

Evaluation of the Phoenix™ and Vitek 2® Systems for the Susceptibility Testing of Staphylococci.

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ABSTRACT

■ **BACKGROUND:** We evaluated a new, automated commercial system, the Phoenix™ (BD Diagnostic Systems, Sparks, MD) and the Vitek 2® (bioMérieux, Hazelwood, MO), for their ability to detect antimicrobial resistance in clinical isolates of *Staphylococcus* spp.

METHODS: A total of 325 clinical isolates of *Staphylococcus* spp. were examined, with 123 oxacillin-resistant *S. aureus* (MRSA), 106 oxacillin-susceptible *S. aureus* (MSSA), and 96 coagulase-negative staphylococci (63 MR-CoNS and 33 MS-CoNS). All isolates were tested simultaneously on the Phoenix™ and Vitek 2® systems using the PMIC/ID-14 and the P526 panels, respectively, according to the manufacturers' instructions and compared to NCCLS recommended broth microdilution (BMDIL).

RESULTS: There was >90% correlation with both systems compared with BMDIL for oxacillin (OXA), erythromycin (ERY), clindamycin (CLD), ciprofloxacin (CIP), quinupristin/dalfopristin (Q/D), teicoplanin (TEI), rifampin (RIF), tetracycline (TET), and vancomycin (VAN). Oxacillin testing of *S. aureus* with both systems produced very major error rates of 9.8% and 8.1% and major error rates of 1.9% and 2.8% for Phoenix™ and Vitek 2®, respectively. The very major error rates were seen with MRSA isolates that had low level oxacillin resistance with MICs between 4–8 µg/mL, confirmed by PCR detection for the presence of the *mecA* gene. The correlation with BMDIL is summarized as follows:

	% Agreement (Phoenix™/Vitek 2®)			
	<i>S.aureus</i>		CoNS	
	MRSA	MSSA	MR-CoNS	MS-CoNS
Oxa	90/92	98/97	94/98	100/97
Cld	97/95	99/99	100/100	94/94
Ery	96/94	93/92	91/94	97/97
Cip	94/94	99/99	94/92	97/94
Q/D	100/100	100/100	97/94	100/100
Tei	100/100	100/100	91/92	100/100
Rif	98/98	100/100	95/97	100/100
Tet	98/99	100/99	100/95	100/100
SXT	98/98	93/99	92/87	97/91
Van	100/100	100/100	100/100	100/100

CONCLUSIONS: Overall, both the Phoenix™ and Vitek 2® systems performed well for the susceptibility testing of *Staphylococcus* species. However, an alternate method should be used for detection of oxacillin resistance. Both systems offer simple and rapid setup, automated detection and decreased turnaround times for most results.

INTRODUCTION

The rapid and accurate detection of antimicrobial resistance in *S. aureus* and in coagulase-negative staphylococci (CoNS) is essential in order to determine appropriate antimicrobial therapy. Some of the currently available semi-automated or automated commercial systems may lack sufficient accuracy for routine use in the clinical microbiology laboratory, especially for antimicrobial agents such as oxacillin. Newer systems such as the BD Phoenix™ (BD Diagnostic Systems, Sparks, MD) and the Vitek 2® (bioMérieux, St. Laurent, Que.) may have the potential to rapidly and accurately detect resistance in *Staphylococcus* species.

We wished to evaluate the abilities of the BD Phoenix™ and Vitek 2® systems to accurately detect antimicrobial resistance in staphylococci using a large number of well-characterized clinical isolates. The performance of both systems was compared to conventional broth microdilution susceptibility testing, and PCR detection of the *mecA* gene.

MATERIALS & METHODS

Clinical specimens: A total of 325 staphylococcal isolates were included in the study. All strains were previously characterized by conventional biochemical testing. In addition, PCR for the detection of the *mecA* gene was used for confirmation of MRSA and methicillin-resistant CoNS (MR-CoNS) (Louie *et al.* J Clin Microbiol 2000 38:2170-2173). The 325 isolates selected for testing consisted of 123 MRSA (both high-level oxacillin-resistant as well as low-level oxacillin resistant strains), 106 MSSA, and 96 CoNS (63 methicillin-resistant and 33 methicillin-susceptible), including 34 *S. epidermidis*, 15 *S. saprophyticus*, 15 *S. haemolyticus*, 10 *S. hominis*, 9 *S. capitis*, 10 *S. warneri*, and 3 *S. lugdunensis*.

Methods The Phoenix™ PMIC/ID-14 and the Vitek 2® P256 panels were used in this evaluation and testing was performed in accordance with the manufacturers' instructions. Broth microdilution (BMDIL) was performed according to current NCCLS

recommended guidelines (M7-A5, M100-S9, 2001). Each batch of isolates was tested concurrently with all three susceptibility methods on the same day. Isolates yielding discrepant results were subjected to repeat testing. Analysis of the results of both the Phoenix™ and Vitek 2® systems were compared with those obtained by broth microdilution testing and calculation of very major, major, and minor errors was determined.

Error definition was as follows: very major errors occurred with organisms that were resistant by BMDIL but susceptible by Phoenix™ or Vitek 2®. Major errors occurred with organisms that tested susceptible by BMDIL and resistant by Phoenix™ or Vitek 2®. Minor errors occurred with organisms that tested intermediate by BMDIL and resistant or susceptible by Phoenix™ or Vitek 2®.

RESULTS

There was a greater than 90% correlation with both systems compared with BMDIL for oxacillin (OXA), erythromycin (ERY), clindamycin (CLD), ciprofloxacin (CIP), quinupristin/dalfopristin (Q/D), teicoplanin (TEI), rifampin (RIF), tetracycline (TET), and vancomycin (VAN). Oxacillin testing of MRSA isolates produced very major error rates of 9.8% and 8.1% for Phoenix™ and Vitek 2®, respectively. The very major errors were seen with MRSA isolates that exhibited low level oxacillin resistance with MICs ranging between 4–8 µg/mL by BMDIL, confirmed by PCR detection for the presence of the *mecA* gene.

Of the 96 CoNS isolates tested, 63 were oxacillin-resistant and 33 were oxacillin susceptible, as determined by BMDIL. Phoenix™ correctly identified 59/63 as being resistant and 33/33 as susceptible, while Vitek 2® correctly identified 62/63 resistant isolates and 32/33 susceptible isolates. For other agents, error rates were calculated separately for the MRSA, MSSA, MR-CoNS, and MS-CoNS isolates in the study, and are summarized in Figures 1-4.

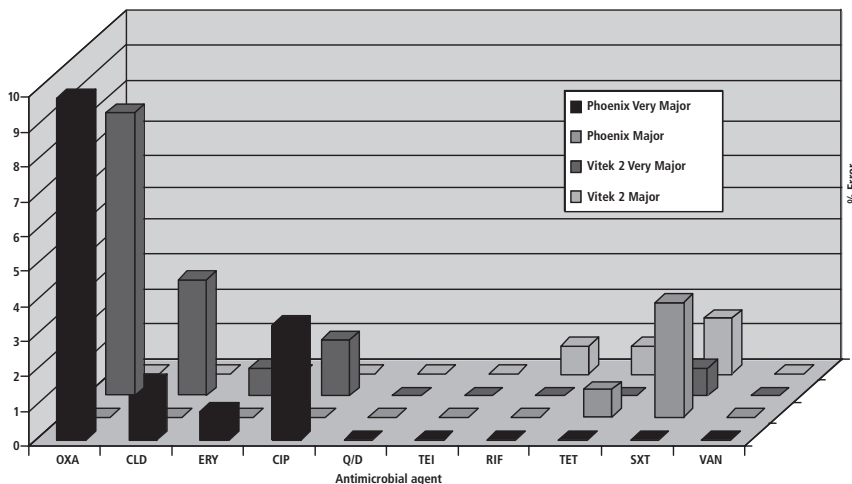


Figure 1. Error rates for Phoenix™ and Vitek 2® when compared with broth microdilution for MRSA isolates.

Figure 2. Error rates for Phoenix™ and Vitek 2® when compared with broth microdilution for MSSA isolates.

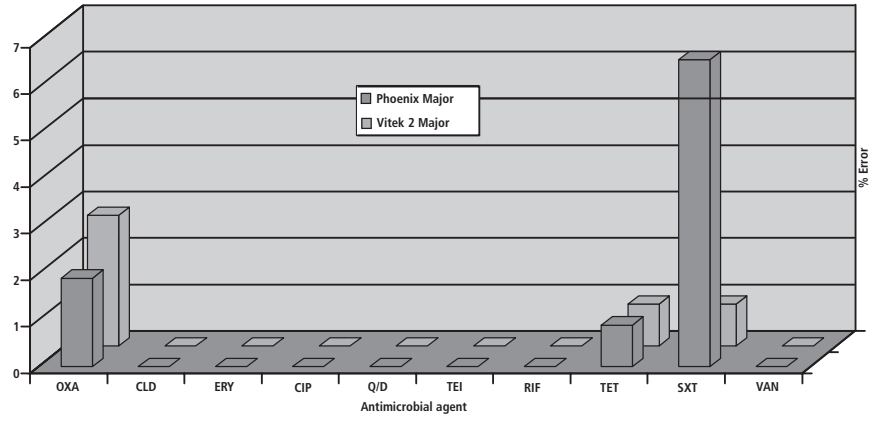


Figure 3. Error rates for Phoenix™ and Vitek 2® when compared with broth microdilution for MR-CoNS isolates.

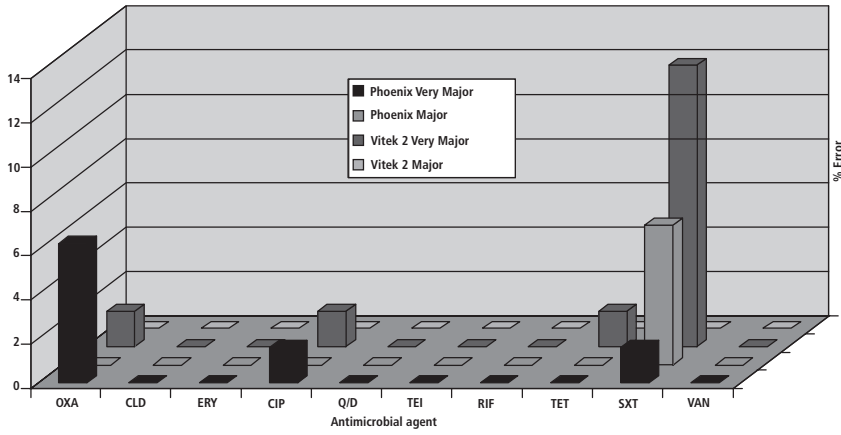
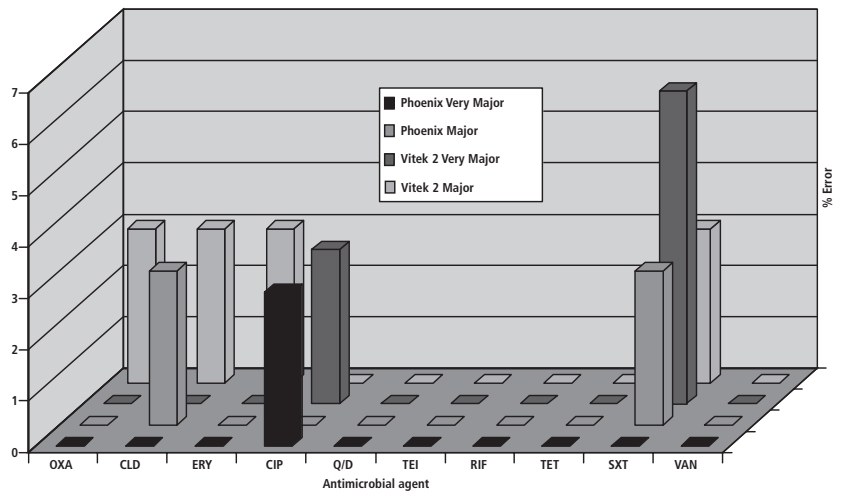


Figure 4. Error rates for Phoenix™ and Vitek 2® when compared with broth microdilution for MS-CoNS isolates.



DISCUSSION

Overall, both systems performed well for the susceptibility testing of *Staphylococcus* species. However, for detection of oxacillin resistance in MRSA, both systems had relatively high very major error rates of 9.8% and 8.1% for the Phoenix™ and Vitek 2® systems, respectively. These errors may be attributed to the fact that a large number of low-level oxacillin resistant MRSA isolates were included in the evaluation to challenge the systems. Although acceptable for determining antimicrobial susceptibilities of other agents, clinical laboratories *cannot* rely on these systems alone in order to accurately identify oxacillin resistance in *S. aureus*. An additional confirmatory test would be required, such as the oxacillin agar screen with 6 µg/mL oxacillin, as currently recommended by the NCCLS, the Velogene assay (Alexon-Trend, Ramsey, MN) for detection of the *mecA* gene, or the MRSA-Screen latex agglutination assay (Denka-Seiken, Tokyo, Japan) for the detection of PBP2a.

Both the Phoenix™ and Vitek 2® systems performed well with good correlation compared with BMDIL for erythromycin, clindamycin, ciprofloxacin, quinupristin/dalfopristin, teicoplanin, rifampin, tetracycline, and vancomycin. It is unclear why very major errors were seen with the testing of trimethoprim-sulfamethoxazole using the Vitek 2®, 6.1% and 12.7% for MS-CoNS and MR-CoNS, respectively. Testing with the Phoenix™ system and MSSA isolates yielded a 6.6% major error rate with trimethoprim-sulfamethoxazole.

The Phoenix™ and Vitek 2® systems were simple to set up, with decreased turnaround and hands-on time, as compared with broth microdilution, although the Phoenix™ system required more preparation time.