DONOR INFECTIOUS DISEASE TESTING

TRANSFUSION

Evaluation of an improved rapid bacterial assay with untreated and pathogen-reduced platelets: Detection of *Acinetobacter* strains

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Abstract

Background: The PGD*prime*® test was updated to enable *Acinetobacter* spp. detection to respond to morbidity and mortality events in 2018 and 2020 involving platelets contaminated with *Acinetobacter-calcoaceticus-baumannii* complex (*ACBC*). In one morbidity event, the first-generation PGD test failed to detect *ACBC*. In two other reported events, pathogen-reduced (PR) platelets contaminated with *ACBC* and other bacteria led to patient morbidity and one death.

Study Design and Methods: A polyclonal antibody to *Acinetobacter* was integrated in the test device and evaluated for detection of *Acinetobacter* spp., including the *ACBC* isolate recovered in one of the 2018 contamination events. Limits of Detection for various *Acinetobacter* strains were determined in dilution studies. Detection of *Acinetobacter* growing in platelets after an initial low inoculum was evaluated. Use of the updated test as a secondary test after pathogen reduction was also evaluated by testing at 12-h intervals PR platelet units inoculated with low levels of the 3 species reported in the fatal PR platelet: *ACBC*, *Staphylococcus saprophyticus*, and *Leclercia adecarboxylata*.

Results: The test detected several *Acinetobacter* strains at the clinically relevant CFU/ml levels associated with septic transfusions and successfully detected *Acinetobacter* growing in various non-PR platelet types after an initial low inoculum. In PR platelets, the test yielded a positive result with the 3 implicated bacteria in 48 h or less after inoculation, or 48–72 h earlier than the reported time of transfusion of contaminated PR platelets.

Conclusion: PGD*prime* was improved to detect *Acinetobacter* and has shown utility to interdict contaminated PR platelets.

KEYWORDS
bacteria, pathogen reduction, platelet transfusion, transfusion-transmitted disease

1 | INTRODUCTION

In 2018, three different sites in the United States reported four platelet contamination events with *Acinetobacter-calcoaceticus-baumannii* complex (*ACBC*), resulting in patient mortality and morbidity.[1] One case of patient morbidity in Utah involved a pathogen-reduced (PR) platelet unit that had been treated 13.5 h after collection and transfused on the fifth day after collection.[2] Later that year, Yale University Medical Center reported two cases of patient morbidity involving two units from a single collection that had been tested with culture at 24 h post-collection, then tested with the Platelet PGD® rapid test within 5 h of transfusion.[1] Both tests yielded negative or non-reactive results for the presence of bacteria. Isolates from the platelet bags and patient plasma from the three sites and all four patients were identified as *ACBC* and *Staphylococcus saprophyticus*. The *ACBC* isolates from all three sites were highly related to each other, differing by 0–32 single nucleotide polymorphisms across a 95.6% core genome.[1]

A patient mortality event was reported in 2020 involving a PR platelet unit.[3] Isolates from that event were identified as *ACBC* and *S. saprophyticus*, both clonal with the previous reported events in 2018, and *Leclercia adecarboxylata*, a Gram-negative enteric bacterium. The collected platelets had been split into two components that were separately treated 16.5 h after collection with the INTERCEPT Blood System for pathogen reduction. The two components were sent to different medical facilities. One of the components was safely transfused on Day 3 after collection. The other component was transfused to a different patient on Day 5, resulting in the reported fatality.

Subsequent investigations demonstrated the efficacy of the pathogen reduction process in eliminating viable *ACBC*, *S. saprophyticus*, and *L. adecarboxylata* bacteria in platelets.[3] In the 2020 report, the authors theorize that bacteria may have entered the stored PR platelet via a leak discovered in the storage container.[3]

Collected platelets undergo PR treatment within 24 h, then transferred to a storage bag. If a PR platelet is transfused on the 5th day post-collection, potential post-treatment contamination and bacterial proliferation could occur in the storage bag over the intervening 72+ h prior to transfusion.

The Platelet PGD Test did not detect *ACBC* at Yale. It was not designed to detect *Acinetobacter* spp. efficiently. These strains had not been reported as platelet contaminants during the test's design and development (ca.2006). In response to the 2018 sepsis events, the current test, Platelet PGD*prime*, has been updated to include *Acinetobacter* spp. detection.[4] At the time of writing, this updated version has completed an extensive validation protocol prior to commercial release in 2021. We report the performance of this updated test in detecting *Acinetobacter* spp. in untreated (non-PR) platelets.

We also tested the utility of the updated test for detecting the bacterial contaminants identified in morbidity and mortality events in 2018 and 2020 in PR platelets. Currently, platelets are not tested for bacterial contamination once they have been pathogen reduced. The assumption is that, given the efficiency of pathogen inactivation, it is not necessary to check for process integrity or post-treatment bacterial proliferation. The recent morbidity and mortality events challenge those assumptions. The absence of any strategy to detect post-treatment contamination events in PR platelets prior to transfusion will continue to expose patients to mortality and morbidity. We therefore evaluated the utility of the updated PGD*prime* rapid test to detect post-treatment contamination of PR platelets prior to transfusion, specifically focusing on the bacteria isolated from the recent PR platelet contamination events.

## 1.1 | *Acinetobacter baumannii* antigenic variation and the development of a polyclonal antibody

In the recent decade, *A. baumannii* has received recognition as a widespread cause of nosocomial infections,[5] with potential antibiotic resistance.[6] Over 50 different species have been identified to date, linked to a range of infections, with pneumonia being the most frequent.[7] *A. baumannii* is genetically diverse but outer surface epitopes such as Type 1 pili, outer membrane protein A (Omp A), the most abundant *A. baumannii* outer membrane protein, and the lipopolysaccharide O-antigen show a high level of homology among strains.[7,8,9]

To develop a broadly reactive antibody, the immunogens used to develop a new polyclonal antibody which included multiple *Acinetobacter* strains included several strains of *A. baumannii* and *Acinetobacter lwoffii*.

2 | MATERIALS AND METHODS

2.1 | Test devices

This study uses an updated PGD*prime* rapid test containing an antibody that recognizes *Acinetobacter* spp. The capture antibody is located on the 6th downstream test line of the PGDprime test device as shown in Figure 1. The capture antibody immobilized on the nitrocellulose test strip is combined with a detector which uses the F(ab')$_2$ of the same antibody in a sandwich assay format.

Location of new *Acinetobacter* spp. antibody
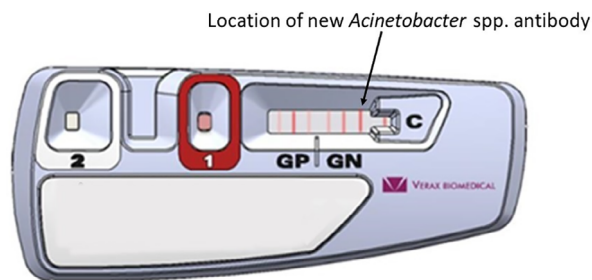
FIGURE 1 Location of the updated detection line on the PGD*prime* test strip [Color figure can be viewed at wileyonlinelibrary.com]

TABLE 1 Observed limits of detection (LoD) for various *Acinetobacter* strains

Strain	Observed LoD (CFU/ml)
Acinetobacter baumannii ATCC 001[a]	4.40E+04
Acinetobacter baumannii ATCC 17961[a]	9.00E+02
Acinetobacter baumannii ATCC 19606[a]	3.20E+04
Acinetobacter baumannii ATCC 51432[a]	5.30E+04
Acinetobacter baumannii BAA-747[a]	1.05E+06
Acinetobacter lwoffii ATCC 17925[b]	1.01E+05
Acinetobacter indicus ATCC 17976[b]	9.53E+04
Acinetobacter baylyi ATCC 33305[b]	6.48E+06

[a]Grown in apheresis platelets.
[b]Grown on blood agar plates.

2.2 | Detection of *Acinetobacter* in non-PR platelets

Observed limits of detection (LoDs) were first determined with various available *Acinetobacter* strains using a bacterial growth model in apheresis platelets suspended in plasma. Samples taken over time from the inoculated platelets were tested with PGD*prime* and the levels of live bacteria in each platelet bag were quantified using viable plate counts by serial dilution (we refer to this as the Dilution Plate Count method or DPC). Of eight available *Acinetobacter* strains tested, three strains did not grow in apheresis platelets, experiencing auto-sterilization in three separate attempts (Table 1). These strains were grown on and recovered from blood agar plates, then transferred to saline, quantitated spectrophotometrically, and tested in serial dilutions in apheresis platelets using PGD*prime* to determine their observed LoD.

Using *A. baumannii* ATCC 19606, a type strain, a spiking stock was prepared to evaluate the reproducibility of *A. baumannii* detection at a level near its observed LoD in apheresis platelets and in other platelet types.

When this spiking stock was diluted 1:21 in platelet samples, the resulting level of *A. baumannii* was 0.4 logs above the LoD established in testing described in the preceding section. Six in-date units of each of the following platelet types were spiked and tested: Pre- or post-storage leukoreduced whole-blood-derived platelet pools (LRWBDp), post-storage non-leukoreduced whole-blood-derived platelet pools (NLRWBDp), and platelets collected with platelet additive solution (PAS-C). Each test run was controlled by spiking the same stock into an apheresis platelet unit.

2.3 | Low inoculum growth studies in non-PR platelets

Growth studies were conducted to evaluate the ability of the updated PGD*prime* test to detect *Acinetobacter* initially present at low levels that culture may miss due to sampling errors. We used a model of platelet contamination that follows the growth of bacteria from low numbers through log phase during storage. *A. baumannii* ATCC 19606 was inoculated at low CFU/ml ($\leq$10 CFU/ml) and tested at 24 h post-inoculation and every 12 h thereafter to determine time to detection in three different types of platelets: apheresis, PAS-C, and LRWBDp. A spiking stock was prepared by establishing the CFU/ml level of a high bacterial stock spectrophotometrically. This stock was then diluted in sterile PBS to create 3 spiking levels so that final target levels of 1, 0.1, and 0.01 CFU/ml were achieved after a 1:100 spike into negative platelet units. Each of these spiking stocks were then tested for levels of live bacteria at the time of spiking using DPC (live bacteria typically did not match the spectrophotometric-based target values). The reason for using 3 inoculum levels was our experience that only a small percentage of bacteria actually grow in platelets with these very low starting inocula. The range of inocula was used to ensure that growth would occur in one or several conditions. A separate complete platelet unit was spiked for each target level for a total of 3 inoculated units of each type. A fourth unit of the same type was inoculated with sterile PBS as a negative control. Two hours after spiking, ten 4.5 ml aliquots were sampled from each inoculated platelet. Only platelets that were not 100% (10/10) positive on agar plate culture were qualified for further investigation in this study. This requirement was meant to simulate sampling errors that would affect culture testing results due to extremely low bacterial levels. Testing was performed using three cGMP lots of the updated rapid test in duplicate at each time point for a total of 6 data points per testing interval. Bacterial plate culture was performed on aliquots from the inoculated units at each timepoint to confirm viability of the

inoculated bacteria (At extremely low levels, many inoculated units autosterilized and did not contain viable bacteria up to the 72 h timepoint). Samples were considered positive when all six results were positive at a given time point, upon which a culture confirmation was carried out. The sample was tested using PGD*prime* at the next time point to further confirm the initial positive result.

2.4 | Detection of *ACBC* and other platelet isolates in PR platelets

Separate studies were undertaken to evaluate the utility of the updated test in detecting bacterial contamination in PR platelets. These were designed to simulate the two morbidity and mortality events involving contaminated PR platelets in 2018 and in 2020. In the 2018 morbidity event, *ACBC* and *S. saprophyticus* were identified as co-contaminants. In the 2020 mortality event, *ACBC*, *S. saprophyticus*, and *L. adecarboxylata* were isolated in the implicated PR platelet unit.

The first study investigated the detection of *ACBC* and *A. baumannii* ATCC 19606, each as single contaminants. Two in-date PR PAS Platelet units were acquired. Each unit was divided aseptically into three aliquots in individual Fenwal Transfer-Pack platelet bags. One aliquot of each unit was inoculated with 10 CFU/ml of the *ACBC* isolate from the Yale morbidity events (*ACBC* Isolate Yale 2018). The second aliquot was inoculated with 10 CFU/ml of *A. baumannii* ATCC 19606. The third aliquot was not inoculated and served as a negative control.

The bags were placed on a rocker at room temperature, sampled aseptically (~200 μl) every 12 h and tested in duplicate with the updated PGD*prime* assay. Time to detection was determined and subsequently confirmed by plate culture and with additional PGD*prime* testing at the next 12 h time point.

At the time of first detection, the level of *ACBC* in the PR platelet sample was measured by DPC and the observed LoD for the *ACBC* isolate with PGDprime was determined by testing serial dilutions of the PR platelet sample in negative platelet with duplicates of the rapid test. The observed LoD was calculated as the CFU/ml at the last serial dilution detected by PGD*prime*.

2.5 | Detection of *ACBC* and *S. saprophyticus* as single and co-contaminants in PR platelets

In this study, the ability of the updated test to detect both *ACBC* and *S. saprophyticus* isolates obtained from the Yale morbidity event as co-contaminants in PR platelets

was evaluated. Two in-date platelets were each divided aseptically into 4 aliquots. *ACBC* was inoculated at 10 CFU/ml into one aliquot (*ACBC* solo). *S. saprophyticus* was inoculated also at 10 CFU/ml into the 2nd aliquot (*S. saprophyticus* solo). *ACBC* and *S. saprophyticus* were inoculated together (10 CFU/ml each) into the 3rd aliquot (Mixed). The 4th aliquot was not inoculated and served as a negative control.

The aliquots were placed on a rocker at room temperature, sampled aseptically (~200 μl) every 12 h and tested in duplicate with the updated PGD*prime* rapid assay. Time to detection was observed, confirmed on plate culture and additional tests at the next 12 h time point.

2.6 | Detection of *ACBC*, *S. saprophyticus*, and *L. adecarboxylata* as single and co-contaminants in PR platelets

We were not in possession of the specific isolates from the 2020 event. In this study, we evaluated the detection of the 3 species identified in the 2020 PR platelet mortality event as co-contaminants. Two in-date PR PAS platelet units were each divided into four aliquots. Each unit was tested for the absence of viable bacteria via aerobic and anaerobic plate culture prior to use. Each unit was also tested to be non-reactive in the rapid test prior to use. Yale isolates of *ACBC* and *S. saprophyticus*, and *L. adecarboxylata* ATCC 23216 (10 CFU/ml each) were inoculated together into the first aliquot from each PR PAS platelet unit. Each organism was also inoculated as a single contaminant into the 2nd, 3rd, and 4th aliquot of each unit.

The aliquots were placed on a rocker at room temperature, sampled aseptically (~200 μl) every 12 h and tested in duplicate with the updated rapid assay. Time to detection was observed and subsequently confirmed by plate culture and with additional tests at the next 12 h time point.

3 | RESULTS

3.1 | Detection of *Acinetobacter* in non-PR platelets

Table 1 summarizes the observed LoDs for several *Acinetobacter* strains in apheresis in plasma platelets.

The observed LoD established for *A. baumannii* ATCC 19606 was 3.20E+04 CFU/ml. A spiking stock of this strain was diluted 1:21 into LRWBDp, NLRWBDp, and PAS platelets to yield a final CFU/ml level within 0.4 logs above this measured LoD. Each spiked unit of each platelet type was tested with PGD*prime* devices from

T A B L E 2 Reproducibility of *Acinetobacter baumannii* detection in different platelet types

Platelet type	No. of units tested	*A. baumannii* 19606 (CFU/ml)	Reactive results/tests run	% detection
Apheresis	5	8.75E+04	15/15	100%
LRWBDp	6	8.75E+04	18/18	100%
NLRWBDp	6	8.75E+04	18/18	100%
Apheresis in PAS-C	6	8.75E+04	18/18	100%

Abbreviation: PAS, platelet additive solution.

T A B L E 3 Time to detection of *Acinetobacter baumannii* ATCC 19606 in non-pathogen-reduced platelets

Platelet type	Initial inoculum (CFU/ml)	Time to detection (hours post-inoculation)
Apheresis in plasma	0.10	96
Apheresis in PAS-C	0.02	48
Apheresis in PAS-C	0.20	60
LRWBDp	0.28	60

Abbreviation: PAS-C, platelets collected with platelet additive solution.

3 different cGMP lots. Table 2 summarizes the results obtained. To confirm the LoD previously observed in apheresis platelets to be valid in other platelet types, all tests with PGD*prime* should yield a reactive result with the spiked samples. The results obtained did demonstrate the ability of the test to reproducibly detect levels of *Acinetobacter* close to the LoD in multiple examples of the different platelet types.

3.2 | Time to detection of *A. baumannii* in non-PR platelets in ultra-low inoculum studies

The times to detection observed for *A. baumannii* ATCC 19606 growing in various non-PR platelets are summarized in Table 3. The variation observed in times to detection are dependent on the growth conditions in the specific platelet units in the study and not the test's ability to detect at its expected LoD. At each timepoint, the sample obtained from each bag was tested with DPC to determine the CFU/ml in the bag. At each negative timepoint prior to the positive timepoint, the CFU/ml had not exceeded the LoD established for the *A. baumannii* ATCC 19606.

The test successfully detected *A. baumannii* ATCC 19606 growing in three types of non-PR platelets from a low-level initial inoculum. Time to detection ranged from 48 to 96 h. No reactive results were obtained from the platelets inoculated with buffer.

3.3 | Time to detection of *ACBC* and *A. baumannii* in PR platelets

Reactive results were observed at 36 h post-inoculation in aliquots from each of the two PR PAS containing the *ACBC* isolate Yale 2018. In the aliquot of one platelet, *A. baumannii* ATCC 19606 was detected at 36 h and in the other platelet at 48 h (Table 4). The observed LoDs for the Yale 2018 isolate of *ACBC* in each platelet are shown as well. The negative control aliquots were non-reactive on the rapid test at all time points.

3.4 | Time to detection of *ACBC* and *S. saprophyticus* as co-contaminants in PR platelets

This study compared the time to detection of the Yale 2018 isolates of *ACBC* and *S. saprophyticus* as co-contaminants to the time to detection of each species as a single contaminant in the same PR platelet units (Table 5). As single contaminants, the Yale isolates of ACBC and *S. saprophyticus* gave positive test results within 48 h or less after initial inoculation in the two PR platelet samples. As combined contaminants, the Yale isolates yielded positive test results between 36 and 48 h after initial inoculation.

3.5 | Time to detection of *ACBC*, *S. saprophyticus*, and *L. adecarboxylata* as co-contaminants in PR platelets

In this study, the time to detection in PR platelets inoculated with the Yale 2018 isolates of *ACBC* and *S. saprophyticus* and *L. adecarboxylata* ATCC 27983 as co-contaminants was compared to the time to detection of each species as single contaminants in the same platelet unit (Table 6). As single contaminants, each organism growing in PR platelets was detected by the rapid test within 48 h or less. When grown together as mixed contaminants in equal initial inocula, the test gave a positive signal, indicative of a contaminated platelet within 36 h or less in the two platelet units tested.

TABLE 4 Time to detection of two *Acinetobacter* species as single contaminants in in-date PR PAS platelets

Sample	Species inoculated (10 CFU/ml)	Time to detection (hours-post inoculation)	Observed LoD for Yale 2018 isolates (CFU/ml)
PR PAS platelet 1	*ACBC* isolate Yale 2018	36	4.8E+05
	Acinetobacter baumannii 19606	36	9.1E+03
PR PAS platelet 2	*ACBC* isolate Yale 2018	36	1.3E+05
	Acinetobacter baumannii 19606	48	5.8E+03

Abbreviation: PR PAS, pathogen-reduced platelet additive solution.

TABLE 5 Time to detection of the Yale isolates of *ACBC* and *Staphylococcus saprophyticus* growing in in-date PR PAS platelets as single and mixed co-contaminants

Sample	Species inoculated (10 CFU/ml each)	Time to detection (hours-post inoculation)
PR PAS platelet 3	*ACBC* isolate Yale 2018 (single contaminant)	36
	S. saprophyticus isolate Yale 2018 (single contaminant)	48
	ACBC isolate Yale 2018 + *S. saprophyticus* isolate Yale 2018 (mixed co-contaminants)	36
PR PAS platelet 4	*ACBC* Isolate Yale 2018 (single contaminant)	24
	S. saprophyticus isolate Yale 2018 (single contaminant)	48
	ACBC isolate Yale 2018 + *S. saprophyticus* isolate Yale 2018 (mixed co-contaminants)	24

Abbreviation: PR PAS, pathogen-reduced platelet additive solution.

TABLE 6 Time to positive reaction of the Yale isolates of *ACBC* and *Staphylococcus saprophyticus*, and *Leclercia adecarboxylata* ATCC 27983 growing in in-date PR PAS platelets as single and mixed co-contaminants

Sample	Species inoculated (10 CFU/ml each)	Time to detection (hours post-inoculation)
PR PAS platelet 5	*ACBC* isolate Yale 2018 (single contaminant)	36
	L. adecarboxylata (single contaminant)	36
	S. saprophyticus isolate Yale 2018 (single contaminant)	48
	ACBC isolate Yale 2018 + *S. saprophyticus* isolate Yale 2018 + *L. adecarboxylata* (mixed co-contaminants)	24
PR PAS platelet 6	*ACBC* isolate Yale 2018 (single contaminant)	36
	L. adecarboxylata (single contaminant)	36
	S. saprophyticus isolate Yale 2018 (single contaminant)	48
	ACBC isolate Yale 2018 + *S. saprophyticus* isolate Yale 2018 + *L. adecarboxylata* (mixed co-contaminants)	36

Abbreviation: PR PAS, pathogen-reduced platelet additive solution.

The PR platelet contaminated with the 3 species identified as co-contaminants in 2020[3] could have generated a positive assay response from 24 to 36 h after PR treatment.

4 | DISCUSSION

4.1 | Detection of *Acinetobacter* spp. by the updated rapid bacterial test

The PGD*prime* rapid test has been updated to detect *Acinetobacter* spp. by the inclusion of an antibody raised in host animals using *Acinetobacter* strains in the immunogen. We demonstrated detection of various strains of *Acinetobacter* at levels well within the threshold of serious septic reactions previously reported for bacteria in
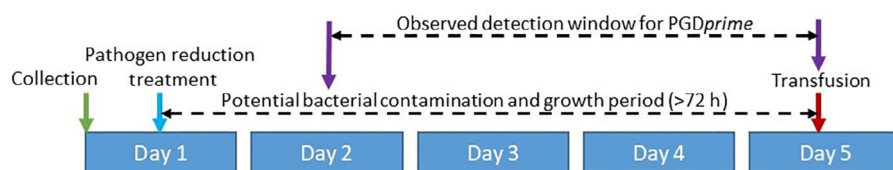
platelets.[10,11] In these retrospective studies, the risk associated with moderate to severe sepsis begins at 10^5–10^6 CFU/ml.

Separate studies not covered in this report show that the very high level of specificity of PGD*prime*[12] (no repeat reactive or false positive result in 3800 confirmed negative non-PR platelet units of various types) has not been compromised by the inclusion of the new antibody. In new specificity studies of the updated test with the *Acinetobacter* antibody, no repeat reactive (false positive) results were observed in 1100 non-PR platelet units. No other performance parameters have been affected.

4.2 | Detection of *ACBC*, *S. Saprophyticus*, and *L. adecarboxylata* in PR platelets

In both reported morbidity and mortality events associated with post-treatment contamination of PR PAS platelets, the PR platelet units were transfused into the patient on the 5th day after collection. Since PR treatment is performed within the first 24 h after collection, transfusion would have occurred on the 4th day or >72 h after pathogen reduction. In our simulation, the time of inoculation represents the start of the post-PR treatment period. The timeline associated with the potential exposure of a 5-day PR platelet is shown in Figure 2.

Assuming contamination was a post-PR treatment event, the levels of *Acinetobacter* in a contaminated bag would have reached high titers associated with potential sepsis in the reported events within the $\geq$72 h period after treatment. A capable rapid test run within 24 h prior to transfusion may have enabled interdiction of those contaminated units. In our simulation, PGD*prime* detected *ACBC*, *S. saprophyticus*, and *L. adecarboxylat*a either as solo or mixed co-contaminants well under the 72 h period after inoculation. In fact, using isolates of *ACBC* and *S. saprophyticus* from a reported morbidity event, a reactive assay result was observed at 24–36 h for mixed contamination scenarios. Fadeyi et al.[3] have suggested that in the absence of any test for post-treatment contamination of PR platelets, the use of a simple and rapid leak test for microsized leaks could be utilized for detecting damaged bags to avoid postmanufacture contamination from bag defects.

5 | CONCLUSION

Inclusion of an antibody highly reactive to *Acinetobacter* spp. has allowed the new version PGD*prime* rapid test for bacteria in platelets to detect these strains. This updated test can be used with a wide range of non-PR platelet types.

In addition, we have demonstrated the feasibility of using this rapid test with stored PR platelets on Days 3–5 after collection to detect *ACBC* and the other reported contaminants (note: Validation studies of the PGD*prime* test for use with PR platelets have not yet been completed. These studies include specificity, detection of other species, interfering substances, and user guardbands). The rapid test is a simple low-cost method that would confer additional patient safety compared to current practice of transfusing PR platelets without any means to detect post-treatment contamination.

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REFERENCES
1. Jones SA, Jones JM, Leung V, Nakashima AK, Oakeson KF, Smith AR, et al. Sepsis attributed to bacterial contamination of platelets associated with a potential common source – multiple states, 2018. MMWR Morb Mortal Wkly Rep. 2019;68:519–23. https://doi.org/10.15585/mmwr.mm6823a2.
2. Fridey JL, Stramer SL, Nambiar A, Moayeri M, Bakkour S, Langelier C, et al. Sepsis from an apheresis platelet contaminated with *Acinetobacter calcoaceticus/baumannii* complex bacteria and *Staphylococcus saprophyticus* after pathogen reduction. Transfusion. 2020;60:1960–9. https://doi.org/10.1111/trf.15951.
3. Fadeyi EA, Wagner SJ, Goldberg C, Lu T, Young P, Bringmann PW, et al. Fatal sepsis associated with a storage container leak permitting platelet contamination with environmental bacteria after pathogen reduction. Transfusion. 2021;61:641–8. https://doi.org/10.1111/trf.16210.
4. LaVerda D, Shinefeld L, Best N, Lisitu J, Tambolleo G, Vallejo R. Updating the Platelet PGDprime® Rapid Test for bacteria in

platelets to detect *Acinetobacter* strains[abstract]. Transfusion. 2020;60(S5):73A-74A:11:861–872. https://doi.org/10.2147/IDR.S163944.

5. Martin-Aspas A, Guerrero-Sanchez FM, Garcia-Colchero F, Rodríguez-Roca S, Girón-González J-A. Differential characteristics of *Acinetobacter baumannii* colonization and infection: risk factors, clinical picture, and mortality. Inf Drug Resist. 2018;11:861–72.

6. Shlaes DM, Bradford PA. Antibiotics-from there to where? Pathog Immun. 2018;3:19–43. https://doi.org/10.20411/pai.v3il.231.

7. Morris FC, Dexter C, Kostoulias X, Uddin MI, Peleg AY. The mechanisms of disease caused by *Acinetobacter baumannii*. Front Microbiol. 2019;10:1601. https://doi.org/10.3389/fmicb.2019.01601.

8. Eijkelkamp BA, Stroeher UH, Hassan KA, Paulsen IT, Brown MH. Comparative analysis of surface-exposed virulence factors of *Acinetobacter baumannii*. BMC Genomics. 2014;15:1020. https://doi.org/10.1186/1471-2164-15-1020.

9. Pantophlet R, Nemec A, Brade L, Brade H, Dijkshoorn L. O-antigen diversity among *Acinetobacter baumannii* strains from the Czech Republic and Northwestern Europe, as determined by lipopolysaccharide-specific monoclonal antibodies. J Clin Microbiol. 2001;39:2576–80. https://doi.org/10.1128/JCM.39.7.2576-2580.2001.

10. Jacobs MR, Good CE, Lazarus HM, Yomtovian RA. Relationship between bacterial load, species virulence, and transfusion reaction with transfusion of bacterially contaminated platelets. Clin Infect Dis. 2008;46:1214–20.

11. Kundrapu S, Srivastava S, Good CE, Lazarus HM, Maitta RW, Jacobs MR. Bacterial contamination and septic transfusion reaction rates associated with platelet components before and after introduction of primary culture: experience at a US Academic Medical Center 1991 through 2017. Transfusion. 2020;60:974–85.

12. Vallejo RP, Shinefeld L, LaVerda D, Best N, Lawrence G, Lousararian A, et al. Performance profile of an updated safety measure rapid assay for bacteria in platelets. Transfusion. 2020;60:2622–263.