ORIGINAL REPORT

A field analysis trial comparing the turnaround times of routine and STAT red blood cell immunohematology testing

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The turnaround time (TAT) for pre-transfusion testing is important for prompt clinical decision-making. TAT includes the time between the arrival of the sample and the initiation of testing, plus the processing time (PT) required to generate and report a result. The TAT in larger blood banks is mostly dependent upon the capability of the analyzer used. In smaller blood banks, where manual work is often performed, the TAT is dependent on availability and experience of staff, testing resources, and workload. Our site performed a comparative analysis of the ORTHO VISION® (Ortho Clinical Diagnostics, Raritan, NJ) and the Echo® (Immucor, Norcross, GA) blood bank analyzers, using the TAT and PT of standard blood bank tests as the outcome metrics. Tests were run in various combinations to reflect the standard workflow of a busy hospital transfusion service and under routine and immediate or STAT conditions. We also compared manual versus automated processing TATs for a variety of pre-transfusion tests and antibody titers. We found that the capacity of the VISION to load and run new samples, even while several other tests were ongoing, allowed for faster overall TAT when compared with samples run on the Echo. The PTs of the two analyzers (from load to result) were also compared, and we found them to be equivalent. These findings highlight the inherent flaw in considering only PT when assessing a laboratory's ability to efficiently and consistently make results available to best meet customer and patient needs. In addition, we observed a tighter distribution of TATs and PTs when the VISION was compared with the Echo analyzer, providing a higher level of predictability for availability of results. Finally, when compared with manual antibody titer testing, the VISION analyzer showed a faster PT.
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Key Words: immunohematology, red blood cell testing, RBC testing, VISION, turnaround times

Short turnaround times (TATs) that do not compromise the precision or accuracy of red blood cell (RBC) phenotyping and antibody detection is of utmost importance in the practice of blood banking. Serologic testing for antigens on RBCs and screening for antibodies have transitioned from time-consuming manual methods, beset with both inter- and intra-tester variabilities, to testing via automated analyzers that show improvement on many parameters.

We define TAT as the time between sample arrival and result availability, as it most accurately reflects the needs of clinicians and patients. Additionally, we define processing time (PT) as the time from when work is begun on a sample, whether by manual testing or by loading it onto an analyzer, to its result availability.

The main aim of this study was to compare the TATs of two blood bank analyzers, the ORTHO VISION® (Ortho Clinical Diagnostic, Raritan, NJ) and that of the Echo® (Immucor, Norcross, GA), by using representative patient samples normally seen in a busy, high-complexity hospital transfusion service. To improve efficiency by decreasing reagent waste, samples for the Echo were usually batched prior to running. In contrast, no batching was used with the VISION, since it has a "load as you go" feature, which allows the introduction of new samples even while the analyzer is in mid-cycle with other tests. Therefore, a secondary aim of this study was to decrease reagent wastage while maintaining a quick TAT.

Materials and Methods

Between January 4 and January 12, 2016, the University of Minnesota Medical Center blood bank laboratory ran type and screens, antibody identifications, crossmatches, direct antiglobulin tests (DATs [both polyspecific and monospecific IgG]), and anti-A and anti-B titers on blood samples using the Immucor Echo, the ORTHO VISION, and manually, for a total of 437 individual tests. Samples were collected on two randomly selected dates during 6-hour windows beginning at 0700 when operating room cases began, since this represented the busiest times in the blood bank. All samples that arrived during this 6-hour time frame were run on both analyzers, per the manufacturers' instructions. All samples were from individual patients except for corresponding antibody workups on those with positive antibody detection tests. Reagents used on the VISION included 0.8 percent Surgiscreen (screen cells 1,2,3), Affirmagen A1 and B Cells, MTS Diluent 2, MTS Diluent 2 PLUS, 0.8 percent Resolve Panel A and Panel B, and 0.8 percent Affirmagen Cells (Ortho Clinical Diagnostics). Reagents used on the Echo included Anti-A, Anti-B, Anti-D,

and Monoclonal Control; A1 and B Cells; Ready ID; Extend I and Extend II strips for panels; CMT strips for type and screens; and DAT strips for autocontrols (Immucor).

For efficient use of reagents, it was standard practice for the laboratory to collect a full batch of samples prior to loading and running the Echo. The Echo can run a minimum of one sample and maximum of 20 per batch. Because the VISION has the capability to load and run samples as they arrive in the lab, batching is not required to avoid reagent wastage, and therefore was not used. The data for each method were recorded and compared in three ways: (1) TAT using samples tested with the VISION versus the Echo, (2) PT of the VISION versus the Echo, and (3) PT of the VISION versus a manual method.

The manual methods of ABO and D typing and DAT (both monospecific IgG and polyspecific) were performed by tube method. Manual indirect antibody detection testing and anti-A and anti-B titer levels were performed by column agglutination using ID-Micro Typing System (MTS) Gel Test (Ortho Clinical Diagnostics). All manual methods were performed in accordance with AABB standards. Tests were completed under routine and immediate or STAT conditions to include analysis of TATs that were representative of busy and slow times in the laboratory. Software for the VISION was updated during the testing period to improve the efficiency and better allow for analysis of individual samples. Some of the tests were run using both the original software and the updated software, and these times were also compared. Statistical analysis of the time to results (TAT) comparisons for the VISION and Echo were performed using Minitab 17.1.0 (Minitab, State College, PA). The SDs about the mean were made assuming a normal distribution. This study was approved by the University of Minnesota institutional review board.

Results

A total of three analyses were performed. The first analysis compared the TATs of the VISION and Echo for routine type and screens, crossmatches, and antibody identification. The TAT was measured from the arrival time of the sample in the laboratory to its result time. To enhance reagent use efficiency, samples for the Echo were batched prior to testing; samples for the VISION were run as they arrived in the blood bank. TATs for a total of 23 type and screens were compared. The mean TAT for the Echo was 1:12 (hours:minutes) versus 0:31 for the VISION. The mean TAT for crossmatches (N = 4) was almost identical (0:34 vs. 0:33 for the Echo and VISION, respectively). Similar times were also obtained for antibody identification testing (N = 3) (Table 1, Fig. 1). The range of these TATs (N = 29) showed a tighter distribution in the TAT of the VISION, as demonstrated by an SD of 6.59 for the VISION, compared with an SD of 18.89 for the Echo. The variation in TAT is largely explained by the ability of the VISION to receive and process test samples as they arrived without manual intervention. By contrast, because of the desire to save resources, samples were batched on the Echo, and the associated wait times had a negative impact upon TAT.

Table 1. A comparison of turnaround times based on arrival pattern*

Test	TYSC (N = 22)		XM (N = 4)		Antibody ID (N = 3)	
Analyzer	Echo	VISION	Echo	VISION	Echo	VISION
Mean	1:12	0:31	0:34	0:33	0:31	0:34
(range)	(0:29–1:31)	(0:28–0:39)	(0:34–0:34)	(0:33–0:33)	(0:29–0:35)	(0:32–0:39)
Median	0:50	0:29	0:34	0:33	0:31	0:33

*The sample turnaround time was measured from the time the sample arrived in the laboratory to when it was resulted. Times are in hours:minutes.
TYSC = type and screen; XM = crossmatch; ID = identification.

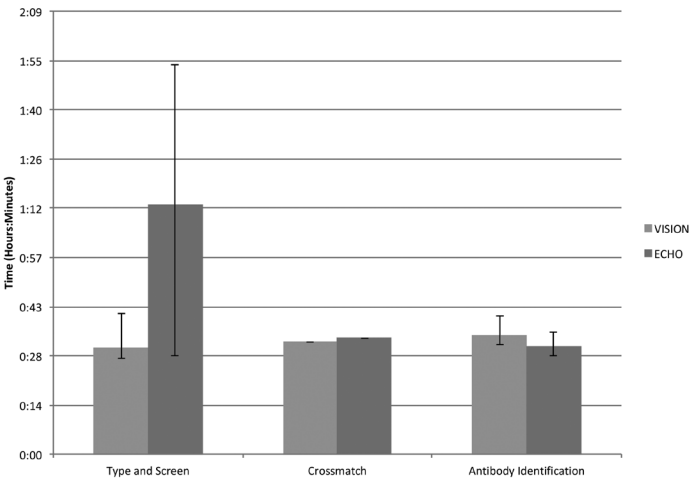

Fig. 1 Turnaround time (hours:minutes) based on sample arrival pattern for VISION versus Echo. A total of 23 type and screens, 4 crossmatches, and 3 antibody identifications were compared.

A second analysis compared the PTs for the VISION and Echo for routine and STAT type and screens, routine crossmatches, and routine antibody identification using RBC panels. The PT for this test cycle was defined as the time from loading the sample to the result time. A total of five routine type and screens were compared. The mean PT for the Echo was 0:29 versus 0:31 for the VISION. The mean PT for STAT crossmatches (N = 4) for the Echo was 0:34, and 0:29 for the

Table 2. A comparison of processing times based on load pattern*

Test	TYSC Routine (*N* = 5)		XM STAT (*N* = 4)		Antibody ID Routine (*N* = 3)		TYSC STAT (*N* = 18)	
Analyzer	Echo	VISION	Echo	VISION	Echo	VISION	Echo	VISION
Mean	0:29	0:31	0:34	0:29	0:31	0:33	0:28	0:28
(range)	(0:26–0:35)	(0:28–0:37)	(0:34–0:34)	(0:29–0:29)	(0:29–0:35)	(0:32–0:34)	(0:25–0:35)	(0:27–0:30)
Median	0:29	0:31	0:34	0:29	0:31	0:33	0:27	0:29

*The sample processing time was measured from the time the sample was loaded onto the analyzer to when it was resulted. Times are in hours:minutes.
TYSC = type and screen; XM = crossmatch; ID = identification.

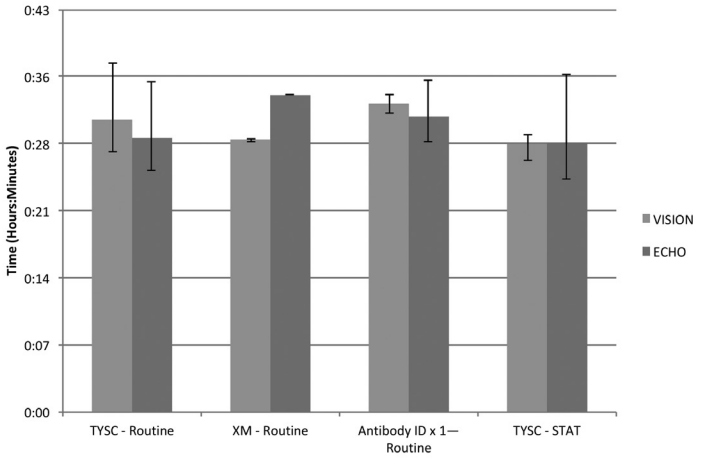

Fig. 2 Processing time (hours:minutes) of VISION versus Echo. A total of 5 routine type and screens, 4 crossmatches, 3 antibody identifications, and 18 STAT type and screens were compared. TYSC = type and screen; XM = crossmatches, ID = identification.

Table 3. A comparison of processing times for the VISION and manual testing, including original and updated software on the VISION, using various combinations of tests

Test (*N* = 1)	Sample type	Manual	VISION (sequential)*	VISION (parallel)†	VISION (parallel)*
Titer: anti-A Titer: anti-B	R	4:09	0:32	0:30	0:32
TYSC DAT-Poly DAT-IgG	R	5:53	0:30	0:31	0:30
TYSC Antibody ID × 2 DAT-Poly XM	R	5:46	1:32	0:33	0:32
TYSC Antibody ID × 1 DAT-Poly XM × 3	S	6:11	1:57	0:58	0:43
TYSC Antibody ID × 2 XM	R	2:15	1:51	0:42	0:41

*Updated software version used.
†Original software version used.
Times are in hours:minutes.
R = routine; S = STAT; TYSC = type and screen; DAT = direct antiglobulin test; Poly = polyspecific; ID = identification; XM = crossmatch.

VISION. The mean PT for routine antibody identifications (*N* = 3) for the Echo was 0:31 and for the VISION was 0:33. Eighteen STAT type and screens were run, and the mean PT for both the Echo and the VISION was 0:28 (Table 2, Fig. 2). The range of PTs for these tests (*N* = 30) was compared. The SD for the Echo was 3.39, versus 2.09 for the VISION.

The third analysis compared the VISION PT to a manual PT for routine and STAT type and screens, DAT (both monospecific IgG and polyspecific), antibody identification by indirect antiglobulin testing with RBC panels, routine ABO typing, anti-A and anti-B titers, and crossmatches (Table 3). These tests were run sequentially to replicate the natural workflow of samples encountered in the blood bank. For example, a positive type and screen would be followed by RBC panels and crossmatches. This analysis recorded the sequential PT, but also noted the time it would take if all samples were run in parallel. As expected, the manual PTs were longer than the VISION PTs. The PT for the VISION to perform an anti-A and anti-B titer was 0:32 each for both titers. This same test performed manually took 4:09. When a type and screen was followed by two RBC panels (antibody ID × 2), a DAT, and a crossmatch, the manual time was 5:46, whereas the VISION PT was 1:32. If these tests had been run simultaneously, the VISION's PT would have been 0:33. During this phase of testing, the VISION software was updated; using the new software, all test combinations were repeated, with greatly improved PTs seen for most tests. These data are displayed in the final column of Table 3.

Discussion

Turnaround time is one of the most important metrics used to measure a laboratory's ability to efficiently meet the needs of its customers and patients. The VISION's ability to simultaneously load and process different tests (even while other samples are running), with minimal human intervention, generated faster TATs for delivery of test results. This capability gives the VISION a unique advantage over

other analyzers that require human intervention to minimize waste or otherwise compensate for what is required to make the instrument run efficiently. Waiting while a full batch of samples is assembled will usually delay the running of the first tests that arrive, thereby increasing a sample's overall TAT.

We compared the TAT of the VISION and Echo from sample arrival in the lab to the time the test was completed (Table 1, Fig. 1) and the PT of each from load time to test completion (Table 2, Fig. 2). Because the VISION load and arrival times were simultaneous, VISION had faster TATs when compared with those of the Echo. When mean run times were compared, the VISION and Echo were equivalent. The range of PTs for the VISION was tighter (SD 2.09 vs. 3.39) than that seen with the Echo, suggesting that the PT for the VISION can be more precisely predicted and is more reproducible when compared with the Echo. Additionally, batching tests on the Echo may have artificially created a longer TAT, which contributed to a wider range of TAT data (SD of VISION 6.59 vs. Echo 18.89). A statistical comparison of the two analyzers was not feasible because of the small sample size of this study.

A final series of tests fully exploited the VISION's capacity to run different kinds of tests simultaneously. We ran type and screens, crossmatches, DATs, and antibody panels. The PTs were compared when these tests were run sequentially, but the longest single test in the group was also noted as the minimum run time for group testing. The VISION performed each test faster than manual testing when run in parallel, or when tested sequentially.

We could not compare the TAT or PT of the two analyzers for antibody titer testing because the Echo does not include this procedure in its test menu. As expected, the VISION determined titers more rapidly than manual testing. Because titers are often ordered in hospitals with obstetric and solid-organ transplant patient populations, the ability to automate this labor-intensive test has improved the blood bank's workflow and efficiency. Although this study tested the isohemagglutinin titer capacity of the VISION, it may also be used to test for anti-D titers, which is often a critical part of care for obstetric patients. The study also showed a vast improvement in PT for combinations of common lab tests (Table 3), which may help expedite TATs as well.

A comparison of analyzers should go beyond the metric of overall TAT. Systems that use multi-sample cartridges either suffer from prolonged TAT because of the batching of staggered samples, or create the potential for wastage of cartridges and reagents when only a partial batch is run. This situation was readily seen during STAT testing with the Echo. When the Echo was running routine tests and a STAT test arrived, the STAT test would be loaded individually to generate a quick result. Although this step kept the PT and TAT short, reagent wastage occurred because the analyzer was using reagents for the routine tests and the STAT tests separately. Using an analyzer that is designed to run samples individually will improve not only TAT but also decrease cartridge and reagent waste.

Studies have shown that gel card testing, as used on the VISION, has either superior sensitivity to manual testing[1] or is at least comparable.[2] Our study showed that manual testing (conventional tube testing) had inferior TATs compared with an automated method. Because gel testing shows similar sensitivities as conventional tube testing, these testing parameters can be improved upon even further with superior TATs, as shown with the VISION.

There were limitations to our study. Because of the small number of samples that were run within each testing category, statistics could not be applied. Also, not all tests were run with the updated software; therefore, some VISION TATs are reflective of the former software, whereas others are reflective of the updated software. Although our study did not specifically look at the consistency of results between each testing method (Echo, VISION, and manual), all three methods have been validated. The Echo was validated through conventional tube testing, since the solid-phase testing had been taken offline.

Overall, our study showed that in a comparative analysis of the Ortho Clinical Diagnostic VISION and the Immucor Galileo Echo blood bank analyzers, the PT of these analyzers was similar, although the "load on the fly" feature of the VISION allowed for faster overall TAT and enhanced workflow within the blood bank. A tighter distribution of TATs was observed with the VISION when compared with the Echo, confirming that the VISION's TATs were more predictable than those of the Echo. Finally, the addition of automated isohemagglutinin and RBC alloantibody titers make this analyzer a welcome addition for busy blood bank laboratories.

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Disclosures

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References

1. Cheng D, Hao Y. Comparative evaluation of the microcolumn gel card test and the conventional tube test for measurement of titers of immunoglobulin G antibodies to blood group A and blood group B. J Int Med Res 2011;39:934–43.
2. Finck R, Lui-Deguzman C, Teng SM, Davis R, Yuan S. Comparison of a gel microcolumn assay with the conventional tube test for red blood cell alloantibody titration. Transfusion 2013;53:811–15.

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