

# Comparison of Phoenix to Vitek2 with a Diverse Group of Bacteria which are Found in Clinical Microbiology Labs

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## ABSTRACT

■ **OBJECTIVES:** Two rapid automated identification (ID) and susceptibility test systems, BD Phoenix and Vitek2, were evaluated for the identification of gram-negative bacilli, *Staphylococcus*, and *Enterococcus*.

**METHODS:** A total of 176 gram-negative bacilli, 121 *Enterococcus* and 400 *Staphylococcal* strains were tested, composing a sample of species that are commonly seen in clinical microbiology. This included: *S. aureus* (172), *Staphylococcus* coagulase negative species (228), *E. faecalis* (51), *E. faecium* (56), other *Enterococcus* spp. (13), *E. coli* 20, *Enterobacter/Citrobacter* spp. (54), *Klebsiella* spp. (35), *Proteus/Morganella* spp. (23), *Serratia* spp. (9), *P. aeruginosa* (22), *Hafnia* spp. (5), and *Acinetobacter* spp. (8). All isolates were tested in both systems following normal procedures recommended for each product. This included recommendations for supplemental tests. When needed the results of the supplemental tests were used to select a final result. Phoenix and Vitek2 ID results were compared and when discordant, the strains were retested and the ID result arbitrated by a third method. Arbitration used API 20E for gram-negatives, API 32Staph for *Staphylococcus*.

**RESULTS:** Phoenix ID results were equal to Vitek2 ID results in 96% of the tests. The comparability by organism group were 95% for gram-negative bacillus, 95% for *Staphylococcus*, and 97% for *Enterococcus*. Arbitration tests of the few discordant results were in favor of Phoenix 8 times, Vitek2 8 times, and neither system 5 times. Overall, supplemental manual ID tests were required for 6.7% of the Vitek tests and 1.4% of the Phoenix tests. With gram-negative bacteria the requirement for supplemental tests was 20.6% Vitek2 and 1.1% Phoenix.

**CONCLUSIONS:** The Phoenix system is highly equivalent to Vitek2 in the identification of common gram-positive and gram-negative strains. Vitek2 frequently requires supplemental testing with gram-negative bacteria whereas with Phoenix supplemental testing is only occasionally required.

## INTRODUCTION AND PURPOSE

The identification of gram-negative and gram-positive bacteria represents a significant function of virtually all clinical microbiology laboratories. Over the years there have been a number of commercially available systems available for performing these tests. These range from fully manual tests (API, bioMérieux, or Crystal, BD) to more automated tests such as Vitek (bioMérieux) or MicroScan (Dade) where incubation and kinetic reading are automatically made by an instrument. Most of the automated systems combine bacterial identification and antimicrobial susceptibility testing. In recent years two newer systems have become available in the German arena. These include the Vitek2 (bioMérieux) and BD Phoenix (BD) systems. These systems claim to offer more rapid test results, broader databases of organisms that can be identified, and improvements to reduce workload of the laboratory (auto inoculation, Expert systems etc.). In this study, we evaluated the Phoenix system in comparison to the Vitek2 system, for identification of some commonly isolated gram-negative and gram-positive bacteria.

## MATERIALS & METHODS

### Bacterial Isolates

A combination of fresh clinical isolates and some frozen stock cultures was tested including 176 gram-negative and 400 *Staphylococcus* strains and 121 *Enterococcus* strains. The gram-negative bacteria included a representative sample of *Enterobacteriaceae* and Non-fermentative species. For gram-positive bacteria a routine mix of 200 fresh strains of Staphylococci and Enterococci isolated from our routine clinical lab was tested. In addition, a larger set of 200 *Staphylococcus* challenge strains from our culture collection was tested to include less routinely isolated species.

### Phoenix

(BD Diagnostic Systems, Sparks, MD): gram-negative panels NMIC/ID-1 [Cat no. 448506] and gram-positive panels PMIC/ID-1 [Cat no. 448502] were used. Phoenix panels were tested strictly following manufacturer's instructions. Briefly, blood agar plates were inoculated with the test cultures and were incubated for 18 - 24 hours at 35°C. Isolated colonies were used to prepare a suspension of the bacteria in the Phoenix ID broth. The suspension was adjusted to match a 0.5 MacFarland standard using the BD CrystalSpec nephelometer. Panels were auto-inoculated by pouring the ID suspension into the ID port of the

panel. After closing, the panels were logged and loaded into the instrument. The instrument automatically incubated and optically scanned the panels at 20 min intervals. An ID result was considered final as soon as a probability of >90% was reached. The Phoenix software version was 1.06.

### Vitek2

Vitek2 ID-GPC and ID-GNB cards were used for all testing. The Vitek2 instrument with "Smart Carrier Station" and DensiCheck was used. All test procedures were performed according to manufacturer's recommendations. ID results with a single acceptable identification were accepted as given ID results (Excellent ID / Very Good ID). Some Vitek2 test results were unable to give a single ID result (Low Discrimination) and supplemental test procedures were recommended to select a final ID result. In these cases supplemental tests were performed and used to select the final ID result.

### Arbitration

If discrepancy was detected between the Phoenix and Vitek2 result, additional testing was performed with the appropriate API system (API 32E, API 32Staph). One strain was arbitrated using 16S RNA PCR for *K. pneumoniae*.

Table 1  
Comparison of Phoenix to Vitek2 with Gram-Negative Organisms

Phoenix ID	Vitek2 ID																Accord to Species			
	ID Code	Total	ACINBAU	ACINBCX	CITBRA	CITFRE	CITKOS	ENTBAER	ENTBAMN	ENTBCLC	ESCCOL	HAFALV	KLEOXY	KLEPNEP	MORGMOR	PROTMIR		PSEAER	SERMAR	UNIORG
<i>Acinetobacter baumannii</i>	ACINBAU	7	7																	100%
<i>Acinetobacter baumannii/calcoaceticus complex</i>	ACINBCX	1		1																100%
<i>Citrobacter braakii</i>	CITBRA	4			4															100%
<i>Citrobacter freundii</i>	CITFRE	11				11														100%
<i>Citrobacter koseri</i>	CITKOS	12					12													100%
<i>Enterobacter aerogenes</i>	ENTBAER	8						8												100%
<i>Enterobacter amnigenus</i> biogroup 1	ENTBAMN1	1							1											100%
<i>Enterobacter cloacae</i>	ENTBCLC	16								16										100%
<i>Escherichia coli</i>	ESCCOL	20				1					19									95.0%
<i>Hafnia alvei</i>	HAFALV	5										5								100%
<i>Klebsiella oxytoca</i>	KLEOXY	14											13	1						92.9%
<i>Klebsiella pneumoniae ssp pneumoniae</i>	KLEPNEP	22						1						21						95.5%
<i>Morganella morganii</i>	MORGMOR	12							1						11					91.7%
<i>Proteus mirabilis</i>	PROTMIR	12														12				100%
<i>Pseudomonas aeruginosa</i>	PSEAER	20															18		2	90.0%
<i>Serratia marcescens</i>	SERMAR	9																9		100%
No ID	UNIORG	2													1			1		0%
Total		176	7	1	4	12	12	9	2	16	19	5	13	22	11	12	18	9	2	95.5%

## RESULTS

■ The results of the performance of the Phoenix system in comparison to Vitek2 system for clinical routine isolates and a collection of gram-negative and gram-positive bacteria as well as a *Staphylococcus* challenge set of cultures are shown in Tables 1 and 2. The concordance of Phoenix compared with Vitek2 was 95.5% and 96.0% for each group, respectively:

Of the 176 gram-negative strains the Phoenix and Vitek2 systems coincided for 168 strains. Of the 8 discordant results:

- There were 4 results arbitrated in favor of Phoenix. One strain was identified as *K. oxytoca* by Phoenix, but as *K. pneumoniae* by Vitek2. One strain was identified as *E. coli* by Phoenix and as *C. freundii* by Vitek2. In 2 cases, Vitek2 gave a *Pseudomonas* species ID result, whereas Phoenix fully identified the species level as *P. aeruginosa*.
- The API arbitration of one strain, which was identified as *K. pneumoniae* by Phoenix and *E. aerogenes* by Vitek2 arbitrated by API 32E in favor of Vitek2. However, molecular testing using a 16S RNA probe and PCR indicated that Phoenix was correct.

- One discordant strain was not tested for arbitration. This was by Phoenix a *M. morgani* and a *Enterobacter amnigenus* by Vitek2.

Of the 520 gram-positive strains the Phoenix and Vitek2 systems coincided with 498 strains.

- Performance with *S. aureus*, Coagulase negative *Staphylococcus*, with *Enterococcus* were 99%, 92%, and 97%, respectively.
- Of the 21 discordant results the majority (16) of discrepancies were with coagulase negative Staphylococci. Arbitration of discordant *Staphylococcus* results was in favor of Vitek2 with 7 strains and in favor of Phoenix with 4 strains. The remaining 5 were not resolved by arbitration.

Supplemental Tests: There were occasional ID test results in both systems where it was not possible to separate 2 or 3 related taxonomic groups without performing off-line supplemental testing. The frequency of tests where such supplemental tests were required is shown in the Table 3 below.

Table 2  
Comparison of Phoenix to Vitek2 with Gram-Positive Organisms

Phoenix ID \ Vitek2 ID	ID Code	Total	STAAUE	STACAI	STACHR	STACOH	STAEPI	STAHAE	STAHOM	STAHYI	STALUG	STASAP	STASIM	STAWAR	ENTCCAS	ENTCDUR	ENTCFAA	ENTCFAI	ENTCGAL	ENTCRAF	ENTCSPA	UINORG	Accord to Species	Species Accord for the Genera		
<i>Staphylococcus aureus</i>	STAAUE	173	172				1																99%	95.7%		
<i>Staphylococcus capitis</i>	STACAI	12		12																					100%	
<i>Staphylococcus chromogenes</i>	STACHR	0																							100%	
<i>Staphylococcus cohnii</i>	STACOH	10				10																			100%	
<i>Staphylococcus epidermidis</i>	STAEPI	70					65		3		1											1			93%	
<i>Staphylococcus haemolyticus</i>	STAHAE	46						46																	100%	
<i>Staphylococcus hominis</i>	STAHOM	26							24					2											92%	
<i>Staphylococcus hyicus</i>	STAHYI	1								1															100%	
<i>Staphylococcus lugdunensis</i>	STALUG	31	1	1			1	1			27														87%	
<i>Staphylococcus saprophyticus</i>	STASAP	17							2			13		2												76%
<i>Staphylococcus simulans</i>	STASIM	1											1													100%
<i>Staphylococcus warneri</i>	STAWAR	12			1									11												92%
<i>Enterococcus casseliflavus</i>	ENTCCAS	4													3				1							75%
<i>Enterococcus durans</i>	ENTCDUR	1														1										100%
<i>Enterococcus faecalis</i>	ENTCFAA	51															50				1				98%	
<i>Enterococcus faecium</i>	ENTCFAI	56																	56						100%	
<i>Enterococcus gallinarum</i>	ENTCGAL	6																		6					100%	
<i>Enterococcus raffinosus</i>	ENTCRAF	2																				2			0%	
<b>Total</b>		<b>519</b>	<b>173</b>	<b>13</b>	<b>1</b>	<b>10</b>	<b>67</b>	<b>47</b>	<b>29</b>	<b>1</b>	<b>27</b>	<b>14</b>	<b>1</b>	<b>15</b>	<b>3</b>	<b>1</b>	<b>50</b>	<b>56</b>	<b>7</b>	<b>0</b>	<b>3</b>	<b>1</b>		<b>96.0%</b>		

Table 3  
Frequency of Supplemental Tests Required for full ID (%)

REQUIRED BY	ALL STRAINS	GNB	STA	ENTC
Phoenix only	0.8	1.1	3.3	0.0
Vitek2 only	6.2	20.6	5.8	0.0
Phoenix & Vitek2	0.6	0.0	3.3	0.0
Overall Phoenix	1.4	1.1	6.7	0.0
Overall Vitek2	6.7	20.6	9.2	0.0

## CONCLUSIONS

The Phoenix Automated Microbiology System provides a high level of agreement to the Vitek2 for identification of common gram-negative and gram-positive clinical isolates.

For gram-negatives Phoenix was in concordance with Vitek2 for 95.5% of the tests. Arbitration for the few discordances were in favor of Phoenix for 5/6 of the disagreements.

For gram-positive strains Phoenix was in concordance with Vitek2 for 96.0% of the tests. The majority of discordant tests were with Coagulase Negative *Staphylococcus* strains. Arbitration of the discordant results resulted in a nearly equal distribution of results in favor of either system.

Phoenix required supplemental testing in far fewer tests than Vitek2 (1% vs. 6%).