Significance of bacterial and white cell counts in midstream urines

PJ LITTLE, BARBARA A PEDDIE, AND ADRIENNE R SINCOCK
From the Department of Renal Medicine, Christchurch Hospital, Christchurch, New Zealand

SUMMARY The results of cultures carried out on urine collected by a midstream technique (MSU) have been compared with the results of cultures of urine collected by suprapubic bladder aspiration (SPA) in the same 903 patients. Comparisons indicate that when there are more than $100 \times 10^6/\text{l}$ (100 000/ml) Gram-negative bacteria in the midstream urine this finding is confirmed by suprapubic aspiration in 92% of patients, and in 70% when the urine contained this number of Gram-positive bacteria. When the culture contained more than one species (mixed organisms), the presence of infection was confirmed in only 11%. When there were 10-100 $\times 10^6/\text{l}$ bacteria in the MSU the finding of Gram-negative bacilli still indicated urinary infection in 74% of patients, but the presence of Gram-positive organisms was confirmed in only 30% and mixed organisms in 2%. In asymptomatic patients, the presence of white cells in the urine was not helpful in confirming the diagnosis of infection. The nature of the organism found in the MSU is almost as important as the number of bacteria in assessing the validity of the result.

The results of urine cultures performed on urine collected by a midstream technique are often misleading in that in some patients heavy contamination may occur. Kass1 provided statistical analyses of multiple midstream urines (MSUs) to establish the criteria separating contamination from true infection. He found the presence of a concentration of organisms greater than $100 \times 10^6/\text{l}$ (> 100 000/ml) could be regarded as indicating urinary infection, but when the counts were less than $100 \times 10^6/\text{l}$ repeat specimens were rarely alike.2 He showed that the finding of greater than $100 \times 10^6$ organisms per litre (> 100 000 per ml) of urine is reproducible on 80% of occasions and that it may therefore be assumed that on 20% of occasions it does not represent true infection of the urinary tract.3 Although the technique of suprapubic bladder aspiration (SPA) gives a more accurate result, this method is often inconvenient and difficult to those not familiar with its use. In this paper an attempt is made to correlate the results of urine examinations using the two techniques so that a more accurate estimate can be made of the significance of the result of examination of an MSU. The results were assessed with particular reference to the identity of the organisms present in the urine.

Method

In this study SPA was carried out in 903 women, and the result was compared with a preceding MSU examination. The patients were 840 asymptomatic women examined at the first attendance at an antenatal clinic, 53 asymptomatic student nurses, and 10 women presenting with symptomatic urinary tract infection (UTI). All the patients had an initial MSU containing $> 10 \times 10^5/\text{l}$ organisms ($> 10$ 000/ml).

The MSU was collected by a nurse employed for this purpose. Perineal cleansing with sterile water preceded collection. SPA was carried out within seven days of the MSU by a method previously described.4 All urine cultures were carried out on the day of urine collection. Bacterial counts were made by pour plate dilution technique.5

Urinary white cell counts (WCC) were made on 462 of the urine samples collected by MSU and on 37 of those collected by SPA.6,7 An upper limit of 10 cells $\times 10^4/\text{l}$ (10/cmm) in uncentrifuged urine was used in this study.8 No limits of normality of

Received for publication 4 April 1979
Significance of bacterial and white cell counts in midstream urines

Table 1  Result of suprapubic aspiration (SPA) after a midstream urine (MSU) containing 10-100 x 10^{9}/l bacteria (10 000-100 000/ml)

<table>
<thead>
<tr>
<th>Organism</th>
<th>MSU (No. tested)</th>
<th>SPA No. infected</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>E. coli</td>
<td>28</td>
<td>21</td>
<td>75</td>
</tr>
<tr>
<td>Klebsiella and Enterobacter spp</td>
<td>2</td>
<td>2</td>
<td>10</td>
</tr>
<tr>
<td>Proteus mirabilis</td>
<td>5</td>
<td>3</td>
<td>60</td>
</tr>
<tr>
<td>Staphylococcus spp</td>
<td>36</td>
<td>9</td>
<td>25</td>
</tr>
<tr>
<td>Streptococcus spp</td>
<td>11</td>
<td>4</td>
<td>36</td>
</tr>
<tr>
<td>Mixed</td>
<td>100</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Total</td>
<td>182</td>
<td>41</td>
<td>23</td>
</tr>
</tbody>
</table>

WCC in urine collected by SPA are available. The technique used requires the administration of a diuretic and forced fluid intake so that considerable dilution of urine occurs.

Results

The results of SPAs done on patients with 10-100 x 10^{9}/l (10 000-100 000/ml) bacteria in the initial MSU are shown in Table 1. Infection was confirmed in 26 of 35 patients with 10-100 x 10^{9}/l Gram-negative bacilli in the MSU. Where the MSU had 10-100 x 10^{9}/l Gram-positive organisms, 13 out of 47 bladder urines were found to be infected. Only two of 100 urines with mixed cultures of 10-100 x 10^{9}/l bacteria in the MSU had infected SPAs.

Table 2 shows the results of the SPA when the MSU showed > 100 x 10^{9}/l (> 100 000/ml) bacteria. This demonstrates that where the initial MSU had > 100 x 10^{9}/l of a pure growth of *Escherichia coli*, *Proteus* spp, *Klebsiella* spp, or *Enterobacter* spp, 92% of the SPAs were infected. With > 100 x 10^{9}/l streptococci in the MSU 81% of SPAs were infected, and with > 100 x 10^{9}/l staphylococci 67% were infected. Where the initial MSU had a mixed culture of > 100 x 10^{9}/l bacteria only 11% of the bladder urines were infected. In only one specimen was a true mixed infection found.

Table 3  Result of white cell concentration (WCC) on initial midstream urine (MSU) compared with bacterial count of MSU and suprapubic aspiration (SPA)

<table>
<thead>
<tr>
<th>MSU bacterial count</th>
<th>Infected WCC x 10^{9}/l</th>
<th>Not infected WCC x 10^{9}/l</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>&lt;10</td>
<td>&gt;10</td>
</tr>
<tr>
<td>10-100</td>
<td>13</td>
<td>11</td>
</tr>
<tr>
<td>100</td>
<td>241</td>
<td>130</td>
</tr>
</tbody>
</table>

Note: Bacterial counts 100 x 10^{9}/l (SI units) = 100 000/ml WCC 10 x 10^{9}/l (SI units) = 10/cm

Discussion

Kass introduced the concept of quantitative urine cultures to enable the diagnosis of urinary tract infection in symptomatic and asymptomatic patients to be made with more accuracy. Since then, a concentration of organisms exceeding 100 x 10^{9}/l in an MSU has been taken to indicate infection. In asymptomatic pregnant women, a count of > 100 x 10^{9}/l was reproducible on 80% of occasions. Kass also showed that if urine contained less than 10 x 10^{9}/l (10 000/ml) bacteria then this represented contamination. The results presented here indicate that knowledge of the identity of organisms in the urine may help in assessing the probability of the presence of a true infection. Infection was confirmed by SPA for 72% of all patients with MSU > 100 x 10^{9}/l bacteria. When MSUs with > 100 x 10^{9}/l mixed organisms were excluded SPAs confirmed infection in 88% of cases.

The technique of SPA is the simplest way to establish with certainty whether or not bacteria are present within the urinary tract. However, it is not always possible or desirable to take a bladder aspirate before starting treatment for symptomatic UTI. Only one-half of patients presenting with the symptoms generally suggestive of UTI will be found to have bacterial infection, and it is probable that those without infection should be dealt with differently.

Table 2  Result of suprapubic aspiration (SPA) after a midstream urine (MSU) containing > 100 x 10^{9}/l bacteria (> 100 000/ml)

<table>
<thead>
<tr>
<th>Organism</th>
<th>MSU (No. tested)</th>
<th>SPA No. infected</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>E. coli</td>
<td>399</td>
<td>370</td>
<td>93</td>
</tr>
<tr>
<td>Klebsiella and Enterobacter spp</td>
<td>12</td>
<td>11</td>
<td>92</td>
</tr>
<tr>
<td>Proteus mirabilis</td>
<td>26</td>
<td>24</td>
<td>92</td>
</tr>
<tr>
<td>Staphylococcus spp</td>
<td>75</td>
<td>50</td>
<td>67</td>
</tr>
<tr>
<td>Streptococcus spp</td>
<td>31</td>
<td>25</td>
<td>81</td>
</tr>
<tr>
<td>Mixed</td>
<td>146</td>
<td>16*</td>
<td>11</td>
</tr>
<tr>
<td>Total</td>
<td>689</td>
<td>496</td>
<td>72</td>
</tr>
</tbody>
</table>

*One had true mixed infection with two bacterial species present in SPA; 15 had only one species present in SPA.
from those with infection.\textsuperscript{10,11} The interpretation of the initial culture of urine collected by the MSU technique is therefore important. Moreover, when an MSU is part of a routine examination, it is desirable to know the significance of an equivocul result in an asymptomatic patient.

When the MSU has $10-100 \times 10^6$ organisms/l, the results of SPAs are very different with different species of bacteria. If a mixed growth is obtained from an MSU at counts below $100 \times 10^6$ organisms/l the probability that SPA will confirm the presence of organisms is very low. When a pure culture of Gram-positive cocci at this concentration is obtained in an MSU one-third can be confirmed by SPA. However, when a pure growth of Gram-negative bacilli is obtained this may be confirmed by SPA even at counts as low as $10 \times 10^6$/l. When the number of organisms in an MSU is above $100 \times 10^6$/l infection is likely to be confirmed except when there is a mixed growth. It is of interest that in only one of the 903 SPAs was a true mixed infection found. The probability that a culture result indicates true infection should be taken into account when carrying out sensitivity testing of isolated organisms and also when initiating or assessing the results of treatment. It has been assumed throughout that if the MSU contains less than $10 \times 10^9$/l bacteria then infection is very unlikely and SPA is unnecessary.

The WCC was not a useful diagnostic aid to confirm the presence or absence of UTI. It should be emphasised that most of these patients were asymptomatic and therefore not clinically comparable with patients with symptomatic UTI.

From this study it is concluded that the nature of the organism found in the urine is almost as important as the concentration of bacteria in assessing whether or not true urinary infection is present.

References

\begin{enumerate}
\item Kass E H. Asymptomatic infections of the urinary tract. \textit{Trans Assoc Am Physicians} 1956; \textbf{69}: 56-64.
\item Kass E H. Bacteriuria and the diagnosis of infections of the urinary tract. \textit{Arch Intern Med} 1957; \textbf{100}: 709-714.
\item Little P J. Urinary white-cell excretion. \textit{Lancet} 1962; \textbf{1}: 1149-1151.
\item Little P J. Diagnostic criteria of pyelonephritis. \textit{J Clin Pathol} 1965; \textbf{18}: 556-558.
\item Little P J. A comparison of the urinary white cell concentration and the white cell excretion rate. \textit{Br J Urol} 1964; \textbf{36}: 360-363.
\item Kass E H. Chemotherapeutic and antibiotic drugs in the management of infections of the urinary tract. \textit{Am J Med} 1955; \textbf{18}: 764-781.
\item Tapsall J W, Bell S M, Taylor P C, Smith D D. Relevance of 'significant bacteriuria' to aetiology and diagnosis of urinary-tract infection. \textit{Lancet} 1975; \textbf{2}: 637-639.
\end{enumerate}
Significance of bacterial and white cell counts in midstream urines.

P J Little, B A Peddie and A R Sincock

doi: 10.1136/jcp.33.1.58

Updated information and services can be found at:
http://jcp.bmj.com/content/33/1/58

**Email alerting service**

These include:

Receive free email alerts when new articles cite this article. Sign up in the box at the top right corner of the online article.

**Notes**

To request permissions go to:
http://group.bmj.com/group/rights-licensing/permissions

To order reprints go to:
http://journals.bmj.com/cgi/reprintform

To subscribe to BMJ go to:
http://group.bmj.com/subscribe/