and the
individual's size, best shown in respect of height and
surface area. Six of the values are so different,
however, that it must be assumed that these patients
had pathologically raised excretion rates. Careful
reappraisal of these cases has not revealed a cause;
one was awaiting tonsillectomy, the others suffered
respectively from asthma, Fallot's tetralogy, idiopathic
thrombocytopenic purpura, temporal lobe epilepsy,
and muscular dystrophy.

In 20 patients, further estimates of the white cell
excretion rate were made at intervals varying between
3 days and 6 months. 13 patients had two, 5 patients
three, 1 four, and 1 five specimens of urine collected.
The results are shown in Table 1. In 15 patients the
initial result was within the normal range and so were
all except one of the subsequent values, though they
sometimes varied considerably from the original one.
Of the 6 patients with unusually high values, 5 had
repeat estimates performed: 2 remained abnormal
and the others became normal.

In 5 children consecutive urine specimens were
collected over a complete 24-hour period (Table 2).
There was sometimes a five- or sixfold difference between minimal and maximal excretion rates in any one day, but there was sufficient consistency in the results to define whether the figures fell, over-all, into a normal or abnormal pattern. Some of this variation could be due to the failure of some children to empty their bladders completely when micturating; collection by catheter would obviate this possibility but cannot be justified in view of the known risks of the procedure.

Discussion

Hodson, Drewe, Karn, and King (1962) have shown that, in childhood, the length and cross-sectional area of the kidneys are closely related to the child's height and weight, especially the height. The present study suggests that urinary white cell excretion is also a function of body size and,
presumably, of renal size. The majority of adults have urinary white cell excretion rates of less than 200,000 cells/hr., and though a few exceed this value it rarely reaches more than 400,000 cells/hr. (Houghton and Pears, 1957; Hutt et al., 1961; Little, 1962). Even the lower of these figures would be quite abnormal for a small child or infant and a separate set of standards must be applied to results obtained from children. Infants up to 36 in. (91 cm.) or 0.55 sq. m. in height or surface area respectively rarely exceed an excretion rate of 50,000 white cells/hr.; with increasing size the acceptable upper limit gradually increases to 100,000 white cells/hr. for a child of 45 in. (114 cm.) or 0.8 sq. m. and eventually reaches an approximately adult level with a height of about 52 in. (132 cm.) or a surface area of 1.0 sq. m. (approximately 8 to 10 years of age). The only comparable report on this subject is that of Gekle (1964) who, from 50 children (2 to 14 years old) obtained figures to suggest that 40,000 white cells/hr. was the normal upper limit of white cell excretion. His results are compatible with the hypothesis that body (or renal) size is a factor in determining white cell excretion; the discrepancy in results in later childhood between that report and the present one may be attributable to the difference in numbers of specimens examined or possibly to the fact that catheterization was the method by which specimens were obtained by Gekle.

**TABLE 1**

<table>
<thead>
<tr>
<th>Patient</th>
<th>Urinary White Cell Excretion (cells/hr.)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>A.M.</td>
<td>39,000</td>
</tr>
<tr>
<td>P.R.</td>
<td>17,000</td>
</tr>
<tr>
<td>D.B.</td>
<td>190,000</td>
</tr>
<tr>
<td>M.B.</td>
<td>2,000</td>
</tr>
<tr>
<td>A.D.</td>
<td>11,000</td>
</tr>
<tr>
<td>T.P.</td>
<td>42,000</td>
</tr>
<tr>
<td>R.M.</td>
<td>73,000</td>
</tr>
<tr>
<td>W.S.L.</td>
<td>3,100,000</td>
</tr>
<tr>
<td>P.C.</td>
<td>18,000</td>
</tr>
<tr>
<td>M.J.</td>
<td>26,000</td>
</tr>
<tr>
<td>A.J.</td>
<td>55,000</td>
</tr>
<tr>
<td>K.L.</td>
<td>260,000</td>
</tr>
<tr>
<td>D.Bo.</td>
<td>104,000</td>
</tr>
<tr>
<td>S.E.</td>
<td>330,000</td>
</tr>
<tr>
<td>R.F.</td>
<td>460,000</td>
</tr>
<tr>
<td>P.N.</td>
<td>570,000</td>
</tr>
<tr>
<td>J.F.</td>
<td>660,000</td>
</tr>
<tr>
<td>D.McC.</td>
<td>1,400,000</td>
</tr>
<tr>
<td>W.H.</td>
<td>3,100,000</td>
</tr>
</tbody>
</table>

**TABLE 2**

<table>
<thead>
<tr>
<th>Time of Day</th>
<th>White Cell Excretion Rate (cells/hr.)</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>P.C.</td>
</tr>
<tr>
<td>A.M.</td>
<td>12,000</td>
</tr>
<tr>
<td>P.M.</td>
<td>33,000</td>
</tr>
<tr>
<td>A.M.</td>
<td>9,000</td>
</tr>
</tbody>
</table>

* In 4 of the 5 patients, the highest rate was recorded between 6 a.m. and midday.

**Fig. 4**—Relationship of white cell excretion to surface area. The mean values for patients in 0.2 sq. m. groups is shown by the horizontal lines. They are respectively (from the left) 20,000, 24,000, 45,000, 58,000, 87,000, 120,000, and 112,000/hour.
There is a disappointingly wide variation in excretion rates in the same child on different days and even at different times of the same day, which makes changes of excretion rate induced by prednisolone or bacterial pyrogen difficult to evaluate. It is desirable not to rely too heavily on the results of a single observation in assessing renal status, though a repeat measurement will usually yield a result sufficiently like the first to say with some certainty that it is, or is not, normal.

As will be seen, the measurement of white cell excretion in the urine has drawbacks, but if the correct set of standards for the child’s size are applied, this sensitive technique can supply very valuable information.

Summary

A set of standards is described relating urinary white cell excretion rates to the size of the child. Though the variation in excretion rates in the same child at different times is sometimes appreciable, the results can usually be quite easily interpreted and can be of great assistance in assessing cases of ‘subclinical’ renal disease.

I should like to thank Dr. H. B. Marsden for his helpful advice and for permitting me to use the facilities of his laboratory. My appreciation is also due to Professor Wilfrid Gaisford for his support and assistance and to the Department of Medical Illustration, Manchester Royal Infirmary, for the figures.

References


