

Evaluation of the BD Phoenix™ for Routine Use in a Tertiary-Care Hospital Microbiology Laboratory

C. ESSMYER, M. BRANDOM, K. ANDERSON, J. HAMMEL, V. FLAUTA

Saint Luke's Hospital, Kansas City, MO

ABSTRACT

BACKGROUND: The new BD Phoenix™ Automated Microbiology System was evaluated with regard to accuracy of bacterial identification (ID), antimicrobial susceptibility testing (AST), effectiveness of the expert system, and impact on workflow.

METHODS: A total of 339 fresh, non-duplicate clinical isolates, reflective of our routine species mix, were tested on the Phoenix. Accuracy of ID and AST was determined by comparison to Vitek Legacy. Discrepant results were repeated once on each instrument, with remaining unresolved discrepancies tested by manual methods e.g. API, disk diffusion or E-test. AST errors were classified as very major, major, or minor. Workflow was evaluated through parallel testing by two technologists trained on both instruments, who set up specimens simultaneously during the course of a normal workday.

RESULTS: Gram-positive isolates included 104 *Enterococcus* sp. (15 VRE), 70 *S. aureus* (50 MRSA), and 15 coagulase-negative staphylococci. Gram-negative isolates included 34 *E. coli* (3 ESBL), 82 other *Enterobacteriaceae*, and 34 non-fermenters. Phoenix provided an accurate ID to species level for 98.5% of isolates. Average time for Phoenix ID results was 3.0 hours (no offline tests needed) vs. 4.4 hours for Vitek (not including offline tests). The average time for ID plus AST results from Phoenix combo panels was 11.5 hours, with no comparable Vitek panel for contrast. The AST very major error rate was 0.6%, with 0.3% major errors. Each instrument falsely identified ESBL production in one *E. coli* (different organisms). Phoenix accurately identified 15/15 VRE vs. 7/15 correct by Vitek. The AST expert system accurately modified results for ESBL-producing organisms and intrinsic resistance. Phoenix required 1-2 minutes hands-on set-up time per panel vs. 5 minutes per Vitek panel.

CONCLUSION: The BD Phoenix provides accurate ID and AST results with acceptable throughput for routine use in a clinical microbiology laboratory. The ease of panel set-up, lack of necessity for offline testing, and technologist-friendly expert system contribute to improved workflow.

INTRODUCTION

Saint Luke's Hospital is a 600-bed tertiary care facility with active solid organ and bone marrow transplant services. The Microbiology section of the laboratory is staffed with 15 FTEs and functions as the core infectious disease testing laboratory for 5 hospitals within Saint Luke's Health System. The scope of service includes bacterial, fungal, AFB, and viral cultures as well as infectious disease serology. We have utilized the Vitek Legacy for bacterial identification and susceptibility testing since 1989. Due to the imminent demise of this 15-year-old instrument, BD Phoenix was evaluated as a potential replacement.

METHODS

All organisms used in the investigation were isolated from clinical specimens obtained for diagnostic purposes from adult and pediatric inpatients and outpatients. The ID/AST evaluation was conducted in two phases. Initially, 104 *Enterococcus* species were tested with both systems. *Enterococcus* was emphasized because of challenges we have faced with accuracy of speciation and susceptibility results with our current methods and the particularly critical nature of timely results for our transplant programs. Subsequently, an additional 235 gram-positive and gram-negative isolates were tested in parallel with Vitek, for a total of 339 fresh, non-duplicate organisms reflective of our routine species mix.

The accuracy of Phoenix ID and AST was determined by comparison to Vitek results. Organisms with a discrepancy in either ID or AST were repeated once on each instrument, with remaining discrepancies resolved by an appropriate manual method.

Phoenix AST results were assessed as categorical agreement with reference method, very major error (false susceptible), or major error (false resistance). All VRE were confirmed by Vancomycin E-test, and MRSA were confirmed by Oxoid PBP2a, in concordance with our standard procedure. ESBL discrepancies were further evaluated by Microscan panels, and double-disk diffusion testing as described in NCCLS M100-S14.

Workflow was evaluated by two technologists trained on both instruments, who set up specimens during the course of a normal workday. Instrument maintenance and QC were performed according to NCCLS and manufacturer's recommendations throughout the evaluation period, and were taken into consideration in the workflow analysis. A stopwatch was used to time technologists setting up panels near the end of the evaluation, with an average time for set-up calculated.

RESULTS

Identification:

- Phoenix provided an accurate ID to species level in 98.5% of isolates, with NO supplemental testing necessary. In contrast, the Vitek Legacy had 10 reproducible identification errors on the gram-positive isolates, and 14 errors on the gram-negative isolates (data not shown).
- The 4 *E. faecalis* isolates that were misidentified by Phoenix all occurred on the same day initially, suggesting inoculum error, but were reproducible when re-tested at a later date.
- Phoenix provided accurate differentiation of *K. pneumoniae* from *K. oxytoca* without supplemental indole testing.

AST:

- We found accurate identification of VRE to be a strength of Phoenix, with 15/15 identified correctly vs. 7/15 identified correctly by Vitek.
- One isolate of MRSA repeatedly had a Phoenix MIC=2 µg/mL, with MIC=4 µg/mL by Vitek & E-test. This isolate was flagged as probable MRSA by the BD Expert system and subsequently tested positive by Oxoid PBP2a.
- Two isolates of mucoid *Pseudomonas* were deleted from the study due to inability of Phoenix to provide susceptibility results.

Workflow:

- No offline testing (indole, coagulase, oxidase, MGP) was necessary to complete identification on any of the isolates correctly identified by Phoenix. The average time for Phoenix ID results was 3.0 hours vs. 4.4 hours for Vitek not including supplemental testing.
- TAT for susceptibility testing alone on the Phoenix could not be accurately assessed since the evaluation panels were combination ID/susceptibility (no susceptibility only panels).
- The BD Expert system is an advantage over our current cumbersome method of building rules within our LIS, in addition to relying on the memory of bench technologists for data interpretation.
- The hands-on specimen set-up time for a single Phoenix panel including diluting the organism is 1–2 minutes.
- Phoenix maintenance is minimal compared to Vitek, and consists of once daily temperature recording and weekly check of LED's. There is no monthly maintenance. Air filters are cleaned or replaced every 6 months.

Table 1. Gram-Positive Identification Data

Organism (# tested)	Phoenix Errors	Average Time to Phoenix ID (hours)
<i>Enterococcus faecalis</i> (83)	4 identified as motile <i>Enterococcus</i> species	2.6
<i>Enterococcus faecium</i> (20)	None	2
<i>Enterococcus gallinarum</i> (1)	None	2
<i>Staphylococcus aureus</i> (70)	None	2.5
Coagulase-negative <i>staphylococci</i> (15)	None	9.6
Total Gram-Positive ID = 189	4 Phoenix Errors	

Table 2. Gram-Positive AST Data

Phoenix Errors	Error Classification
<i>E. faecalis</i> vs. penicillin	Very major
<i>S. aureus</i> vs. oxacillin	Very major
<i>S. aureus</i> vs. T/S	Major
Total Gram-Positive AST = 189	3 Phoenix Errors

Table 3. Gram-Negative Identification Data

Organism (# tested)	Phoenix Errors	Average Time to Phoenix ID (hours)
<i>E. coli</i> (34)	None	2.9
<i>Pseudomonas aeruginosa</i> (23)	None	2.2
<i>Klebsiella pneumoniae</i> (19)	None	2.2
<i>Klebsiella oxytoca</i> (8)	None	2.5
<i>Enterobacter</i> spp. (16)	None	3.1
<i>Proteus</i> spp. (14)	None	3.2
<i>S. maltophilia</i> (5)	None	2
<i>Serratia</i> spp. (10)	None	3.6
<i>Morganella morganii</i> (3)	None	3.3
<i>Citrobacter</i> spp. (8)	1 isolate repeatedly identified as <i>Enterobacter</i>	2.3
<i>A. xylosoxidans</i> (1)	None	12
<i>A. baumannii</i> (1)	None	12
<i>Pasteurella multocida</i> (2)	None	2
<i>E. vulneris</i> (2)	None	2
<i>Providencia</i> spp. (2)	None	2
<i>Myroides odoratus</i> (1)	None	9
<i>Ralstonia pickettii</i> (1)	None	13.5
Total Gram-Negative ID = 150	1 Phoenix Error	

Table 4. Gram-Negative Susceptibility Data

Phoenix Error
1 False Positive ESBL
Total Gram-Negative AST = 136, 1 Phoenix Error

CONCLUSION

- The BD Phoenix provides accurate ID and AST results with acceptable throughput for routine use in a clinical microbiology laboratory. The ease of panel set-up, lack of necessity for offline testing, and technologist-friendly expert system contribute to improved workflow.

