

Screening for bacteriuria with Clinitec-200

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SUMMARY A method of testing for bacteriuria with multiple reagent strips for blood, nitrite, and leucocyte esterase was evaluated. Of 669 urine specimens tested, 267 were negative on the reagent strips and so would ordinarily be discarded, creating a reduction in the workload of culturing urine specimens of 40%. Thirteen of these were false negative results, however, which represented 10% of all the samples with definite bacteriuria. Additional time was required for the screening test which reduced potential savings in manpower. Overall, we found costs to be slightly increased. In our laboratory this screening test was not economic and would produce an unacceptable rate of false negative results.

The culture of urine is a considerable part of the work of any routine microbiology laboratory. In this laboratory between 60 and 120 specimens are received daily; only 20% show a clinically important growth of bacteria. This study investigates a screening test for bacteriuria intended to detect quickly and reliably urine specimens that are negative on culture.

Traces of blood or protein on reagent strip testing in outpatient clinics and general practitioners' surgeries are regarded as indications for sending midstream specimens of urine for bacteriological investigation. Nitrite in the urine correlates with the presence of nitrate reducing bacteria, but only if dietary nitrate and the time that the urine remains in the bladder are adequate. Pyuria may be associated with infection, and quicker and easier tests for leucocyte esterase, a specific white cell marker, have recently been developed.

Previous studies of rapid screening methods such as Dipslides, Microstix,¹ Chemstrip 9,² Chemstrip LN,³ BacTscreen⁴ and ATP assay⁵ have concluded that they are not sufficiently reliable for routine laboratory use. Two recent studies, however,^{6,7} using a dipstick test for blood, protein, and nitrite, concluded that a negative result for all three reliably predicted the absence of bacteriuria. In one of these studies⁶ a separate leucocyte esterase test was also used but the authors concluded that this did not improve the predictive power of the screening.

We decided to test a dipstick method for all four measurements incorporating a rapid dipstick test for leucocyte esterase, to discover firstly, whether specimens negative for all four could be safely discarded without further testing and, secondly, whether—if this were done—the workload of the laboratory would decrease to any extent.

Material and methods

A total of 669 consecutive routine specimens of urine were tested as they arrived at the laboratory. They included samples from hospital inpatients, outpatient clinics, and general practice. Screening samples from antenatal patients were not included.

Multiple reagent strips including chemical tests for blood, protein, nitrite, and leucocyte esterase were used, and were read mechanically by the Clinitec-200 reflectance photometer (Ames Laboratories, Slough, Buckinghamshire, England). Each strip was dipped into well mixed urine, drawn out against the side of the container to remove excess urine, and read at the appropriate time intervals. Urines could be tested at the rate of six specimens/minute, and all results were automatically printed on to heat sensitive paper.

For microscopy and culture of the urine, 50 μ l of well mixed urine was placed into a well of a microtitre plate with a pipette and examined by inversion microscopy. The numbers of red and white blood cells were recorded and the presence of any organisms noted. One standard loop (5 μ l) of urine was plated on to blood agar and MacConkey's agar (two specimens/plate) and a further loopful was placed on a DST plate inoculated with a sensitive strain of *Escherichia coli* (*E. coli* 10148) to detect antibiotic activity in the urine (16 specimens/plate). The culture plates were incubated for 24 hours at 37°C in 10% carbon dioxide. All specimens were tested by both methods in parallel.

For the purposes of this study a culture result showing $> 10^5$ organisms/ml of urine of one species alone or of one predominating species indicated definite bacteriuria; a mixed growth with no predominating organism indicated contamination. A separate analysis was made if specimens yielded $> 10^4$ but $< 10^5$ pure growth of organisms/ml or if yeasts or protozoa were seen on microscopy, as these may also

Table 1 Comparison of strip testing for blood, protein, nitrite and leucocyte esterase with results of culture

	No (%) of positive strips	No (%) of negative strips	Total No (%)
Positive culture	117 (18)	12 (2)	129 (19)
Negative culture	333 (50)	207 (31)	540 (81)
Total No	450 (67)	219 (33)	669 (100)

Sensitivity 91%, specificity 38%; predictive value for positive result 26%, and for negative result 95%.

be considered clinically important and are reported by our laboratory.

We used the statistical formulas listed below.⁸ Sensitivity (%) = true positives × 100/true positives + false negatives. Specificity (%) = true negatives × 100/true negatives + false positives. Predictive value (%) for positive result = true positives × 100/true positives + false positives, and predictive value (%) for negative result = true negatives × 100/true negatives + false negatives.

Results

When the 669 samples were tested for blood, protein, nitrite, and leucocyte esterase with the multiple reagent strips, 219 (33%) were negative for all four and so would have been discarded (table 1). Twelve (2%) of these were positive on culture—that is, false negatives. Four hundred and fifty (67%) were positive and so would have gone on to be cultured. Of the others, 117 (18%) were also positive on culture and 333 (50%) were negative on culture—that is, false positives. The sensitivity of the screening test was 91% but the specificity was only 38%. The predictive value for a negative result was 95% but for a positive result only 26%.

If the test for protein was discounted (table 2) then the number of negative strip results rose to 267 (40%) with only one more false negative (n = 13, 2%). The positive strip results dropped to 402 (60%), 286 (43%) being false positives and 116 (17%) true positives. This improved the specificity to 47% while reducing the sensitivity only slightly to 90%. The predictive values changed little.

Table 2 Comparison of strip testing for blood, nitrite, and leucocyte esterase with culture

	No (%) of positive strips	No (%) of negative strips	Total No (%)
Positive culture	116 (17)	13 (2)	129 (19)
Negative culture	286 (43)	254 (38)	540 (81)
Total No	402 (60)	267 (40)	669 (100)

Sensitivity 90%, specificity 47%; predictive value for positive result 29%, and for negative result 95%.

Table 3 Analysis of results of culture and strip testing for blood, nitrite, and leucocyte esterase of other "positive" results

Result of culture	No of positive strips	No of negative strips	Total No
> 10 ⁴ < 10 ⁵ organisms	14	2	16
Yeasts present	8	2	10
<i>Trichomonas vaginalis</i>	0	1	1

Twenty seven (4%) yielded culture results that would have been reported by our laboratory, although < 10⁵ organisms/ml (table 3). Sixteen contained > 10⁴ < 10⁵ organisms/ml of one species and 14 of these were strip positive. Ten contained yeasts on microscopy, and eight of these were detected by the strip. One case of *Trichomonas vaginalis* was detected on microscopy and this was negative on the strip. If the results were reanalysed counting these cases as positive (table 4) then the number of false negatives became 18 (3%). The number of false positives dropped to 264 (40%) and the sensitivity and specificity became 89% and 49%, respectively.

Discussion

Our results show that screening for blood, nitrite, and leucocyte esterase but not protein produced an improvement in specificity from 38% to 47%. If the other reported categories were included the sensitivity was reduced to 89% but the predictive value for a positive result rose to 34%. This screening test picked up most of the specimens that might be considered clinically important although they contained < 10⁵ organisms/ml.

We evaluated the costs of the three reagent method. Of the specimens received, 40% were discarded. It took about one hour to screen 100 urine specimens, including the time taken to set up the machine. Although the Clinitec-200 can accept six strips/minute, it is not possible for one person to use it at this rate continually. Some time is also spent sorting out the negative specimens on the printout.

The discard of 40% of the specimens without

Table 4 Comparison of strip testing for blood, nitrite, and leucocyte esterase with results of culture. Cases from table 3 are taken as culture positive

	No (%) of positive strips	No (%) of negative strips	Total No (%)
Positive culture	138 (21)	18 (3)	156 (23)
Negative culture	264 (40)	249 (37)	513 (77)
Total No	402 (60)	267 (40)	669 (100)

Sensitivity 89%, specificity 49%; predictive value for positive result 34%, and for negative result 93%.

microscopy or culture would save about one to one and a half hours of a technician's time each day. The average cost of equipment for culture was 13p a specimen at the time of writing. Each multiple reagent strip costs about 13p. The cost of screening before culture is 60% more than current expenditure, because 60% of the specimens must undergo both methods of testing. The average daily expenditure would rise by about £9.50.

Savings would increase as the specificity of the screening test increased: the quality of the service offered depends on the sensitivity of the method. Although false negatives made up only 2% of the total number of specimens screened (a figure comparable with that of other studies^{5,6}), they constitute 10% of the total positive cultures. Discarding these specimens would therefore result in an unacceptable fall in the accuracy of reporting from this laboratory.

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