Accuracy of User-Friendly Blood Typing Kits Tested Under Simulated Military Field Conditions

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ABSTRACT Rapid user-friendly ABO–Rh blood typing kits (Eldon Home Kit 2511, ABO–Rh Combination Blood Typing Experiment Kit) were evaluated to determine their accuracy when used under simulated military field conditions and after long-term storage at various temperatures and humidities. Rates of positive tests between control groups, experimental groups, and industry standards were measured and analyzed using the Fisher's exact chi-square method to identify significant differences ($p \leq 0.05$). When Eldon Home Kits 2511 were used in various operational conditions, the results were comparable to those obtained with the control group and with the industry standard. The performance of the ABO–Rh Combination Blood Typing Experiment Kit was adversely affected by prolonged storage in temperatures above 37°C. The diagnostic performance of commercial blood typing kits varies according to product and environmental storage conditions.

INTRODUCTION

U.S. military forces are deployed around the world in operational and support roles. During the course of military operations, warfighters may require blood transfusions because of hemorrhagic injury. As of December 31, 2009, 5,311 U.S. warfighters had received transfusions during Operations Enduring Freedom and Iraqi Freedom.[1] When banked blood is unavailable at forward treatment locations, donors may act as the source of blood. Under ideal conditions, determining ABO blood group type and Rh factor and crossmatching should be done prior to administering a transfusion. This is possible at echelon III and IV levels. At second-echelon and first-echelon units, capabilities may be limited or nonexistent. For example, second-echelon units are authorized to transfuse only universal-donor (blood group O) packed red blood cells (RBCs)[2] and first-echelon units have no blood product support.

Despite the limited capabilities of echelon I units, emergency transfusions may be necessary at far-forward locations. Although O blood type, the universal donor, may not be available, other warfighters who could serve as donors of whole blood for transfusion may be available. Under certain contingency situations, the donor's identification card or tag (i.e., dog tag) may be used to determine blood type and Rh factor status. Unfortunately, studies have found that 3.7% to 11% of them list incorrect blood types.[3–5] Therefore, the use of a field-friendly screening test for determining donors' ABO and Rh compatibilities could be extremely beneficial.

Numerous rapid commercial tests are available for ABO and Rh blood typing; however, only a few are suitable for use in the field. To be appropriate for field use, the product needs to possess the following characteristics: (1) be small and light weight, (2) have no moving parts, (3) be simple to use, (4) produce reliable diagnostic results, (5) yield results assessed visually with an unaided eye, and (6) be independent of the need for electricity and extraneous laboratory equipment or supplies. Although all these criteria are important if a product is to be appropriate for field use, obtaining rapid results can be especially critical for a blood typing product because of the potential for it to be used when exsanguination from a wound or injury is possible. Two products, the Eldon Home Kit 2511 (Eldon Biologicals, Gentofte, Denmark) and the ABO–Rh Combination Blood Typing Experiment Kit (Lab Aids, Ronkonkoma, NY), met these selection criteria and produced results in a matter of minutes. These were the products chosen for study in this investigation.

Although these 2 products have somewhat different configurations, they function using the same basic principle of forward blood typing. Briefly, this involves determining the ABO–Rh blood group based on the presence or absence of inherited antigenic substances called agglutinogens (e.g., antigen A, antigen B, and antigen D) on the surface of RBCs. Blood typing is achieved by mixing a drop of blood with antisera directed against antigen A, antigen B, or antigen D. If the surfaces of the RBCs possess the respective agglutinogens, agglutination will be observed. If no agglutination is observed, the blood is classified as type O negative. When using the products, the presence or absence of agglutination is assessed qualitatively. Past user experience has found that the test results are typically clear and unequivocal in their presentation. If a weak agglutination reaction was difficult to discern, 2 laboratorians would assess the result and come to a consensus.

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By necessity, U.S. military forces must be capable of operating anywhere in the world, regardless of ambient climatic conditions. Recently, in Operations Iraqi Freedom and Enduring Freedom, U.S. forces have been operational in areas of the world known for their high summertime temperatures and low relative humidities. Other past operations have been conducted in Korea, an area known for its relatively extreme seasonal conditions of high temperature, high humidity and low temperature, low humidity.

Naturally, supplies and equipment must accompany warfighters to support their operations. Although established guidelines recommend against storing medicines and other medical products under high heat and humidity conditions,[6,7] by necessity, the military may need to store such supplies in non–climate controlled warehouses. Published studies of the effects of uncontrolled storage on the efficacy of medical supplies can be found, and some general conclusions can be drawn from them.[8–13] However, results have varied, perhaps because of the range of products tested and the conditions under which they were stored and used. It is always best to test such products under actual storage and use conditions.

The Naval Medical Research Center Detachment Great Lakes (formerly the Naval Institute for Dental and Biomedical Research) has exposed medical and dental supplies and equipment to different environmental conditions for various time periods and then tested their performance.[14–16] Adverse effects on many of these products have been found. However, there remains a need to evaluate the performance of these products after long-term storage.

It is equally important to assess the effect of operational temperature and humidity conditions on medical products. Even if products are stored in warehouses and depots under climate-controlled conditions, they are often used in the field under ambient environmental conditions. It is vital to determine if exposure during use adversely affects their performance.

The objective of this study was to determine the accuracy of point-of-care blood typing devices when used under temperature and humidity conditions simulating those commonly encountered in the field. The study also assessed the effects of long-term storage at constant temperatures (−30°C, −20°C, 4°C, 22°C, 37°C, 45°C, and 50°C) for 1, 3, 6, and 9 months.

MATERIALS AND METHODS

Specimens

Fresh whole blood was purchased from Golden West Biologicals (Temecula, CA), using a donor site that is a U.S. Food and Drug Administration (FDA)–inspected and American Association of Blood Banks–accredited facility. The only donor information that accompanied each sample was age, ethnic group, gender, and blood type. As such, the investigation was deemed to be Institutional Review Board – exempt. The donor facility used BD Vacutainer spray–coated K2EDTA tubes (Becton Dickenson, Franklin Lakes, NJ) to collect approximately 5 mL of blood by venipuncture. Samples were packed, maintained at a temperature of approximately 4°C, and shipped to the authors for analyses. Upon receipt, the specimens were stored at 4°C until tested. Consistent with the American Association of Blood Bank guidelines,[17] we considered blood specimens to be expired (and they were excluded from the study) if not used within 21 days of collection.

Blood type was determined using industry-standard procedures set forth by the FDA. These involve determining the ABO group for each collection by testing the individual's RBCs with anti-A and anti-B grouping reagents (i.e., forward typing). These results were then confirmed by testing the serum with red cells known to be either group A or group B (i.e., reverse or serum typing). Anti-D blood grouping reagent was used to test RBCs for the presence or absence of D antigen. If the initial test with anti-D was negative, an additional test (i.e., Du test) was performed to distinguish weak D-positive cells from those that are truly Rh-negative. These results served as the golden standard against which the control group (i.e., manufacturer's recommended storage conditions) was compared.

Agglutination Card Rapid Tests

The 2 commercial, field-friendly screening products for determining a donor's ABO type and Rh factor tested in this study were the Eldon Home Kit 2511 and the ABO–Rh Combination Blood Typing Experiment Kit. It should be noted that having received premarket clearance from the FDA [i.e., 510(k)], which is required before a medical device is marketed in the United States, was not a requirement for testing a particular device in this study because the purpose of the research was solely to identify blood typing products whose performance was unaffected by operational environmental exposures during use or by long-term storage. For forward typing, both products were used as per their manufacturers' instructions and as previously described.[15]

Operational Conditions

To simulate environmental conditions based on possible operational scenarios, a walk-in environmental chamber was used (model WP-216-THCM1-3-3; Thermotron Industries, Holland, MI). The testing of the devices for operational environmental conditions was performed inside the enclosed chamber. Laboratory personnel worked in the chamber for intervals limited to 60 minutes. Normal artificial lighting supplied by standard fluorescent bulbs was used in the laboratory, whereas environmental chamber testing was done under incandescent lighting. Before conducting this experiment, all devices were stored under the manufacturer's recommended storage conditions.

To simulate high-temperature environments, the chamber was adjusted to 41°C and 13% relative humidity (RH) and 33°C and 73% RH. For low-temperature environments, the chamber was set to 6°C and 70% RH and 6°C and 35% RH. The chamber's hot-weather settings were chosen by referring to the data gathered during deployments to Kuwait and

Okinawa.[18] The cold-weather settings were determined by reviewing available climatic data for Korea.[19,20] For each set of test conditions, a new group of 396 devices (198 blood samples tested in duplicate) was used.

The control groups were stored and tested under ambient laboratory conditions (20°C–26°C and 27%–58% RH). Because no significant differences were previously found between the results of Eldon Home Kit 2511 and ABO–Rh Combination Blood Typing Experiment Kit (i.e., stored and used in laboratory conditions) and those of the industry standard,[15] the sample size of the control group was decreased. Specifically, 101 blood samples were tested in duplicate on a new group of devices.

Long-term Storage

The Eldon Home Kit 2511 and ABO–Rh Combination Blood Typing Experiment Kit were also tested to determine the effects of prolonged constant-temperature exposure on their accuracy. Kits of both types were placed in an environmental chamber and exposed to constant temperatures (−30°C, −20°C, 4°C, 22°C, 37°C, 45°C, and 50°C) for 1, 3, 6, and 9 months. The environmental chamber was frequently monitored to ensure that the particular set temperature was maintained. For each temperature and time point, 160 test devices were exposed. After the designated storage period, the materials were removed from the chamber and subsequently tested under ambient laboratory conditions (20°C–26°C and 27%–58% RH) according to the manufacturer's instructions. The control groups were stored and tested under the same ambient laboratory conditions.

Statistical Analyses

For the ABO–Rh blood types, differences in rates of positive tests between the control groups and the various environmental test exposure groups were analyzed using the Fisher's exact chi-square method (which is necessary when cell frequencies are at or near 0) to determine if differences existed between 2 independent proportions. This approach was also used to determine whether significant differences existed between the control groups and the industry-standard groups. For all analyses, $p \leq 0.05$ was considered to be significant.

RESULTS

Operational Conditions

There were no significant differences between any of the Eldon Home Kit 2511 groups tested under operational conditions and those stored and tested under laboratory conditions (Table I). With 1 exception (the AB+ group tested at 41°C and 13% RH), none of the exposed ABO–Rh Combination Blood Typing Experiment Kit groups exhibited significant differences compared to those stored and tested under laboratory conditions.

Long-term, Constant-temperature Storage

Temperature monitoring throughout the duration of the experiment indicated that chamber temperatures were maintained within anticipated ranges (Table II).

Prolonged exposure (≤9 months) to a broad range of temperatures (−30°C to 50°C) did not adversely affect the results seen with the Eldon Home Kit 2511 groups compared to those of the respective control groups (i.e., the groups stored under the manufacturer's recommended laboratory conditions; Table III). Also, with the exception of the 3-month B+ control, all the Eldon Home Kit 2511 control groups exhibited no significant difference compared to the industry standard. Along with the 3-month B+ control group, all the other 3-month B+ exposure groups, except for the 4°C group, were significantly different than the industry standard.

TABLE I. Operational Environmental Testing of Commercial Rapid Point-of-care Whole Blood Card Tests for ABO and Rh Blood Typing (Positive Reactions/Number of Devices Tested)

	Blood Type							
Environmental Treatment	A+	A−	AB+	AB−	B+	B−	O+	O−
41°C and 13% RH								
Eldon Home Kit 2511	51/52	48/48	46/46	24/24	56/56	56/56	58/58	56/56
ABO–Rh Combination Blood Typing Experiment Kit	52/52	48/48	37/46*	23/24	54/56	56/56	58/58	56/56
6°C and 70% RH								
Eldon Home Kit 2511	52/52	48/48	46/46	24/24	54/56	56/56	58/58	54/56
ABO–Rh Combination Blood Typing Experiment Kit	52/52	48/48	46/46	24/24	56/56	56/56	58/58	55/55
6°C and 35% RH								
Eldon Home Kit 2511	52/52	48/48	46/46	24/24	52/56	56/56	58/58	56/56
ABO–Rh Combination Blood Typing Experiment Kit	52/52	48/48	46/46	24/24	54/56	56/56	58/58	56/56
33°C and 73% RH								
Eldon Home Kit 2511	52/52	48/48	46/46	24/24	55/56	56/56	58/58	56/56
ABO–Rh Combination Blood Typing Experiment Kit	52/52	48/48	46/46	24/24	56/56	56/56	58/58	56/56
Laboratory Conditions								
Eldon Home Kit 2511	30/30	22/22	26/26	12/12	28/28	32/32	28/28	23/24
ABO–Rh Combination Blood Typing Experiment Kit	30/30	22/22	26/26	12/12	28/28	32/32	28/28	24/24

*$p < 0.02$ when compared to ABO–Rh Combination Blood Typing Experiment Kits stored and tested under laboratory conditions.

In general, the performance of the ABO–Rh Combination Blood Typing Experiment Kits was negatively affected by prolonged exposure to constant temperatures of 37°C, 45°C, and 50°C (Table IV). After 1 month of exposure to 45°C or 50°C, no agglutination was observed in any of the test samples. With the exception of O–, all 45°C or 50°C test groups were significantly different from the control group. After 3 months of exposure, the majority of the 50°C test kits was unusable as the antibodies had solidified. Similarly, the reagents in the kits were solidified after 6 and 9 months of exposure to 50°C. With 3 exceptions (3-month AB+ control, 3-month B+ control, and 9-month AB+ control), none of the ABO–Rh Combination Blood Typing Experiment Kits' control groups exhibited significant differences compared to the results of the industry standard.

TABLE II. Environmental Chamber Temperature Settings and Actual Temperatures (°C)

Temperature Setting	Actual Temperature[a]
−30	−30.1 ± 0.47 (−30.0 to −33.0)
−20	−20.6 ± 2.49 (−16.0 to −24.0)
4	3.8 ± 1.47 (2.0 to 9.0)
22	22.1 ± 0.18 (22.0 to 24.0)
37	36.6 ± 0.18 (36.0 to 37.0)
45	45.0 ± 0.01 (45.0 to 45.1)
50	49.1 ± 2.18 (45.0 to 52.0)
Control	24.0 ± 1.05 (22.0 to 26.0)

[a]Mean ± SD (range).

DISCUSSION

The results seen for the operational testing of the 2 commercial brands of ABO and Rh blood typing products should be reassuring to military users in the field if future studies find them medically and legally acceptable for use. Of the 8 blood-type

TABLE III. Results of Long-term, Constant-temperature Storage on the Eldon Home Kit 2511 (Positive Reactions/Number of Devices Tested)

	A+	A−	AB+	AB−	B+	B−	O+	O−
1 Month								
50°C	22/22	16/16	22/22	10/10	24/24	18/18	24/24	24/24
45°C	22/22	15/16	22/22	10/10	24/24	18/18	24/24	24/24
37°C	22/22	16/16	22/22	10/10	24/24	18/18	24/24	24/24
22°C	20/22	16/16	21/22	10/10	24/24	18/18	23/24	24/24
4°C	22/22	16/16	20/20	10/10	23/24	18/18	24/24	24/24
−20°C	22/22	16/16	22/22	10/10	24/24	18/18	24/24	24/24
−30°C	22/22	16/16	22/22	10/10	24/24	18/18	24/24	24/24
Control	22/22	16/16	22/22	10/10	24/24	18/18	23/24	23/24
3 Months								
50°C	22/24	20/20	26/26	8/8	20/26**	10/10	26/26	20/20
45°C	22/24	20/20	26/26	8/8	20/26**	10/10	26/26	20/20
37°C	22/24	20/20	26/26	8/8	20/26**	10/10	26/26	20/20
22°C	21/24	20/20	26/26	8/8	20/26**	10/10	26/26	20/20
4°C	24/24	20/20	26/26	8/8	22/26	10/10	26/26	20/20
−20°C	22/24	20/20	26/26	8/8	20/26**	10/10	26/26	20/20
−30°C	22/24	20/20	25/26	8/8	19/26**	10/10	26/26	20/20
Control	22/24	20/20	26/26	8/8	20/26***	10/10	26/26	20/20
6 Months								
50°C	22/24	18/18	16/16	6/6	26/26	24/24	22/26	18/20
45°C	22/24	18/18	16/16	6/6	26/26	24/24	26/26	18/20
37°C	22/24	17/18	16/16	6/6	26/26	23/24	22/26	18/20
22°C	22/24	18/18	16/16	6/6	26/26	24/24	24/26	18/20
4°C	22/24	18/18	16/16	6/6	26/26	24/24	26/26	18/20
−20°C	22/24	18/18	16/16	6/6	26/26	24/24	25/26	18/20
−30°C	19/24	18/18	16/16	6/6	26/26	23/24	25/26	15/20
Control	22/24	18/18	16/16	6/6	26/26	24/24	26/26	18/20
9 Months								
50°C	28/28	12/12	28/28	2/2	28/28	6/6	28/28	26/28
45°C	28/28	12/12	28/28	2/2	28/28	6/6	27/28	26/28
37°C	28/28	12/12	26/28	2/2	28/28	6/6	28/28	26/28
22°C	28/28	12/12	26/28	2/2	28/28	6/6	28/28	26/28
4°C	28/28	12/12	26/28	2/2	28/28	6/6	28/28	26/28
−20°C	28/28	12/12	28/28	2/2	28/28	6/6	28/28	26/28
−30°C	28/28	12/12	28/28	2/2	27/28	6/6	28/28	26/28
Control	28/28	12/12	28/28	2/2	28/28	6/6	28/28	26/28

**Sample is significantly different than the industry standard ($p \leq 0.05$). ***Control group sample is significantly different than the industry standard ($p \leq 0.05$).

TABLE IV. Results of Long-term, Constant-temperature Storage on the ABO–Rh Combination Blood Typing Experiment Kit (Positive Reactions/Number of Devices Tested)

	A+	A−	AB+	AB−	B+	B−	O+	O−
1 Month								
50°C	0/10*	0/46*	0/14*	0/18*	0/4*	0/46*	0/4*	18/18
45°C	0/10*	0/46*	0/14*	0/18*	0/4*	0/46*	0/4*	18/18
37°C	10/10	44/46	12/14	12/18	4/4	44/46	2/4	18/18
22°C	10/10	46/46	12/14	16/18	4/4	44/46	4/4	18/18
4°C	10/10	45/45	12/14	16/18	4/4	44/46	4/4	18/18
−20°C	10/10	46/46	12/14	18/18	4/4	44/46	4/4	18/18
−30°C	10/10	46/46	12/14	18/18	4/4	44/46	4/4	18/18
Control	8/10	24/24	12/14	4/4	4/4	20/20	4/4	ND
3 Months								
50°C	0/17*	0/2*	—	0/2	—	—	—	—
45°C	0/24*	0/20*	0/26*.**	0/8*	0/26*.**	0/10*	0/26*	20/20
37°C	0/24*	0/20*	0/26*.**	0/8*	0/26*.**	0/10*	0/26*	20/20
22°C	17/24	20/20	18/26**	5/8	20/26**	10/10	26/26	20/20
4°C	23/24	20/20	26/26*	7/8	22/26	10/10	26/26	20/20
−20°C	22/24	20/20	26/26*	6/8	20/26**	10/10	26/26	20/20
−30°C	21/24	20/20	23/26	8/8	20/26**	10/10	26/26	20/20
Control	20/24	18/20	18/26***	6/8	19/26***	10/10	26/26	20/20
6 Months								
50°C	—	—	—	—	—	—	—	—
45°C	0/24*	0/16*	0/4*	—	0/26*	0/2*	0/26*	20/20
37°C	0/24*	0/18*	0/16*	0/6*	0/26*	0/24*	0/26*	20/20
22°C	22/24	18/18	11/16*	6/6	26/26	24/24	25/26	18/20
4°C	22/24	18/18	16/16	6/6	26/26	24/24	25/26	18/20
−20°C	22/24	18/18	16/16	6/6	26/26	24/24	26/26	18/20
−30°C	22/24	18/18	16/16	6/6	26/26	24/24	24/26	18/20
Control	22/24	18/18	16/16	6/6	26/26	24/24	25/26	18/20
9 Months								
50°C	—	—	—	—	—	—	—	—
45°C	0/28*	0/12*	0/28*.**	0/2	0/28*	0/6	0/28*	28/28
37°C	0/28*	0/12*	0/28*.**	0/2	0/28*	0/6	0/28*	28/28
22°C	28/28	12/12	22/28**	2/2	22/28	5/6	28/28	28/28
4°C	27/28	12/12	26/28	2/2	27/28	6/6	28/28	28/28
−20°C	28/28	12/12	27/28*	2/2	28/28	5/6	28/28	26/28
−30°C	28/28	12/12	28/28*	2/2	26/28	6/6	28/28	27/28
Control	28/28	12/12	20/28***	2/2	26/28	4/6	28/28	26/28

Groups whose results are denoted by a dash (—) could not be tested because the kit was unusable (i.e., the antibody component had solidified as a result of storage). *Sample is significantly different than the control group sample ($p \leq 0.05$). **Sample is significantly different than the industry standard ($p \leq 0.05$). ***Control group sample is significantly different than the industry standard ($p \leq 0.05$).

groups tested for each product under each of the 4 temperature and RH test conditions, only one was significantly different than its control group. Specifically, the ABO–Rh Combination Kit AB+ group tested at 41°C and 13% RH had 9 discrepancies. For all these discrepancies, the results indicated B+, suggesting that the anti-A reagent was adversely affected by the operational condition. It is difficult to explain the result seen for this group as the A+ samples did not differ significantly from the laboratory control conditions. Moreover, laboratory procedures were carefully standardized and followed to avoid variation, and no unusual circumstances were observed during testing that might explain the result. As previously reported with the ABO–Rh Combination Blood Typing Experiment Kit, it is possible that these differences are due to batch-to-batch variability.[15]

Although the 2 commercial blood typing products used in this study under simulated real-world environmental conditions generally yielded accurate results, the ABO–Rh Combination Kits proved to be less accurate after long-term storage, especially at high temperature. This finding is consistent with those of a previous study, which evaluated the effect of relatively short-term storage.[15] The fact that high-temperature, long-term storage affected this product but not the Eldon Home Kit 2511 may be due, at least in part, to its operational design. In the case of the ABO–Rh Combination Kits, the antibody component is provided in a liquid state, which must be applied to the blood sample during testing. The Eldon Home Kit 2511 product, on the other hand, uses test cards precoated with the antibodies, which are then rehydrated during testing. Being in dehydrated form, the antibody solutions are more stable.

The ABO–Rh Combination Kits produced an unexpected result for the O– blood group when tested after long-term, high-temperature storage. After storage for any duration (i.e., 1 month or longer), if the reagents had not solidified and were still usable, the test results for O– blood type were consistently correct, unlike the results seen with the 7 other blood type groups. These findings are probably due to the fact that the O– blood type, unlike the others, does not agglutinate when tested. All the other blood types show 1, 2, or 3 agglutination reactions. It appears that this blood sample was identified as being O–, not because the post-storage reagents were effective and produced the correct result (i.e., nonagglutination) but because they were inactive and could not cause agglutination even if the sample normally would agglutinate when tested. This finding has considerable potential clinical importance because of the role O– plays as the universal donor. If misidentified and provided to a patient, the potential exists for a fatal hemolytic reaction during transfusion. This finding, therefore, adds greater significance to the earlier finding that high-temperature storage negatively affects the accuracy of the ABO–Rh Combination Kits.

One final result of the storage testing of the 2 blood typing kits bears mentions because it deals with the overall accuracy of these products. For 4 of the blood-type groups tested (3-month B+ for the Eldon Kits; 3-month AB+ and B+ and 9-month AB+ for the ABO–Rh Combination Kits), the results for the control groups were significantly different from those of the industry standard. For the Eldon Kits tested after 3 months, the control group exhibited 4 Rh-type errors and 2 ABO-type errors. Of the collective abovementioned errors observed with the ABO–Rh Combination Kits, 7 of 23 were Rh-type errors and 16 were ABO-type errors. Of the latter, 14 errors were attributed to the failure of the anti-A reagent (i.e., AB+ samples that yielded B+ result). Since these results were in the minority for all groups tested with the products, reasons were sought to explain the findings. It was determined that the blood used for testing these blood types was from 2 particular shipments; however, the blood sample provider could not identify anything unusual about the collection procedure or typing that might bear on the results of our study. The finding may be due to a weak anti-A response or anti-D response in these particular blood samples. Standards for blood banks and transfusion services by the American Association of Blood Banks require that, if the initial test with anti-D reagent is negative, the blood is tested using a method that is designed to test weak antigen D. When either test is positive, the blood sample is deemed to be Rh-positive.[17] Limitations present in a field setting may not allow confirmatory testing.

As with most research, there are always ways of improving the design or process of the work. One variable that might affect results seen with these products is the lighting available for reading the cards after use. All cards for the operational testing were read under laboratory lighting rather than under lighting used in an actual field facility. Although many field hospitals or treatment facilities use fluorescent light fixtures, it is possible that incandescent lighting may be used. Also, depending on the field facility, lighting may be uneven or inadequate, and so there is the chance that cards will be examined under less-than-optimal lighting conditions. Future testing of the operational use of these products, which requires some subjectivity in reading the results, may be better conducted under actual field conditions. Another potentially fruitful area of research would be to determine whether the products' accuracy is affected by a combination of long-term storage under various temperature/humidity conditions and use in a real-world field environment. Lastly, studies that assess variable performance between lots/batches of these products are likely to yield valuable information that can be utilized in a deployed environment.

CONCLUSIONS

Under the conditions of this study, 2 commercial blood typing products produced accurate results when used under temperature and humidity conditions typically encountered in the field. However, long-term storage at high temperatures adversely affected the use and accuracy of the ABO–Rh Combination Blood Typing Experiment Kit.

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