Comparison of the BACTOMETER Microbial Monitoring System with Conventional Methods for Detection of Microorganisms in Urine Specimens

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A rapid impedance-based screen for bacteriuria ($>10^5$ organisms per ml) was compared with a standard loop method, using 156 clinical urine specimens. Agreement between the methods was 96.8%.

Several of the techniques that are in current use in the diagnostic laboratory can be considered time consuming for the detection of microorganisms from clinical specimens. Recent technical advances have been introduced that can detect the initial growth and metabolic activities of most microorganisms in considerably less time than that required with conventional techniques. One of the most promising of these methods employs the principle of measuring a change in electrical impedance, which occurs as a result of both growth and active metabolism of microorganisms in broth medium (1, 3, 4, 6; W. K. Hadly and G. Senyk, *Microbiology*—1975, p. 12-21, American Society for Microbiology, Washington, D.C.).

The intent of this study was to use the principle of impedance measurements in the quantitative detection of microorganisms in urine specimens and to correlate these findings with those obtained by conventional techniques.

Freshly voided, midstream urine specimens were properly collected in sterile containers and submitted to the laboratory. Most specimens were submitted to the laboratory within 0.5 h from the time of collection and were promptly processed. Specimens that could not be processed immediately were refrigerated. Each specimen was divided and processed in the following manner. For initial isolation, all urines were cultured on both a blood agar plate and a MacConkey agar plate by the calibrated loop method (5). All plates were incubated at 35°C for 18 to 24 h and then examined for growth of bacteria. Standard biochemical test procedures were used for final identification of microorganisms (2, 5).

Impedance measurements were made by the BACTOMETER (trademark, Bactomatic, Inc.) microbial monitoring system (Bactomatic, Inc., Palo Alto, Calif.), which has been described elsewhere (Hadly and Senyk, *Microbiology*—

1975, p. 12-21). Measurements were made at 2,000 Hz by impedance-measuring chambers (modules) obtained from Bactomatic, Inc. Both reusable modules with gold-plated electrodes and disposable modules with stainless steel electrodes were used in this study. Trypticase soy broth medium (0.5 ml; BBL) was pipetted into each sample well, and 1.0 ml was poured into each of the reference wells of a module. Well-mixed, undiluted urine specimen (0.5 ml) was then aseptically pipetted into the sample wells. The modules were then inserted into the incubator portion of the instrument, which was set at 35°C. The impedance change was monitored by the strip chart recorder. An accelerating change in impedance of 0.8% (one full-channel width) was designated as a significant impedance change. For the screening test, only urines showing a significant impedance change occurring within a selected cutoff time (either 4 or 2 h) were considered as impedance positive.

A total of 156 urine specimens was examined, of which 35 had colony counts indicative of $>10^5$ organisms per ml. The organisms isolated from these specimens are shown in Table 1. Designating only urines with $>10^5$ organisms per ml as positive by culture, all but one were detected by impedance within 4 h. In addition, there were four false positives (Table 2). One hundred fifty-one samples were correctly classified, for an agreement of 96.8%.

A cutoff time of 2 h gives the results shown in Table 3. One fewer sample is detected; however, the agreement remains high. It should be noted that some slow-growing organisms, even in high concentrations, may fail to give a significant impedance change within the cutoff period. In other experiments, yeasts were noted to consistently give slower responses than the bacteria encountered in our urine specimens. Also, mixed cultures containing two or more organisms invariably gave a positive response,

even though the concentrations of the individual organisms were well below 10^5 /ml.

It should be stressed that in this study no attempt was made to distinguish urine specimens containing antibiotics. Thus, further studies are warranted to explore the effect of antibiotics upon impedance response and to determine the optimum dilution of specimens in medium to provide, on the one hand, the best conditions for growth while maintaining, on the other hand, sufficiently high concentrations for rapid response.

From the position of per-unit test cost in the

examination of urines for bacteriuria, it would appear the automated impedance procedure is comparable with the more conventional methods, i.e., the use of the Gram stain for unspun urines. This would seem particularly true when one considers the amount of technician time involved in carrying out conventional procedures.

We conclude that on the basis of these studies impedance measurements offer a method for the rapid detection of large concentrations of microorganisms in urine.

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TABLE 1. *Organisms recovered by conventional techniques from urine specimens containing $>10^5$ bacteria/ml*

Organism	No. of samples
<i>Escherichia coli</i>	17
<i>Proteus mirabilis</i>	5
<i>Pseudomonas aeruginosa</i>	2
<i>Staphylococcus epidermidis</i>	2
<i>Enterobacter cloacae</i>	1
<i>Klebsiella pneumoniae</i> , <i>E. coli</i> , <i>P. mirabilis</i>	1
<i>E. cloacae</i> , <i>P. aeruginosa</i>	1
<i>Moraxella</i> sp., <i>Corynebacterium</i> sp., <i>S. epidermidis</i>	1
<i>E. coli</i> , group D streptococcus	1
Group D streptococcus	1
Group B streptococcus	1
<i>P. mirabilis</i> , <i>E. coli</i>	1
<i>S. epidermidis</i> , <i>E. coli</i> , group D streptococcus	1

TABLE 2. *Four-hour impedance urine screen*

Detection system	Culture colony count $>10^5$			Results
	Pos	Neg	Total	
Impedance monitoring	Pos	34	4	38
	Neg	1	117	118
Total		35	121	156
				False negatives 1/156 = 0.64%
				False positives 4/156 = 2.56%
				Positives missed 1/35 = 2.86%
				Agreement 151/156 = 96.8%

TABLE 3. *Two-hour impedance urine screen*

Detection system	Culture colony count $>10^5$			Results
	Pos	Neg	Total	
Impedance monitoring	Pos	33	1	34
	Neg	2	120	122
Total		35	121	156
				False negatives 2/156 = 1.28%
				False positives 1/156 = 0.64%
				Positives missed 2/35 = 5.72%
				Agreement 153/156 = 98.1%

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