Clinical Performance Evaluation of VIRTUO Blood Culture System in a Tertiary Care Hospital

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Abstract (revised)

Background: Bloodstream infections are a major cause of morbidity and mortality. BACT/ALERT VIRTUO (VIRTUO) blood culture system is an automated, closed system used with resin-containing media which may enhance the growth of microorganisms. Our objective was to assess the real-world performance of the VIRTUO system.

Methods: We retrospectively reviewed all blood cultures performed between January-December 2018 (VersaTREK) and January-December 2019 (VIRTUO) at a 1250-bed academic medical center. Blood culture positivity rates, contamination rates, and time from collection to arrival in the laboratory were compared pre- versus post-VIRTUO implementation. Contamination was defined as a single blood culture with common skin microbiota.

Results: A total of 101803 blood cultures were performed during the study period: 48969 (48.1%) were processed with VersaTREK system and 52834 (51.9%) with VIRTUO system. A decreased median time from collection until arrival to the laboratory was seen post-implementation (2.0 pre- vs. 0.8 hours post-implementation, p<0.001). The positivity rate increased from 3987 (8.1%) pre-implementation to 6141 (11.6%) post-implementation (p <0.001) (Table and Figure). *Staphylococcus aureus* was the most frequently isolated species for both periods and had higher recovery rate with the VIRTUO system (717 (1.5%) pre- vs. 1764 (3.3%) post-implementation, p<0.001). Higher recovery rate was also noted for other *Staphylococcus* spp. in the post-implementation period (985 (2.0%) pre- vs. 1644 (3.1%) post-implementation, p<0.001). Difference in the organism recovery rate was also noted for E. coli, K. pneumoniae, and *Candida* spp. The inpatient contamination rate was higher post-implementation (1.5% pre- vs. 1.9% post-implementation, p <0.001).

Conclusion: The VIRTUO system showed a higher rate of positive blood cultures compared to the VersaTREK system primarily from a higher detection of *Staphylococcus* spp. Further studies are needed to assess whether an increased rate of positive blood cultures is associated with changes in management and clinical outcomes.

Background / Methods

- Newer blood culture (BC) systems are being developed to improve detection of bacteremia.
- We assessed VIRTUO's performance after it was implemented in our institution (a 1250-bed academic medical center) by retrospectively reviewing all BCs performed between Jan 1, 2018 and Dec 31, 2019.
- Pre-implementation period (Jan 1, 2018 - Jan 13, 2019) used VersaTREK BC system.
  - Glass BC bottles transported physically via courier.
  - VersaTREK REDOX 1 (aerobic) and REDOX2 (anaerobic) media.
  - External sensors detect any pressure changes in BC bottles.
  - Microorganisms consume nutrients from BC bottles which produce gases and triggers positivity.
- Post-implementation period (Jan 14, 2019- Dec 31, 2019) used VIRTUO system.
  - FA Plus (aerobic) and FN Plus (anaerobic) media.
  - Plastic BC bottles transported through pneumatic tube system.
  - Colorimetric technology detects changes in color.
  - Microorganisms produce CO_2 which changes color of media and triggers positivity.
- Our primary endpoints were proportion of BC positivity rate, contamination rate, and time from blood cultures collection to arrival to the laboratory.
- Categorical variables were compared using chi-square test. Two-sided p values of less than 0.05 were considered as statistically significant.

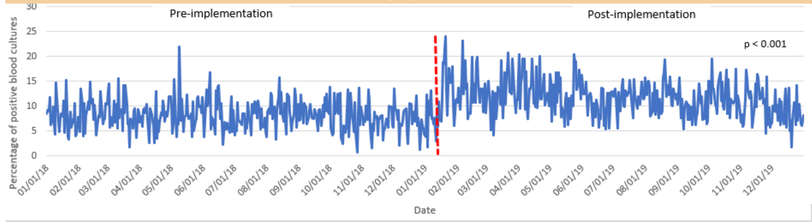
Results

- A total of 101803 blood cultures were performed:
  - 48969 (48.1%) were processed with VersaTREK.
  - 52834 (51.9%) with VIRTUO.
- A decreased median time from collection until arrival to the laboratory was seen post-implementation (2.0 pre- vs. 0.8 hours post-implementation, p<0.001).

Table 1. Comparison of blood culture positivity rate pre- vs. post-implementation, by culture location

	Overall		Pre-implementation		Post-implementation		*p*
	N	Positive	n	Positive	n	Positive	
All locations	101803	10128 (10.0%)	48969	3987 (8.1%)	52834	6141 (11.6%)	<0.001
Inpatient	71621	6580 (9.2%)	36972	2627 (7.1%)	34649	3953 (11.4%)	<0.001
Emergency	15023	2111 (14.1%)	6225	809 (13.0%)	8798	1302 (14.8%)	0.002
Outpatient	15159	1437 (9.5%)	5772	551 (9.6%)	9387	886 (9.4%)	0.826

Figure 1. Daily positivity rate for blood cultures processed during the study period



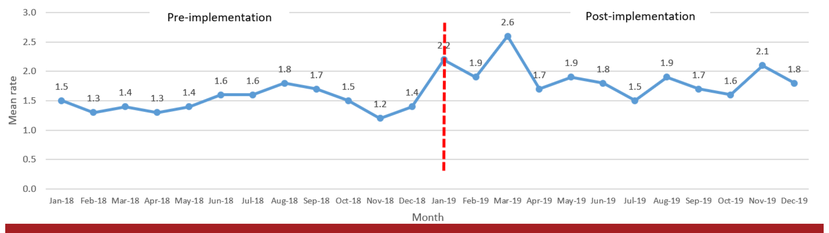
- *Staphylococcus aureus* was the most frequently isolated species for both periods and had higher recovery rate with the VIRTUO system (1.5% pre- vs. 3.3% post-implementation, p<0.001).
- Coagulase-negative staphylococci was also more frequently recovered with VIRTUO system (1.3% pre- vs. 1.6% post-implementation, p<0.001).
- Among Gram negative organisms, *E. coli* (0.8% pre- vs. 1.0% post-implementation, p<0.001) and *K. pneumoniae* (0.4% pre- vs. 0.5% post-implementation, p=0.006) showed higher recovery rate with VIRTUO system.
- *Micrococcus spp.* (0.11% pre- vs. 0.05% post-implementation, p=0.003) *and Bacteroides fragilis* (0.12% pre- vs. 0.07% post-implementation, p=0.03) were the only organisms recovered more frequently with the VersaTREK system.

Table 2. Comparative positivity rate of blood cultures by key organisms

Microorganisms, n (%)	Pre-implementation (n=48969)	Post-implementation (n=52834)	*p* value
Gram positive organisms			
Staphylococcus aureus	**717 (1.5)**	**1764 (3.3)**	**<0.001**
Coagulase negative staphylococci	**613 (1.3)**	**858 (1.6)**	**<0.001**
Staphylococcus epidermidis	**90 (0.6)**	**578 (1.1)**	**<0.001**
Staphylococcus haemolyticus	**10 (<0.1)**	**52 (0.1)**	**<0.001**
Staphylococcus lugdunensis	**11 (<0.1)**	**41 (0.1)**	**<0.001**
Viridans group streptococci	61 (0.1)	64 (0.1)	0.95
Streptococcus mitis group	73 (0.2)	76 (0.1)	0.89
Streptococcus pneumoniae	57 (0.1)	51 (0.1)	0.38
Enterococcus faecium	213 (0.4)	213 (0.4)	0.46
Enterococcus faecalis	168 (0.3)	182 (0.3)	0.97
Micrococcus spp.	**54 (0.1)**	**29 (<0.1)**	**0.003**
Cutibacterium spp.	**4 (<0.1)**	**43 (0.1)**	**<0.001**
Corynebacterium striatum	6 (<0.1)	14 (<0.1)	0.16
Gram negative organisms			
Escherichia coli	**385 (0.8)**	**534 (1.0)**	**<0.001**
Klebsiella pneumoniae	**176 (0.4)**	**250 (0.5)**	**0.006**
Klebsiella variicola	39 (0.1)	43 (0.1)	0.92
Klebsiella oxytoca	32 (0.1)	26 (0.1)	0.34
Enterobacter cloacae	80 (0.2)	80 (0.2)	0.69
Enterobacter aerogenes	34 (0.1)	33 (0.1)	0.76
Proteus mirabilis	51 (0.1)	73 (0.1)	0.14
Pseudomonas aeruginosa	162 (0.3)	212 (0.4)	0.07
Bacteroides fragilis	**57 (0.1)**	**39 (<0.1)**	**0.03**
Candida spp.	**159 (0.3)**	**276 (0.5)**	**<0.001**
Candida albicans	**63 (0.1)**	**95 (0.2)**	**0.05**

- *Candida spp.* had higher recovery rate with VIRTUO system compared with VersaTREK system (0.1% pre- vs. 0.2% post-implementation, p=0.05).
- The overall contamination rate was higher post-implementation (1.5% pre- vs. 1.9% post-implementation, p <0.001).

Figure 2. Monthly inpatient BC contamination rate during study period



Conclusions

- The VIRTUO BC system showed a higher rate of positive blood cultures compared to the VersaTREK system
- There was a higher detection rate of *Staphylococcus* spp. by VIRTUO BC system
- Further studies are needed to assess whether an increased rate of positive blood cultures is associated with changes in management and clinical outcomes.

References
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