Comparison of BD Phoenix AP Workflow with Vitek 2

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ABSTRACT

Background: An important advantage of automated identification and susceptibility testing systems is labor savings. The BD Phoenix™ (BD Diagnostics, Sparks, MD) requires more manual manipulation time than Vitek 2 (BioMérieux, Durham, NC) – 179 vs. 91 seconds (s) per isolate (JCM 2005; 43:3829). The new BD Phoenix AP (AP) instrument is designed to automate the adjustment of inoculum density and reduce technologists' hands-on time when processing isolates for Phoenix panel inoculation. We compared the manual manipulation time required for panel preparation with the Phoenix System using the AP instrument and card inoculation for the Vitek 2 system.

Methods: Sixteen batches of 14 isolates (ATCC and clinical strains) were processed using the AP instrument and Vitek 2 following manufacturers' instructions. After demonstrating proficiency, two different operators set up eight batches on both instruments using panels for identification and susceptibility testing (one MIC/ID panel for Phoenix; ID and AST cards for Vitek 2). The total time for batch preparation and time required for each defined step in the process were measured. For comparison purposes, two batches of 14 organisms were also set up for the BD Phoenix using the standard manual processing steps.

Results: The average manual manipulation times per isolate were 101 s (range of 88-113 s) for Vitek 2 and 89 s (range of 82-101 s) for Phoenix using the AP instrument. The mean Phoenix hands-on time (without AP) was 178 s per isolate. The Phoenix AP workflow allows placement of up to 5 inoculated ID broths in the rack loaded on the instrument for inoculum density adjustment and transfer to AST broth. For each batch of 14 isolates, there was an average total wait time of 6.6 min while the AP instrument was processing the 2nd and 3rd racks. The wait time could be utilized by performing other laboratory tasks and appeared to be dependent on the initial inoculum density.

Conclusions: The BD Phoenix AP instrument standardized inoculum density and reduced the hands-on processing time for the Phoenix system by 50%. The Vitek 2 workflow required 12 s more manual manipulation time per isolate than BD Phoenix AP (P<0.001).

Introduction

Facing labor shortages and financial constraints, clinical microbiology laboratories are under pressure to make more efficient use of available resources. Chief among these resources is human talent in the form of knowledgeable and skilled technologists. Continued development of instruments to automate routine procedures is essential in the current economic climate. Among the most successful automated instruments are those for identification and susceptibility testing. The BioMérieux Vitek 2 and the BD Phoenix have demonstrated excellent accuracy in identification and susceptibility testing of most common bacterial isolates. However, it has been demonstrated that the BD Phoenix requires more hands-on technologist time to set up an isolate than does the Vitek 2 (1). BD Diagnostics has recently introduced the Phoenix AP instrument to automate much of the front-end processing involved in set-up of the Phoenix. The AP automatically adjusts turbidity of the bacterial suspension to that of a 0.5 McFarland standard, prepares a dilution for susceptibility testing, and adds indicator to the susceptibility testing inoculum. The purpose of this study was to quantitate hands-on time savings afforded by the AP instrument and to compare set-up time to that on the Vitek 2.

Methods

Two operators were chosen to perform the testing. Neither had been involved in routine set-up of either instrument, but completed numerous practice runs on both instruments until proficiency was demonstrated. The most efficient workflow and workplace organization for setting up both instruments was determined during the practice runs and individual steps in the workflow were clearly delineated.

Bacterial isolates (both ATCC strains and clinical isolates) were set-up on both the Vitek 2 and Phoenix using the AP instrument. Isolates were tested in 16 batches of 14 organisms each. Each operator set up eight batches. The second operator served as an observer and recorded time required to complete each individual step in the workflow using a Microsoft Excel spreadsheet running a "stopwatch" macro. Mean time requirement for each individual step, as well as overall time and overall hands-on time, were calculated. For comparison purposes, two batches of 14 organisms were set up on the Phoenix instrument using the manual method without the AP instrument.

Four batches of 35 organisms were set up on the Vitek 2 and Phoenix instruments, measuring total time and total hands-on time only.

Table 1. Vitek and Phoenix AP workflow, with times required for individual steps, in seconds (mean ± standard deviation)

		Vitek 2		Phoenix AP			
					Single	Shuttle of 5	Shuttle of 4
X2	X7	Transfer saline to tube, onto SmartCarrier	10.8 ± 3.2				
		Prepare 0.5 McFarland suspension	42.9 ± 22.6				
		Label & streak purity plate	17.4 ± 2.3				
		Scan Acc# and cards, place onto SmartCarrier	27.3 ± 4.4				
		Place SmartCarrier in Vitek	10.6 ± 3.7				
		Remove SmartCarrier from Vitek, dispose of tubes	7.0 ± 1.5				
				Order tests in EpiCenter (scan)		33.8 ± 7.2	
X3	X5, 4			Place broths in shuttle, label purity plate	12.5 ± 4.0		
				Inoculate ID broth	17.5 ± 3.7		
				Streak purity plate	15.5 ± 2.5		
				Place shuttle on AP	9.4 ± 4.0		
				Prepare plates for next shuttle		20.2 ± 4.1	19.2 ± 6.3
X3				Remove shuttle from AP	7.9 ± 4.4		
				Open panels		44.1 ± 9.3	37.7 ± 9.0
				Scan broths & panels		22.6 ± 5.9	17.8 ± 3.4
				Pour broths & cap panels		51.4 ± 8.9	43.6 ± 5.6
				Place on transport caddy		10.1 ± 2.9	7.9 ± 2.6
				Place in Phoenix	44.9 ± 4.8		

Results

- Table 1 illustrates the individual steps and workflow for each instrument when setting up a batch of 14 isolates. The Vitek 2 SmartCarrier can hold seven isolates when testing for both identification and susceptibility testing; therefore, two fully loaded SmartCarriers were used for each batch. Time necessary to print bar code labels for Vitek 2 purity plates was not included in this study. The Phoenix AP uses shuttles that can hold ID and AST broths required to set up five isolates. Therefore, for batches of 14, three shuttles were used, with the third shuttle holding only four isolates. The Phoenix AP hands-on workflow is divided into two sections – steps taken in preparing the shuttle to be placed on the AP, and steps taken after the shuttle is removed from the AP. For this study, each shuttle was prepared and loaded onto the AP in succession before removing the first shuttle for post-AP processing.
- Times required to complete individual steps are shown in Table 1. Among steps comparable between the two instruments, a clear difference is in time requirement for preparing the bacterial suspension (mean of 42.9 seconds on the Vitek 2 and 17.5 seconds on the Phoenix AP). This difference can be explained by the need for the technologist to manually adjust the turbidity of the suspension for the Vitek 2 to equivalency of a 0.5 McFarland standard. For the Phoenix AP it is only necessary for the turbidity of the suspension to be equal or greater than a 0.5 McFarland standard, greatly reducing the hands-on time needed to prepare the suspension.
- The Phoenix AP instrument reduces hands-on time needed to inoculate panels for the BD Phoenix instrument by approximately 50% compared to the standard manual method (Table 2). When tested in batches of 14 isolates, the mean hands-on time to set up a single isolate was 177.7 seconds by the manual method and 89.5 seconds using the AP instrument, a savings of 88.2 seconds per isolate.
- Setting up Phoenix panels using the AP instrument takes less hands-on time than setting up an equivalent number of isolates on the Vitek 2 (Table 2). When tested in batches of 14, hands-on technologist time required per isolate was 101.0 seconds on the Vitek 2 and 89.5 seconds on the Phoenix AP, a savings of 11.5 seconds per isolate. This difference was highly significant ($p < 0.001$).
- Both instruments required some "wait" time, in which no further manual steps could be taken until the instrument completed processing. On the Vitek 2 this involved occasionally having to wait until the instrument door was accessible before placing the second SmartCarrier on the instrument. On the Phoenix AP, during testing of batches of 14, there was always wait time while the AP finished processing of the second and third shuttles before inoculation of the panels could continue. The amount of wait time on the Phoenix AP was largely dependent on the proximity of the initial bacterial suspension to a 0.5 McFarland standard, and therefore the amount of dilution needed. The mean amount of wait time when using the Phoenix AP was over 6.5 minutes for a batch of 14 isolates, compared to 48 seconds on the Vitek 2 (Table 2). For this reason, total time to process a batch of 14 isolates was approximately three minutes longer on the Phoenix AP than on the Vitek 2 ($p = 0.002$). However, on both instruments, wait time could be used by the technologist for performing other duties.
- Setting up panels in batches of 35 isolates allowed for more efficient use of hands-on time, as wait time could usually be utilized for further manual processing of isolates. Under these conditions, both instruments performed comparably, with mean hands-on time per isolate ranging from 87.3 seconds on the Phoenix AP to 93.6 seconds on the Vitek 2 ($p = 0.083$). Total time for processing a batch of 35 was nearly equivalent on the two instruments (Table 3)
- In addition to reducing hands-on technologist time, the Phoenix AP may also improve accuracy of identification and susceptibility testing. The instrument standardizes the panel inoculum to a 0.5 McFarland, reducing the likelihood of operator error and narrowing the range of turbidities used. It also prepares a dilution for susceptibility testing and adds a specific volume of indicator to the susceptibility testing broth. Whether these attributes significantly improve the accuracy of Phoenix test results remains to be demonstrated.

Table 2. Overall times for batches of 14 organisms, in seconds (mean ± standard deviation)

	Vitek 2	Phoenix AP	Phoenix Manual
Number of batches tested	16	16	2
Hands-on time for batch	1414.2 ± 103.7 (23 min 34.2 sec)	1252.5 ± 70.0* (20 min 52.2 sec)	2487.5 (41 min 27.5 sec)
Wait time for batch	48.2 ± 46.0	398.1 ± 173.2 (6 min 38.1 sec)	0
Total time for batch	1464.4 ± 99.6 (24 min 22.4 sec)	1650.6 ± 187.6** (27 min 30.6 sec)	2785.5 (41 min 27.5 sec)
Mean hands-on time per isolate	101.0 sec	89.5 sec	177.7 sec

*p < 0.001 compared to Vitek 2
**p = 0.002 compared to Vitek 2

Table 3. Overall times for batches of 35 organisms, in seconds (mean ± standard deviation)

	Vitek 2	Phoenix AP
Number of batches tested	4	4
Hands-on time for batch	3276.3 ± 46.0 (54 min 36.3 sec)	3053.8 ± 186.8* (50 min 53.8 sec)
Total time for batch	3483.3 ± 19.2 (58 min 3.3 sec)	3455.5 ± 114.6** (57 min 35.5 sec)
Hands-on time per isolate	93.6 sec	87.3 sec

*p = 0.083 compared to Vitek 2
**p = 0.648 compared to Vitek 2

Conclusions

- The Phoenix AP instrument reduces the hands-on time requirement for setting up Phoenix panels by 50% over manual processing.
- Less technologist time is required to set up a batch of 14 isolates on the Phoenix using the AP instrument than is required to set up the Vitek 2 ($p < 0.001$).
- The Phoenix AP required less hands-on time than the Vitek 2 to set up 35 organisms, but this difference did not attain statistical significance ($p = 0.083$) in the limited number of batches tested.

Reference

1. Eigner, U., A. Schmid, U. Wild, D. Bertsch, and A.–M. Fahr. (2005) Analysis of the comparative workflow and performance characteristic of the VITEK 2 and Phoenix systems. J Clin Microbiology 43(8):3829-3834.

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