

# Evaluation of the BD Phoenix System for Identification and Susceptibility Testing of Gram-Positive and Negative Clinical Isolates

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## ABSTRACT

BD Phoenix was compared to Pasco for identification and antibiotic susceptibility of gram-negative and susceptibility of gram-positive clinical isolates. Pasco is a semi-automated broth dilution system that uses frozen microtiter trays that are read manually and interpreted by computer. BD Phoenix is an automated system that uses a colorimetric redox indicator for AST and colorimetric and fluorometric indicators for identification. A total of 190 randomly selected gram-positive and negative isolates were evaluated using investigational BD Phoenix panels with the exception of the ESBLs which were tested at a later date using the newly released FDA cleared panels and software. Discrepant identifications were confirmed by an alternate method or a reference laboratory using conventional biochemicals. Discrepant antibiotic susceptibility results were arbitrated by Etest. The overall agreement between the two systems for identification of gram-negative organisms was 94%. The most commonly misidentified organism was *Serratia* species. The essential agreement for antibiotic susceptibility of gram-negative and positive organisms was 94%. The lowest essential agreement was with cefepime (88%) mostly attributed to non-fermenting gram-negative bacilli and the lowest categorical agreement was with cefotaxime (92%). 79 known ESBL producing *E. coli* and *Klebsiella* species were tested and all were detected by the BD Phoenix system, sensitivity 100%. 69 SA were tested 37 of which were MRSA by Pasco and 41 by Phoenix. Two of the four isolates were confirmed as MRSA by Etest for a sensitivity of 95% and a specificity of 96.7%. The automated BD Phoenix system which includes Expert software for interpretation required less hands on time for technologists as compared to Pasco which was manually set up and read. Excellent agreement was demonstrated for identification and antibiotic susceptibility between the BD Phoenix and the Pasco "reference broth microdilution" method. BD Phoenix would be a good alternative as an automated system for identification and antibiotic susceptibility testing of gram-positive and negative organisms in the routine clinical laboratory.

## INTRODUCTION

The BD Phoenix (BD Biosciences, Sparks Md) is an automated system for bacterial identification and antimicrobial susceptibility testing (AST). Microbroth dilution wells are read for growth every 20 minutes up to 16 hours. Organism identification is based on growth and enzyme activity detected by colorimetric and fluorometric indicators. Time for determination of the identification is between 8-12 hours. Antimicrobial resistance is detected by growth in the presence of the antimicrobial as determined by a colorimetric redox indicator. Panels are stored at room temperature and are manually inoculated at the time of use and loaded onto the instrument. Panels can not be read manually and can only be read by the Phoenix instrument. The EpiCenter includes an advanced BDXpert System to aid in the identification of AST errors or unusual results and also in compiling epidemiologic data for ease in creation of antibiograms. This system therefore has the potential to be a cost effective method for routine testing in the clinical laboratory. We evaluated the BD Phoenix system for identification and susceptibility testing of gram-positive and negative organisms as compared to the Pasco (BD Biosciences) manual system.

## METHODS

**Study Protocol:** Fresh clinical isolates were identified and tested for antimicrobial susceptibility simultaneously using BD Phoenix and Pasco systems. Stock isolates previously tested by Etest were chosen for evaluation of the Phoenix system for ESBL determination. Isolates which gave discrepant identifications were repeated by both methods and tested by an alternative method or sent to a reference laboratory for arbitration if concordance was not achieved. Isolates for which antimicrobial susceptibility results did not agree were retested by BD Phoenix and Pasco as well as Etest (AB BIODISK, Solna Sweden) as the arbitrator. Manufacturers instructions were followed for the setup and reading of both systems.

**Isolates:** A total of 280 isolates were evaluated, 68 staphylococci, 15 enterococci and 197 gram-negative bacilli (including 79 ESBL positive isolates). All isolates were stocked on BHI agar slants for repeat testing if necessary. All gram-positive isolates were identified by off line, rapid methods (PYR, latex agglutination) and were not identified to the species level, therefore identification was only compared with Phoenix for gram-negative bacilli.

## RESULTS

Table 1. AST of *Enterococcus* species

Antibiotic	n	EA(%)	CA(%)	MiE(%)	Major Errors PHX = "R" Pasco = "S"			Very Major Errors PHX = "S" Pasco = "R"			ARBITRATION (ME & VME)				Arbitration Favors		Repeat						
					Sens(n)	ME(n)	ME(%)	Res(n)	VME(n)	VME%	ME + VME	Expert Change	Arb Avail	Arb Unavail.	Phoenix	Pasco	Phoenix Error Repeats	Phoenix Error Resolves	Pasco Error Repeats	Pasco Error Resolves			
Streptomycin-Syn	15	100.0%	100.0%	0.0%	8	0	0%	7	0	0%													
Gentamicin-Syn	15	100.0%	100.0%	0.0%	11	0	0%	4	0	0%													
Ampicillin	15	87.0%	100.0%	0.0%	12	0	0%	3	0	0%													
Penicillin G	15	93.3%	100.0%	0.0%	13	0	0%	2	0	0%													
Vancomycin	15	93.3%	93.3%	0.0%	13	0	0%	2	1	50%	1		1			0	1			1			*repeat error*
Erythromycin	15	100.0%	100.0%	0.0%	2	0	0%	9	0	0%													
Quinupristin/ dalpofristin	15	93.3%	93.3%	7.0%	1	0	0%	10	0	0%													
Chloramphenicol	15	100.0%	100.0%	0.0%	14	0	0%	1	0	0%													
Linezolid	15	80.0%	80.0%	20.0%	15	0	0%	0	0														
Nitrofurantoin	15	100.0%	100.0%	0.0%	12	0	0%	1	0	0%													
Gatifloxacin	15	100.0%	100.0%	0.0%	9	0	0%	6	0	0%													
Levofloxacin	15	100.0%	100.0%	0.0%	9	0	0%	6	0	0%													
<b>Total</b>	<b>180</b>	<b>96.1%</b>	<b>97.2%</b>	<b>2.2%</b>	<b>119</b>	<b>0</b>	<b>0.0%</b>	<b>51</b>	<b>1</b>	<b>2%</b>	<b>1</b>	<b>0</b>	<b>1</b>	<b>0</b>	<b>0</b>	<b>1</b>	<b>0</b>	<b>1</b>	<b>0</b>	<b>1</b>	<b>0</b>	<b>0</b>	<b>0</b>

Table 2. AST of *Staphylococcal* species

Antibiotic	n	EA(%)	CA(%)	MiE(%)	Major Errors PHX = "R" Pasco = "S"			Very Major Errors PHX = "S" Pasco = "R"			ARBITRATION (ME & VME)				Arbitration Favors		Repeat				PHX errors using ARB for reference in discrepant tests			
					Sens(n)	ME(n)	ME(%)	Res(n)	VME(n)	VME%	ME + VME	Expert Change	Arb Avail	Arb Unavail.	Phoenix	Pasco	Phoenix Error Repeats	Phoenix Error Resolves	Pasco Error Repeats	Pasco Error Resolves	ME n	Me %	VME	VME %
Gentamicin	68	100.0%	100.0%	0.0%	65	0	0%	3	0	0%											0	0%	0	0%
Ampicillin	9	na	89.0%	0.0%	3	0	0%	65	1	2%	1		1		1	0			1		0	0%	0	0%
Penicillin G	6	na	100.0%	0.0%	2	1	50%	66	1	2%	2	1	1		1	0			1		0	0%	0	0%
Oxacillin	68	85.3%	94.1%	0.0%	32	4	13%	36	0	0%	4		4		4			na	na	0	0%	0	0%	
Trimethoprim/Sulfa.	68	99.0%	99.0%	0.0%	65	0	0%	3	1	33%	1		1		0	1	1			0	0%	1	33%	
Vancomycin	68	99.0%	99.0%	0.0%	68	1	1%	0	0	0%	1		1		1	0			1	1	1%	0		
Clindamycin	68	97.1%	99.0%	0.0%	49	1	2%	19	0	0%	1		1		1	0			1		0	0%	0	0%
Erythromycin	68	97.1%	97.1%	0.0%	18	1	6%	49	1	2%	2		1	1	1	0			1		0	0%	1	2%
Quinupristin/dalpofristin	66	97.0%	97.0%	0.0%	66	2	3%	0	0		2		2		1	1	1		1		1	2%	0	
Chloramphenicol	66	95.5%	97.0%	3.0%	60	0	0%	0	0											0	0%	0		
Linezolid	68	99.0%	100.0%	0.0%	65	0	0%	0	0											0	0%	0		
Nitrofurantoin	68	100.0%	100.0%	0.0%	68	0	0%	0	0											0	0%	0		
Gatifloxacin	68	99.0%	99.0%	0.0%	49	0	0%	9	0	0%			1		1	0			1		0	0%	0	0%
Levofloxacin	68	97.1%	99.0%	0.0%	43	0	0%	22	0	0%			1		1	0			1		0	0%	0	0%
Rifampin	68	97.1%	97.1%	1.5%	67	1	1%	0	0		1		1		1	0			1		0	0%	0	
<b>Total</b>	<b>895</b>	<b>95.8%</b>	<b>98.0%</b>	<b>0.3%</b>	<b>720</b>	<b>11</b>	<b>1.5%</b>	<b>272</b>	<b>4</b>	<b>1%</b>	<b>15</b>	<b>1</b>	<b>15</b>	<b>1</b>	<b>13</b>	<b>2</b>	<b>2</b>	<b>0</b>	<b>9</b>	<b>0</b>	<b>2</b>	<b>0.3%</b>	<b>2</b>	<b>0.7%</b>

Table 3. AST of gram-negative bacilli

Antibiotic	n	EA(%)	CA(%)	MiE(%)	Major Errors PHX = "R" Pasco = "S"			Very Major Errors PHX = "S" Pasco = "R"			ARBITRATION (ME & VME)				Arbitration Favors		Repeat				PHX Using ARB for Discrepant			
					Sens(n)	ME(n)	ME(%)	Res(n)	VME(n)	VME%	ME + VME	Expert Change	Arb Avail	Arb Unavail.	Phoenix	E test "1"	Pasco	Phoenix Err Repeats	Phoenix Err Resolves	Pasco Err Repeats	Pasco Err Resolves	ME n	Me %	VME
Amikacin	197	97.0%	98.0%	1.0%	180	1	1%	16	1	6%	2	1	1	0	1				1		0		0	
Gentamicin	197	99.0%	99.0%	1.0%	171	1	1%	25	0	0%	1		1	0	1				1		0		0	
Tobramycin	197	95.0%	96.0%	2.0%	172	4	2%	19	0	0%	4		1	3	1				1		3	2%	0	
Cefoxitin	197	96.0%	97.0%	1.0%	89	4	4%	91	1	1%	5	1		4						3	3%	1	1%	
Ceftazidime	197	89.0%	94.0%	2.0%	180	8	4%	9	0	0%	8		5	3		5	5			8	4%	0		
Cefotaxime	196	90.3%	92.0%	7.1%	142	2	1%	26	0	0%	2		1	1	1				1		2	1%	0	
Cefepime	196	88.3%	94.0%	1.0%	180	10	6%	9	0	0%	10		7	3	4	2	1	1		4	4	2%	0	
Ampicillin	196	91.3%	97.4%	1.0%	35	4	11%	156	0	0%	4	1	1	2				1	1	3	9%	0		
Amoxicillin/clavulanate	196	96.0%	98.0%	1.0%	81	3	4%	92	0	0%	3	1	2	0	1				1	1	1	1%	0	
Ciprofloxacin	196	97.4%	97.4%	1.0%	161	3	2%	28	1	4%	4		1	3					1	1	3	2%	1	4%
Levofloxacin	195	98.0%	98.0%	1.0%	160	1	1%	32	2	6%	3		1	2					1		1	1%	2	6%
<b>Total</b>	<b>2160</b>	<b>96.1%</b>	<b>96.4%</b>	<b>1.8%</b>	<b>1551</b>	<b>41</b>	<b>2.6%</b>	<b>503</b>	<b>5</b>	<b>1%</b>	<b>46</b>	<b>4</b>	<b>21</b>	<b>21</b>	<b>9</b>	<b>2</b>	<b>10</b>	<b>9</b>	<b>0</b>	<b>9</b>	<b>1</b>			

Table 4. Identification Discrepancies for gram-negative bacilli

Initial Phoenix ID	Pasco ID	Arbitrator ID	Repeat Phoenix ID
<i>Moellerella wisconsensis</i>	<i>Serratia marcescens</i>	none	<i>Serratia marcescens</i>
<i>Providencia rustigianii</i>	<i>Morganella morganii</i>	none	<i>Morganella morganii</i>
<i>Klebsiella oxytoca</i>	<i>Enterobacter cloacae</i>	none	<i>Enterobacter cloacae</i>
<i>Klebsiella pneumoniae</i> ssp <i>ozanae</i>	<i>Acinetobacter baumannii</i>	none	No Identification
<i>Pasteurella pneumotropica</i>	<i>Alcaligenes</i> sp	<i>Alcaligenes xylosoxidans</i>	<i>Achromobacter</i> sp
<i>Burkholderia cepacia</i>	<i>Stenotrophomonas maltophilia</i>	<i>Stenotrophomonas</i>	<i>Burkholderia cepacia</i>
<i>Klebsiella pneumoniae</i>	<i>Enterobacter cloacae</i>	none	<i>Klebsiella pneumoniae</i>
<i>Klebsiella pneumoniae</i>	<i>Serratia odorans</i> / <i>E. cloacae</i> (rpt)	<i>Klebsiella terr.</i>	<i>Klebsiella pneumoniae</i>

### CONCLUSIONS

- Overall agreement between BD Phoenix and Pasco for identification of gram-negative bacilli was 96.8%. The majority of the discrepant identifications were among *Serratia* species.
- Essential and categorical agreement between BD Phoenix and Pasco for antimicrobial susceptibility testing of gram-negative bacilli was 96% with 2.6% major errors and 1% very major errors for a total of 2160 tests.
- Essential and categorical agreement for antimicrobial susceptibility testing of Enterococci was 96 and 97% respectively with no major errors and 1 very major error (False susceptible vancomycin by Phoenix).
- Essential and categorical agreement for antimicrobial susceptibility of Staphylococci was 96 and 98% respectively with 1.5% major errors and 1% very major errors.
- The sensitivity of the BD Phoenix for identification of 79 ESBL positive *E. coli* or *K. pneumoniae* was 97.5% (2 *E. coli* isolates positive for ESBL were not detected as such by Phoenix).
- BD Phoenix automated system demonstrated excellent agreement with the manual Pasco system and would be a good alternative for routine use in the clinical microbiology laboratory.

