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Evaluation of BACTEC System for Urine Culture Screening

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We compared urine culturing performed by the calibrated loop method with a screening system (BACTEC). A total of 852 urine specimens were examined by both the conventional loop method and the BACTEC system. With the loop method, 193 (22.6%) urine samples were positive, whereas with the BACTEC system, 185 (21.7%) were positive (sensitivity, 96.01%). At a breakpoint of 10^4 CFU/ml, eight false-negatives were detected (sensitivity, 87.09%), and at a breakpoint of 10^5 CFU/ml, four false-negatives were observed (sensitivity, 97.6%). The specificity of the BACTEC system was 100%. We propose the BACTEC method as an effective alternative to the other growth-dependent screening tests for bacteriuria.

In a clinical microbiology laboratory, urine culturing constitutes the major work load. Moreover, in 70 to 80% of the cases, urine cultures are negative and, therefore, a test which rapidly, accurately, and relatively inexpensively eliminates these negative specimens is useful. Such a test, if specific, has the advantage of providing a more rapid answer to the physician and enables antibacterial treatment to be started earlier, if necessary.

Several biochemical urine screening methods, such as assays for leukocyte esterase activity and nitrate reduction (10) and glucose detection (8), have been described. Physical methods, such as impedance (4), filtration (12), particle counting (1), and microscopic examination (6), have been reported, as have semiautomatic systems, including the MS-2 (11), AutoMicrobic system (7), Autobac (5), Lumac (3), and Bac-T-Screen (3).

The large number of methods with different performance and test characteristics indicates the interest in urine screening as well as the need for a rapid, simple, and inexpensive method. In this study, we compared the calibrated loop urine culture method (9) with a screening system (11) (BACTEC NR 660; Johnston Laboratories, Inc., Towson, Md.). The BACTEC NR 660 is usually used for blood cultures and is based on the infrared detection of CO_2 produced by the metabolism of growing bacteria.

MATERIALS AND METHODS

A total of 852 urine specimens were submitted on ice for culturing to the microbiology laboratory from inpatients and outpatients and were tested by both the calibrated loop method and the BACTEC screening method. No more than 2 h elapsed between collection and processing. Quantitative culturing was performed with a 0.01-ml calibrated loop on the Uroplate system (Sclavo, Siena, Italy), a plate subdivided into six sectors containing the following media: enterococcal confirmatory agar, mannitol salt agar, cysteine lactose electrolyte deficient agar, cetrimide agar, and MacConkey agar (two sectors). The plates were incubated at 37°C, and colonies were counted after 18 to 24 h. Identification of microorganisms and antibiotic susceptibility testing were carried out with the Sceptor system (BBL Microbiology Systems, Cockeysville, Md.). For the BACTEC screening method, 2 ml of the same urine specimen was inoculated into 10 ml of medium prepared in our laboratory and consisting of Trypticase soy broth (4 g/liter; BBL), yeast extract (2.5 g/liter; Difco Laboratories, Detroit, Mich.), and sodium citrate (2 g/liter; BDH, Poole, England). The medium was dispensed into vials (Becton Dickinson, Milan, Italy) of the same shape and dimensions as those used for blood cultures. The inoculated vials were incubated with continuous shaking in the BACTEC NR 660 for 5 h. A 5-h incubation time was chosen because it provided optimum separation of growth indices (GIs) between positive and negative cultures. The vials were then analyzed with the BACTEC NR 660. All vials with a (GI) of <3 were considered negative. Specimens with a GI of >3 were considered positive. The following statistical parameters were determined (2): sensitivity, specificity, and predictive values of positive and negative results.

RESULTS

Of the 852 urine specimens tested with the BACTEC screening system, 667 were negative and 185 were positive. With the calibrated loop method, 659 specimens were negative and 193 specimens were positive. A total of 27 specimens contained $>10^4$ to $<10^5$ CFU/ml, and 166 specimens contained $>10^5$ CFU/ml. The BACTEC test was 100% specific, and the sensitivities were 87.09 and 97.6%, respec-

TABLE 1. Isolates from 193 culture-positive urine specimens[a]

Isolate	Total no. isolated	No. isolated at indicated colony count[b]:	
		$>10^4$ to $<10^5$	$>10^5$
Escherichia coli	90	4	88
Group D streptococci	19	6	14
Klebsiella sp.	7	1	6
Candida sp.	4	2	2
Pseudomonas sp.	9	3	8
Staphylococcus sp.	4	2	3
Proteus mirabilis	5	3	3
Enterobacter sp.	11	4	7
Acinetobacter sp.	4	2	3
Proteus rettgeri	2	0	2
Providencia sp.	2	0	2
Mixed bacterial species	28	0	28

[a] Of the 193 specimens, 8 were false-negative in the BACTEC screening system: 2 *Pseudomonas* sp., 2 *E. coli*, 1 *P. mirabilis*, 1 *Staphylococcus* sp., 1 group D streptococcus, and 1 *Acinetobacter* sp.
[b] Colony counts are given in CFU per milliliter.

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TABLE 2. Correlation between the GIs of the BACTEC screening test and bacterial colony counts

Isolate	GI (no. of strains tested) at indicated colony count[a]:			
	$<10^4$	$>10^4$ to $<10^5$	$>10^5$ to $<10^6$	$>10^6$
Pseudomonas sp.	1 (5)	5 (3)	25 (3)	45 (3)
Staphylococcus sp.	1 (1)	20 (1)	40 (1)	120 (2)
Proteus sp.	1 (2)	15 (3)	30 (4)	
Klebsiella, *Enterobacter*, and *Serratia* spp.	3 (5)	25 (5)	95 (6)	170 (7)
Candida sp.	3 (4)	35 (2)	70 (2)	
Group D streptococci	3 (3)	20 (5)	60 (7)	90 (7)
E. coli	2 (2)	30 (3)	100 (60)	170 (27)

[a] Colony counts are given in CFU per milliliter.

tively, for $>10^4$ to $<10^5$ CFU/ml and $>10^5$ CFU/ml. The predictive values were 98.8% for a negative test and 100% for a positive test.

The variety and numbers of bacteria isolated from the 185 BACTEC-positive samples are shown in Table 1.

The correlation between mean GIs and colony counts is shown in Table 2. GIs of >25 were usually seen with a clinically significant colony count. Generally, for bacterial colony counts exceeding $>10^4$ CFU/ml, the GI was >15. For *Pseudomonas* sp., the GI was usually lower, and a GI of <3 was not significant.

DISCUSSION

A rapid method of screening urine cultures is needed to reduce costs as well as work loads in clinical microbiology laboratories. Because only 20 to 30% of urine cultures are positive, usually 18 h elapses before a culture is determined by conventional methods to be negative. Several screening systems evaluate directly only the bacterial concentration present in the urine specimen at the time of testing, e.g., the Lumac (3) and Bac-T-Screen (3). These systems are rapid, and results can be made available within 1 h. The results are not always reliable because of low specificity and sensitivity (13). Other methods, e.g., the MS-2 (11) and the AutoMicrobic system (7), evaluate bacterial growth and allow identification of the most common urinary tract pathogens. The AutoMicrobic system, however, requires 13 h for urine screening. The BACTEC system is as rapid as the MS-2 and more rapid than the AutoMicrobic system. It is sensitive and simple to use. A significant advantage is that an instrument (BACTEC NR660) already present in microbiological laboratories for blood culture processing can be used, maximizing the utilization of the BACTEC NR660 and reducing the cost of each determination because there is no need to acquire another instrument.

It is interesting to note that when the colony count was $<10^4$ CFU/ml, a GI of >3 was never achieved. One might assume that if colony counts were near the 10^4-CFU/ml breakpoint, e.g., 7×10^3 to 8×10^3 CFU/ml, then a GI of >3 would be realized, particularly with fast-growing bacteria. However, no such growth pattern was observed in the urine specimens cultured. It is possible that if greater numbers of specimens were tested, the GI breakpoint would not be so sharp.

The cost of each BACTEC vial is estimated to be competitive with the cost of the existing methods, but these vials are not yet available commercially. A cost comparison of screening methods versus traditional culture methods is difficult because there is so much variation in the pricing of individual screening tests as well as the numbers of agar plates used for traditional culture methods. Equally confounding is any attempt to compare costs between laboratories in the United States and those in Europe or the United Kingdom.

The results of this comparative study indicate that the BACTEC NR660 method is an effective alternative to other available growth-dependent urine screening methods.

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