Comparative evaluation of Accelerate Pheno™ and Vitek® 2 systems for rapid antibiotic susceptibility testing of pathogens in positive blood cultures

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Introduction

Bloodstream infection (BSI) remains a major public health concern because of its high incidence and consequences in terms of mortality, morbidity and cost — particularly in the case of nosocomial infection. While timely administration of effective antimicrobial therapy may reduce hospital length of stay and mortality of patients with BSI, a delayed (and potentially less effective) treatment often results in more severe stages of BSI-related disease.

Antimicrobial susceptibility testing (AST) of organisms causing BSI is an undisputed prerequisite for optimal antimicrobial therapy. In contrast to conventional automated methods, e.g. the widely used VITEK® 2 system (bioMérieux, Marcy-l'Étoile, France), recent efforts led to developing new generation methods for AST. Among them, the Accelerate Pheno™ system (Accelerate Diagnostics, Tucson, AZ, USA) is an automated microscopy platform that uses fluorescence *in situ* hybridization for identification and morphokinetic cellular analysis to provide AST results directly from positive blood cultures (PBCs).

Objective

The objective of this study was to compare the performance of the Accelerate Pheno™ system (Accelerate Diagnostics, Inc.) with that of the conventional phenotypic VITEK® 2 system for rapid antimicrobial susceptibility testing of bacterial pathogens from positive blood culture samples, based on the reference broth microdilution (BMD) method.

Materials and Methods

Prospectively collected blood cultures that represented single bloodstream infection patient/episodes over a 6-month period in 2017 were included. Blood cultures were collected in BacT/ALERT® FA and FN PLUS bottles (bioMérieux, Marcy-l'Étoile, France) and incubated until growth detection using the BacT/ALERT® VIRTUO® system (bioMérieux). For PBC samples showing monomicrobial growth (n = 86), AST was performed directly using both Accelerate Pheno™ and VITEK® 2 systems with PBC broth. Thereafter, colony isolates derived from subculture of PBC broth were used for the BMD method. AST results were interpreted according to 2017 EUCAST breakpoints.

Table 1: Performance of the Accelerate Pheno™ and VITEK® 2 systems compared to BMD for Gram-negative bacterial species (n = 62)

Antibiotic	Accelerate Pheno™ system								VITEK® 2 system							
	CA		VME	ME	mE	S	I	R	CA		VME	ME	mE	S	I	R
Enterobacteriaceae (n=46)																
Amikacin	40/46	87.0%	0	0	6	40	5	1	37/46	80.4%	0	2	7	40	5	1
Cefepime	40/45	88.9%	0	0	5	28	2	15	39/46	84.8%	0	0	6	28	2	16
Ceftazidime	43/46	93.5%	0	0	3	24	4	18	42/46	91.3%	0	0	4	24	4	18
Ciprofloxacin	44/46	95.7%	1	0	1	25	1	20	45/46	97.8%	0	0	1	25	1	20
Colistin	39/41	95.1%	0	2	0	39	0	2	40/41	97.6%	1	0	0	39	0	2
Ertapenem	45/46	97.8%	1	0	0	36	1	9	45/46	97.8%	0	0	1	36	1	9
Gentamicin	45/46	97.8%	0	0	1	37	0	9	40/46	87.0%	0	0	6	37	0	9
Meropenem	44/46	95.7%	2	0	0	37	0	9	45/46	97.8%	0	0	1	37	0	9
Piperacillin-tazobactam	41/46	89.1%	1	1	3	29	3	14	40/46	87.0%	0	0	7	29	3	14
TOTAL	381/408	93.4%	5	3	19	295	16	97	373/409	91.2%	1	2	33	295	16	98
***Acinetobacter baumannii* (n=8)**																
Amikacin	7/8	87.5%	0	0	1	2	1	5	7/8	87.5%	0	0	1	2	1	5
Ciprofloxacin	8/8	100%	0	0	0	1	0	7	8/8	100%	0	0	0	1	0	7
Colistin	5/8	62.5%	0	3	0	6	0	2	7/8	87.5%	1	0	0	6	0	2
Meropenem	8/8	100%	0	0	0	1	0	7	8/8	100%	0	0	0	1	0	7
TOTAL	28/32	87.5%	0	3	1	10	1	21	30/32	93.8%	1	0	1	10	1	21
***Pseudomonas aeruginosa* (n=8)**																
Amikacin	7/8	87.5%	0	0	1	3	1	4	8/8	100%	0	0	0	3	1	4
Cefepime	8/8	100%	0	0	0	4	0	4	8/8	100%	0	0	0	4	0	4
Ceftazidime	5/8	62.5%	0	3	0	3	0	5	7/8	87.5%	0	1	0	3	0	5
Ciprofloxacin	7/8	87.5%	1	0	0	1	0	7	8/8	100%	0	0	0	1	0	7
Colistin	8/8	100%	0	0	0	8	0	0	8/8	100%	0	0	0	8	0	0
Gentamicin	8/8	100%	0	0	0	2	0	6	7/8	87.5%	1	0	0	2	0	6
Meropenem	7/8	87.5%	0	0	1	3	0	5	7/8	87.5%	0	0	1	3	0	5
Piperacillin-tazobactam	8/8	100%	0	0	0	3	0	5	7/8	87.5%	0	1	0	3	0	5
TOTAL	58/64	90.6%	1	3	2	27	1	36	60/64	93.8%	1	2	1	27	1	36
Overall	**467/504**	**92.7%**	**6**	**9**	**22**	**332**	**18**	**154**	**463/505**	**91.7%**	**3**	**4**	**35**	**332**	**18**	**155**

Table 2: Performance of Accelerate Pheno™ and VITEK® 2 systems compared to BMD for Gram-positive bacterial species (n = 24)

Antibiotic	Accelerate Pheno™ system								VITEK® 2 system							
	CA		VME	ME	mE	S	I	R	CA		VME	ME	mE	S	I	R
***Staphylococcus aureus* (n=10)**																
Daptomycin	10/10	100%	0	0	0	10	0	0	10/10	100%	0	0	0	10	0	0
Erythromycin	10/10	100%	0	0	0	7	0	3	10/10	100%	0	0	0	7	0	3
Linezolid	10/10	100%	0	0	0	10	0	0	10/10	100%	0	0	0	10	0	0
Trimethoprim-Sulfamethoxazole	9/10	90.0%	0	0	1	10	0	0	10/10	100%	0	0	0	10	0	0
Vancomycin	10/10	100%	0	0	0	10	0	0	10/10	100%	0	0	0	10	0	0
TOTAL	49/50	98.0%	0	0	1	47	0	3	50/50	100%	0	0	0	47	0	3
Coagulase-Negative *Staphylococcus* spp. (n=6)																
Daptomycin	6/6	100.0%	0	0	0	6	0	0	6/6	100%	0	0	0	6	0	0
Erythromycin	5/5	100.0%	0	0	0	1	0	4	6/6	100%	0	0	0	1	0	5
Linezolid	6/6	100%	0	0	0	6	0	0	6/6	100%	0	0	0	6	0	0
Vancomycin	6/6	100%	0	0	0	6	0	0	6/6	100%	0	0	0	6	0	0
TOTAL	23/23	100%	0	0	0	19	0	4	24/24	100%	0	0	0	19	0	5
***Enterococcus* spp. (n=8)**																
Ampicillin	8/8	100%	0	0	0	5	0	3	8/8	100%	0	0	0	5	0	3
Linezolid	8/8	100%	0	0	0	8	0	0	8/8	100%	0	0	0	8	0	0
Vancomycin	7/7	100%	0	0	0	5	0	2	7/8	87.5%	1	0	0	5	0	3
TOTAL	23/23	100%	0	0	0	18	0	5	23/24	95.8%	1	0	0	18	0	6
Overall	**95/96**	**99.0%**	**0**	**0**	**1**	**84**	**0**	**12**	**97/98**	**99.0%**	**1**	**0**	**0**	**84**	**0**	**14**

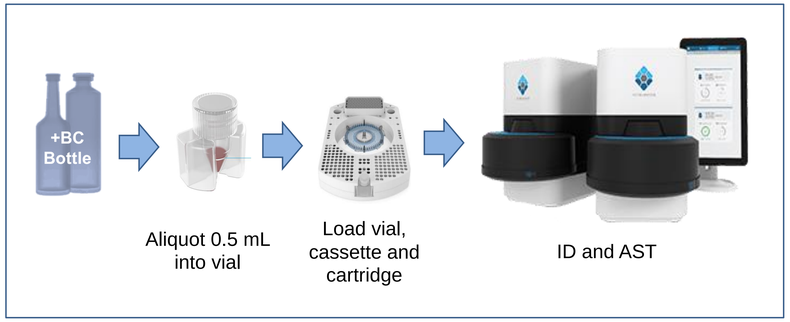

Figure 1: Accelerate Pheno™ system workflow.

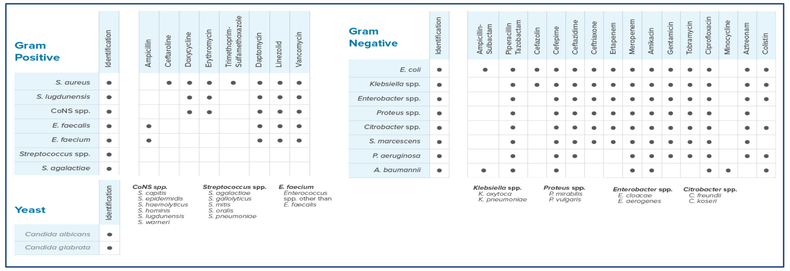

Figure 2: Accelerate Pheno™ system blood culture identification and AST panel.

Results

The overall categorical agreement between Accelerate Pheno™ system and BMD was 92.7% (467/504) for Gram-negative organisms and 99.0% (95/96) for Gram-positive organisms, with rates for very major errors of 3.6% (6/166), major errors 2.2% (9/416) and minor errors 3.8% (23/600).

The overall categorical agreement between the VITEK® 2 system and BMD was 91.7% (463/505) for Gram-negative organisms and 99.0% (97/98) for Gram-positive organisms, with rates of very major errors of 2.4% (4/169), major errors 1.0% (4/416) and minor errors 5.8% (35/603).

Importantly, in contrast with the VITEK® 2 system, no false-susceptible results occurred with two colistin-resistant organism-growing PBCs tested using the Accelerate Pheno™ system.

Conclusions

Based on these findings, the Accelerate Pheno™ system can be a valid alternative for the rapid AST of Gram-negative and Gram-positive bacteria in bloodstream infections.

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