### Hospital Practice

#### EVALUATION OF FOUR SCREENING TESTS FOR BACTERIURIA IN ELDERLY PEOPLE

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**Summary**  
Four screening tests for bacteriuria were assessed at ward level in 418 elderly subjects and were compared with standard methods of bacterial culture. The tests were visual appearance; microscopy; dipstick for nitrite, leucocyte esterase, protein, and blood; and dipstick for nitrite and organisms. The sensitivity of the tests varied from 85·6% to 98·3%, and the specificity from 18·4% to 82·9%. A combination of visual appearance and dipstick testing for nitrite and leucocyte esterase gave a sensitivity of 96·1% with a specificity of 50·6%, and could have reduced by almost one-third the number of urine samples submitted to the laboratory for processing.

**INTRODUCTION**

A MAJOR part of the workload of the bacteriology laboratory is the processing of urine samples. This workload could be reduced if there was an effective ward screening test for bacteriuria: only urine samples which were likely to be positive would be sent to the laboratory. The laboratory would then identify the causal organism and determine its sensitivity to antibiotics. Screening tests for bacteriuria include numerous chemical tests and several techniques of microscopy. However, most studies have been done in bacteriology laboratories on urine samples received by them; the need for processing by laboratory staff limits the scope for cost reduction. Few studies have been done at ward level where there would be an immediate indication of whether bacteriuria is likely to be present; even fewer have been done on elderly subjects, despite the fact that the prevalence of both bacteriuria and urinary symptoms is high in elderly people. Therefore, we decided to investigate the efficacy of various screening tests for bacteriuria in a group of elderly subjects.

#### PATIENTS AND METHODS

**Patients**

Urine samples were obtained from 418 elderly people—322 women (mean age 82·2 years, range 63–100) and 96 men (79–94). 373 were inpatients in a geriatric medical unit and 45 were living in residential homes in the community. The urine samples were obtained, on admission, from all patients admitted to the geriatric medical unit during the period of the study. Samples were also collected from all patients already in long-stay wards and from all residents of residential homes in the district who agreed to take part in the study. Patients who were already on antibiotic therapy or who could not provide suitable samples were excluded. Tests were also done on follow-up urine samples that were obtained to assess the efficacy of antibiotic treatment for urinary tract infections. 63% of the samples were from people who had no urinary symptoms and 37% were from people whose urinary symptoms included dysuria, frequency, nocturia, urgency, and incontinence.

| Table I—Criteria for Regarding Multistix as Positive |
|---|---|---|---|---|
| Multistix A | Positive | Any positive reaction | — | — |
| Multistix B | Positive | More than trace positive | — | — |
| Multistix C | Positive | More than trace positive | More than trace positive | — |
| Multistix D | Positive | More than trace positive | Any positive reaction | — |

Criteria are satisfied if at least one of the appropriate reaction pads is positive as indicated.

**Urine Samples**

A total of 698 samples were collected by a “clean-catch” method with a standardised technique. If possible, early morning urine samples were tested; otherwise a sample obtained at any time during the day was used. Part of the urine sample was immediately stored at 4°C without preservative, and the screening tests were done within 3 h. The remainder of the sample was sent to the laboratory.

**Laboratory Tests**

Urine samples were cultured on horse blood agar and MacConkey medium by the Leigh and Williams method. If a urine sample yielded ≥10⁵ organisms/ml, a second sample was obtained; if this sample yielded ≥10⁶/ml of the same organism in pure culture, the 2 samples were regarded as positive. A urine sample with fewer than 10⁶ organisms/ml was regarded as negative whereas one that produced a mixed growth in relevant numbers (≥10⁵ organisms/ml) was regarded as contaminated. Likewise, a positive first sample followed by a negative repeat sample was regarded as contaminated.

**Screening Tests**

**Visual appearance.**—The urine sample was examined against a bright background. A turbid sample was positive, whereas a clear sample was negative.

**Microscopy.**—Part of a well-mixed centrifuged urine was pipetted into a Kova slide and was examined under high power magnification (×400). The test was positive if there were at least 5 organisms or 5 leucocytes per high power field.

*Multistix 10SG* dipstick.—This dipstick (Ames Division, Miles Laboratories, England) has biochemical reagent pads to test for glucose, bilirubin, ketones, blood, protein, urobilinogen, specific gravity, and pH. There are also pads to detect nitrite and leucocyte esterase. The nitrate pad is a test for the presence of bacteriuria since some organisms (mainly those of the Enterobacteriaceae) reduce nitrate to nitrite in urine—the result is either positive or negative. The leucocyte esterase pad is a test for pyuria: the pad changes colour according to the concentration of leucocytes. By comparison with a standard colour chart, the sample is graded as negative, trace positive, + positive, ++ positive, or +++ positive. Different criteria (A–D) were assessed for regarding this dipstick test as positive (table I).

*Microstix-3* dipstick.—This dipstick (Ames Division, Miles Laboratories) consists of a plastic strip with three reagent pads. The top pad detects nitrite, and is read 30 s after immersing the dipstick into the urine. The other two pads contain dehydrated culture media for the growth of bacteria—one for both gram-negative and gram-positive organisms, and the other for gram-negative organisms only. After the nitrite pad has been read, the microstix-3 dipstick is incubated for 18–24 h at 37°C. The density of the colour change on the two culture pads is compared with the standard colour chart provided to estimate the concentration of organisms present in the urine. The microstix-3 test was regarded as positive if the nitrite was positive or if the sample contained ≥10⁶ organisms/ml according to the colour change of the two culture pads.
The negative predictive value as a screening test for bacteriuria varies widely: sensitivities range from 60 to 100% and specificities from 49 to 100%. A major factor in this variation is the lack of standardisation both in the technique of microscopy and in the criteria for defining abnormal results; however, if these are carefully standardised, a sensitivity and a specificity of up to 95% can be attained. Also, microscopy requires special equipment and training of personnel and, if a urine sample is not examined immediately after collection, there can be a reduction in sensitivity due to lysis of leucocytes.

In the present study, the delay between collection of samples and microscopy, may explain why the sensitivity was lower than that obtained in other studies. The use of dipsticks with a strip that detects leucocytes has been advocated as a good alternative to microscopy, particularly because these strips can detect lysed leucocytes. In one study, the use of microscope to detect pyuria as a screening test for bacteriuria in elderly ambulatory men patients had a sensitivity of 68%, with a specificity of 99.6% whereas in a group of elderly ambulatory women such a screening test had a high sensitivity but low specificity.

The importance of the screening test to detect leucocytes, blood, or protein can be effectively used for such screening. Dipsticks with a reagent pad that detects leucocytes are effective in screening both for microscopical abnormalities (which eliminates the need for microscopy to detect cells, casts, and bacteria) and for the detection of bacteriuria in symptomatic elderly men. Dipsticks with a reagent pad that detects leucocytes have not assessed the screening tests for detection of these types of infection. In these circumstances, clinicians ask for specific tests. We therefore emphasise that these are definitive tests (microscopy, urine culture, and special culture for fastidious organisms or mycobacteria) may be indicated by the clinical assessment of the patient, irrespective of the result of the screening test.

### TABLE II--EFFECTIVENESS OF EACH SCREENING TEST

<table>
<thead>
<tr>
<th>Test</th>
<th>Sensitivity (%)</th>
<th>Specificity (%)</th>
<th>Positive predictive value (%)</th>
<th>Negative predictive value (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visual appearance</td>
<td>90-4</td>
<td>66-4</td>
<td>64-2</td>
<td>91-2</td>
</tr>
<tr>
<td>Microscopy</td>
<td>85-6</td>
<td>82-9</td>
<td>77-1</td>
<td>89-6</td>
</tr>
<tr>
<td>Multistix A</td>
<td>98-3</td>
<td>18-4</td>
<td>44-6</td>
<td>94-0</td>
</tr>
<tr>
<td>Multistix B</td>
<td>89-5</td>
<td>70-3</td>
<td>66-8</td>
<td>90-9</td>
</tr>
<tr>
<td>Multistix C</td>
<td>97-0</td>
<td>32-2</td>
<td>48-9</td>
<td>94-1</td>
</tr>
<tr>
<td>Multistix D</td>
<td>97-0</td>
<td>21-4</td>
<td>46-1</td>
<td>92-2</td>
</tr>
<tr>
<td>Microstix-3</td>
<td>89-3</td>
<td>79-6</td>
<td>68-7</td>
<td>93-5</td>
</tr>
<tr>
<td>Multistix B + visual</td>
<td>96-1</td>
<td>50-6</td>
<td>56-9</td>
<td>95-1</td>
</tr>
</tbody>
</table>

Sensitivity = true positives/(true positives + false negatives) × 100.
Specificity = true negatives/(true negatives + false positives) × 100.
Positive predictive value = true positives/(true positives + false positives) × 100.
Negative predictive value = true negatives/(true negatives + false negatives) × 100.

Multistix B and visual appearance—This combination was assessed to see if the sensitivity of the combined tests was greater than that of the individual tests. This combined test was positive if the nitrite was positive or if the leucocyte esterase showed more than a trace positive or if the urine sample was cloudy.

The sensitivity, specificity, positive predictive value, and negative predictive value were calculated for each of the screening tests.7

### RESULTS

According to the laboratory results, 233 (33.4%) of the urine samples were positive, 344 (49.3%) were negative, and 121 (17.3%) were contaminated. Results for the screening tests were calculated separately for patients with and without urinary symptoms, but were combined because the results of the two groups were similar. The most sensitive but least specific screening tests were multistix A, multistix C, and multistix D (Table II). The other screening tests had lower sensitivities but higher specificities. The combination of multistix B and visual appearance seemed to be the most effective test: sensitivity was 96.1%, specificity was 50.9%, and the negative predictive value (95.1%) was the highest.

We then considered the effect of the use of screening tests on the workload of the bacteriology laboratory: if only those samples that were positive according to each screening test were sent to the laboratory, there would be a reduction in the number of samples sent as follows: visual appearance 42.6%, microscopy 54.6%, multistix A 11.3%, multistix B 43.6%, multistix C 19.9%, multistix D 15.3%, microstix-3 49.5%, and multistix B plus visual appearance 31.5%.

### DISCUSSION

Although assessment of the visual appearance of the urine has been practised through the centuries, there are no reports on its use by itself as a screening test for bacteriuria. However, visual appearance can be used in combination with biochemical dipstick testing as a screening procedure for the detection of abnormalities found on sediment microscopy and as a screening test for bacteriuria. An infected urine sample is likely to show abnormal turbidity because of the presence of organisms or leucocytes or both. Since normal uninfected urine can also be turbid because of the presence of amorphous phosphates, visual appearance is not a very specific test. In our study, the sensitivity and the negative predictive value of the visual appearance were similar to those of microscopy, multistix B, and microstix-3, although it gave a lower specificity.

The efficacy of microscopy as a screening test for bacteriuria varies widely: sensitivities range from 60 to 100% and specificities from 49 to 100%. A major factor in this variation is the lack of standardisation both in the technique of microscopy and in the criteria for defining abnormal results; however, if these are carefully standardised, a sensitivity and a specificity of up to 95% can be attained. Also, microscopy requires special equipment and training of personnel and, if a urine sample is not examined immediately after collection, there can be a reduction in sensitivity due to lysis of leucocytes. In the present study, the delay between collection of samples and microscopy, may explain why the sensitivity was lower than that obtained in other studies. The use of dipsticks with a strip that detects leucocytes has been advocated as a good alternative to microscopy, particularly because these strips can detect lysed leucocytes. In one study, the use of microscopy to detect pyuria as a screening test for bacteriuria in elderly ambulatory men patients had a sensitivity of 68%, with a specificity of 99.6%, whereas in a group of elderly ambulatory women such a screening test had a high sensitivity but low specificity.

Lately, there has been increasing interest in the use of urinary dipsticks as screening tests for bacteriuria, and there is a suggestion that testing for the presence of nitrite, blood, or protein can be effectively used for such screening. Dipsticks with a reagent pad that detects leucocytes are effective in screening both for microscopical abnormalities (which eliminates the need for microscopy to detect cells, casts, and bacteria) and for the detection of bacteriuria in symptomatic elderly men. Because the efficacy of dipsticks will vary with different patient populations, such tests must be evaluated in specific groups of patients, as in our study. In the only other study done on patients from a geriatric medical unit, a nitrite and leucocyte esterase strip had a sensitivity of 95%, specificity 70%, and negative predictive value 96% for the detection of bacteriuria in elderly men. In our study the nitrite and the leucocyte esterase strips gave as high a sensitivity as the blood or protein strips but with a higher specificity. Therefore there is much to be said for a dipstick with only nitrite or leucocyte esterase strips: such a test is available in the USA ('Chemstrip LN').

The sensitivity of the microstix-3 dipstick ranges from 65.3% to 93.9% and specificity ranges from 88.5% to 99.1%. Their use for detecting bacteriuria in elderly subjects has not previously been reported but our results show a sensitivity within this range with a lower specificity. However, because there is a delay of 24 h before this dipstick can be read, its usefulness as a screening test for bacteriuria at ward level is limited.

In our study, ≥10⁶ organisms/ml was used as the criterion for a positive laboratory result. In some patients, much lower bacterial counts (eg, ≥10³ organisms/ml) may be of pathological significance, and some screening tests (particularly dipsticks) are less sensitive at these lower levels. Additionally, standard methods of urine culture, as used in this study, cannot detect the presence of either fastidious organisms or tuberculous infection, and so we have not assessed the screening tests for detection of these types of infection. In these circumstances, clinicians ask for specific tests. We therefore emphasise that these are screening tests only and that in certain patients the definitive tests (microscopy, urine culture, and special culture for fastidious organisms or for mycobacteria) may be indicated by the clinical assessment of the patient, irrespective of the result of the screening test.
We believe that screening tests for bacteriuria can be used accurately in elderly subjects; a suggested protocol for such screening is shown in the figure. If this protocol is followed, 96-1% of infected urine samples will be detected and the number of urine samples that will need processing by the bacteriology laboratory will be reduced by 30-1%. In the bacteriology laboratory of the Belfast City Hospital about 300 urine samples are processed every day; the use of screening tests could reduce this number by about 100. Moreover, a multistix 10SG dipstick costs about $0.15 ($0.25) and although the cost for the processing of a urine sample by the laboratory is difficult to estimate, the current Department of Health figure is about £10.

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REFERENCES

P. G. FLANAGAN AND OTHERS: REFERENCES—continued