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Comparison of the VersaTREK® and the BacT/ALERT® Blood Culture Systems for the Growth of Fastidious Microorganisms

Fastidious organism recovery in automated blood culture systems is poorly documented. For this reason, in-vitro simulations were performed at Duke University Medical Center comparing the VersaTREK Automated Microbial Detection System (VT) (TREK Diagnostic Systems, Cleveland, OH) to the BacT/ALERT system (3D) (bioMeriéux, Inc., Durham, NC). Thirty seven strains of organisms grown from frozen stocks were used in the study. Organisms were diluted in sterile saline and were targeted to achieve a concentration of 10-100 CFU/ml. REDOX 1® and REDOX 2® bottles from TREK Diagnostic Systems and BacT/ALERT standard aerobic and anaerobic bottles from bioMeriéux were inoculated with the organisms. The bottles were supplemented with fresh human blood prior to incubation in their respective instrument. To further assess media performance, identical bottles were inoculated with the same organism set and were not supplemented with blood. Parameters assessed in the analysis included recovery of the organisms and mean time to detection in hours for both systems in bottles with and without blood. Results demonstrated the VT REDOX 1 bottle was the most productive bottle in the study. The REDOX 1 bottle (with blood) yielded faster time to detection compared to bioMeriéux standard aerobic bottles for 100% of all aerobic organisms tested. Overall detection for VT was 100% (37/37) compared to 97.0% (36/37) for the 3D system with blood supplementation. The VT system had an overall recovery rate of 94.6% (35/37) compared to 86.5% (32/37) for the 3D system without blood supplementation. In conclusion, this study demonstrated that the VT system is superior compared to the 3D system for fastidious organism recovery when blood is not used as a nutritional supplement and can be attributed to the highly enriched media components of the REDOX media.

The VersaTREK Microbial Detection System (VT) (TREK Diagnostic Systems, Cleveland, OH) and the BacT/ALERT 3D system (3D) (bioMeriéux, Inc., Durham, NC) are FDA-cleared continuous monitoring blood culture instruments. The VT system is highly unique compared to the other two systems because it is the only blood culture system that monitors pressure changes within the headspace of the bottle to detect organisms in blood or other sterile body fluids. Because of the versatility of the technology, any gas (CO_2, H_2, N_2, O_2) produced or consumed by an organism can be detected by the VT system. Unlike the CO_2 based technologies the VT comprehensive detection technology does not have limitations regarding low CO_2 producing organisms and the system is not affected by high white blood cell counts. The VT system is also FDA-cleared for four testing applications; blood culture, sterile body fluids, Mycobacteria detection, and *Mycobacterium tuberculosis* (*Mtb)* susceptibility testing. All REDOX 1 (aerobic) VT bottles contain a stir bar that effectively mixes the media to provide enhanced oxygenation resulting in faster time to detection for aerobic organisms. The anaerobic bottles are stationary in VT. The 3D system does not have FDA-clearance for any *Mtb* susceptibility testing. Both the aerobic and anaerobic bottles are agitated using a rocking motion.

In this study the performance of the VersaTREK system and the BacT/ALERT 3D system was evaluated for fastidious organism recovery. To further challenge both systems and evaluate the need for nutritional supplementation, blood bottles without blood supplementation were tested as well.

MATERIALS AND METHODS

Background information: An in-vitro study comparing the VersaTREK system to the BacT/ALERT system was performed at Duke University Medical Center. Thirty seven organisms previously isolated from patients and stock strains were used in the study. Organisms tested include ***Neisseria catarrhalis, N. gonorrhoeae (1 isolate only), N. meningitidis, Haemophilus aphrophilus, Actinobacillus actinomycetemcomitans, Cardiobacterium spp., Eikenella spp., Kingella spp., Bordetella bronchiseptica,*** and ***Campylobacter jejuni***. In addition, two isolates each of group B beta hemolytic streptococci, ***Enterococcus faecalis***, and ***E. faecium*** were tested along with ATCC® control strains of ***Streptococcus pneumoniae*** (6305), ***Pseudomonas aeruginosa*** (27853), and ***Bacteroides fragilus*** (25285). Each isolate was subcultured for 24-72 hours depending on the time required for adequate growth to prepare a 0.8 McFarland standard. The 0.8 standard was then diluted with sterile saline to achieve a target inoculum of 10-100 CFU per bottle. One each of TREK's REDOX 1 and REDOX 2 blood culture bottles and bioMeriéux's standard aerobic and anaerobic bottles was inoculated with the standardized inoculum. A second set of identical bottles was prepared and each bottle in this set was inoculated with human blood. All bottles were incubated in their respective instruments until they became positive or for a total of 5 days if negative.

Data Analysis: Information recorded included recovery of the isolate as well as time to detection for each bottle tested.

RESULTS

Overall recovery including both the aerobic and anaerobic bottles for the VT system was 37/37 with blood and 35/37 without blood. For the 3D system overall recovery including both the aerobic and anaerobic bottles was 36/37 blood with and 32/37 without blood.

Microorganisms not detected by each bottle type are shown in Table 1. Blood was required for the isolation of 2/3 strains of *Eikenella spp*, in the aerobic bottles for both systems. With blood supplementation all strains were detected by the VT system. One isolate of *N. meningitidis* was missed by the 3D system.

Table 1: Microorganisms Missed by Each Bottle Type

Microorganism (n)	TREK Aerobic No Blood	BacT/ALERT Aerobic No Blood	TREK Anaerobic No Blood	BacT/ALERT Anaerobic No Blood	TREK Aerobic Blood	BacT/ALERT Aerobic Blood	TREK Anaerobic Blood	BacT/ALERT Anaerobic Blood
Group B ß-streptococci (2)	0	0	0	0	0	0	0	0
E. faecalis (2)	0	0	0	0	0	0	0	0
E. faecium (2)	0	0	0	0	0	0	0	0
M. catarrhalis (3)	0	0	3	0	0	0	3	1
N. gonorrhoeae (1)	0	1	1	1	0	1	1	0
N. meningitidis (3)	0	2	3	2	0	1	3	1
H. aphrophilus (3)	0	1	0	0	0	0	0	0
A. actinomycetemcomitans (3)	0	2	0	0	1	1	0	0
C. hominis (3)	0	3	3	1	0	3	0	0
Eikenella sp. (3)	2	3	3	0	0	1	2	0
Kingella sp. (3)	0	3	3	1	0	0	3	2
B. bronchiseptica (3)	0	0	1	2	0	0	2	2
C. jejuni (3)	0	3	3	1	0	3	3	0
P. aeruginosa-ATCC 27853 (1)	0	0	0	1	0	0	0	0
B. fragilus-ATCC 25285 (1)	1	1	0	1	1	1	0	0
S. pneumoniae-ATCC 6305 (1)	0	0	0	0	0	0	0	0
Total	**3**	**19**	**20**	**10**	**2**	**11**	**17**	**6**

All microorganisms tested in this study were aerobes with the exception of one isolate of *B. fragilus*. In reviewing missed microorganisms per bottle type without blood supplementation (Table 1), the VersaTREK REDOX 1 (aerobic) bottle without blood supplementation missed only two aerobes. The organisms missed were two *Eikenella spp*. and require blood for growth. Conversely, the BacT/ALERT aerobic bottle did not recover 19 aerobes in the aerobic bottle. When reviewing data from aerobic bottles with blood supplementation, the VersaTREK REDOX 1 (aerobic) bottle missed only one isolate of *A. actinomycetemcomitans* and the anaerobic isolate of *B. fragilus.* BacT/ALERT missed eleven aerobes in the aerobic bottle. Better aerobic microorganism recovery occurred in the BacT/ALERT anaerobic bottle which recovered 31 of the 37 microorganisms. Explanations for better recovery of aerobes in the anaerobic bottle for the BacT/ALERT system are unknown, however; it appears from this study that the BacT/ALERT anaerobic bottle provides a better aerobic environment for the microorganisms tested. These data show that in low volume situations the aerobic VT bottle should be used, but raised question of which bottle should be used with the 3D system.

The mean time to detection in hours for bottles with blood supplementation for each system is shown in Table 2. The VT REDOX 1 bottle had faster times to detection for 100% of the isolates tested. It should be noted that the 3D standard aerobic bottle did not detect *N. gonorrhoeae*, *C. hominis*, and *C. jejuni*.

Table 2: Mean Time to Detection (hours) with Blood Supplementation

Microorganism (n)	TREK Aerobic	BacT/ALERT Aerobic	TREK Anaerobic	BacT/ALERT Anaerobic
Group B β-streptococci (2)	10.6	10.8	14.0	10.6
E. faecalis (2)	10.0	11.5	12.9	10.8
E. faecium (2)	14.3	15.2	15.5	14.1
M. catarrhalis (3)	15.8	18.2	0.0	16.9
N. gonorrhoeae (1)	33.5	0.0	0.0	33.0
N. meningitidis (3)	18.0	23.5	0.0	18.6
H. aphrophilus (3)	24.7	32.2	20.7	19.9
A. actinomycetemcomitans (3)	29.4	48.2	53.0	32.4
C. hominis (3)	41.2	0.0	88.6	39.4
Eikenella sp. (3)	39.1	50.4	44.3	21.1
Kingella sp. (3)	23.7	60.8	0.0	18.6
B. bronchiseptica (3)	19.4	22.4	19.2	15.3
C. jejuni (3)	35.2	0.0	0.0	32.9
Controls				
P. aeruginosa-ATCC 27853 (1)	14.5	15.9	24.8	15.9
B. fragilis-ATCC 25285 (1)	0.0	0.0	28.0	55.2
S. pneumoniae-ATCC 6305 (1)	14.5	15.1	17.9	14.0

The mean time to detection in hours for bottles without blood supplementation for the two systems is shown in Table 3. The VT REDOX 1 bottle had faster times to detection for 97.3% of the isolates tested compared to the 3D system. Additionally, the 3D system did not detect *N. gonorrhoeae*, *C. hominis*, *Eikenella spp*., *Kingella spp*., and *C. jejuni* in the aerobic bottle (Table 3).

Table 3: Mean Time to Detection (hours) without Blood Supplementation

Microorganism (n)	TREK Aerobic	BacT/ALERT Aerobic	TREK Anaerobic	BacT/ALERT Anaerobic
Group B β-streptococci (2)	11.2	12.2	14.5	11.0
E. faecalis (2)	10.9	38.9	12.9	11.1
E. faecium (2)	14.8	16.5	16.2	14.9
M. catarrhalis (3)	16.4	19.5	0.0	40.0
N. gonorrhoeae (1)	38.4	0.0	0.0	0.0
N. meningitidis (3)	20.6	42.0	0.0	20.3
H. aphrophilus (3)	24.2	18.0	41.6	20.4
A. actinomycetemcomitans (3)	43.3	62.4	63.8	39.1
C. hominis (3)	34.4	0.0	0.0	56.3
Eikenella sp. (3)	15.6	0.0	0.0	21.5
Kingella sp. (3)	23.8	0.0	0.0	27.5
B. bronchiseptica (3)	21.3	24.1	19.1	16.6
C. jejuni (3)	55.7	0.0	0.0	57.6
Controls				
P. aeruginosa-ATCC 27853 (1)	14.4	17.4	22.4	0.0
B. fragilis-ATCC 25285 (1)	0.0	0.0	26.8	0.0
S. pneumoniae-ATCC 6305 (1)	14.3	16.3	18.7	14.5

RESULTS AND DISCUSSION

Although numerous studies recommend blood draw volumes of 20-30 ml per set for adult patients, the reality is that low blood draws do exist in the clinical environment. When low sample volumes do occur, common practice is to place the entire sample into the aerobic bottle. When low blood draws occur with the VT system, it is a clear decision that all of the sample could be placed into the REDOX 1 bottle for good recovery of fastidious organisms. The decision is not that clear for the 3D system because several of the aerobic organisms, notably *N. gonorrhoeae*, *C. hominis*, *Eikenella spp*., *Kingella spp*., and *C. jejuni* were not recovered in the aerobic bottle but rather in the anaerobic bottle.

These data show that in low volume situations where only the aerobic bottle is inoculated; the BacT/ALERT will miss some of the fastidious organisms. Conversely, it is demonstrated from this study that VersaTREK REDOX 1 (aerobic) bottle with or without blood was the single most productive bottle in this study.

VersaTREK media was developed as a highly enriched two bottle media system with four major design requirements 1.) will grow and detect all metabolic microbial groups, 2.) is effective for all patient populations, no specialty media needed for pediatric patients, 3.) uses minimal blood volumes as a nutritional factor, and 4.) utilizes dilution for antibiotics and serum factors. This was the first study that demonstrated the need for a "media system" (both aerobic and anaerobic) to optimize the recovery of organisms, and that TREK's REDOX 1 bottle is the single most productive bottle for growth and detection of fastidious organisms.