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Letter to Editor

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An active transport refrigerator is optimal for blood preservation in small medical facilities

Abstract

Objective: In small medical institutions in Japan, red blood cell (RBC) solutions are commonly stored in household refrigerators because of the high cost of blood-only refrigerators. Therefore, we assessed and compared the methods used for preserving the RBC solutions in an active transport refrigerator (ATR), a blood-only refrigerator, and a household refrigerator.

Materials and methods: Irradiated RBC solution samples (280 mL) supplied by the Japanese Red Cross Society (experiments 1–8) and in-house whole blood waste (experiments 9–10) were each divided into two bags. The quality of blood stored in an active transport refrigerator was compared with that of blood stored in a blood-only refrigerator or a household refrigerator. We tested the hemolytic effects of storage and filtration through a transfusion set on the lactate dehydrogenase ratio (LDR) of the RBC solutions.

Results: Although the LDR of the RBC solutions stored in the ATR was similar to that of the RBC solutions stored in the blood-only refrigerator, the LDR of the RBC solutions stored in the household refrigerator was significantly higher than that of the RBC solutions stored in the ATR.

Conclusion: Temperature management using an ATR is critical for the maintenance of the quality of the RBC solution, which is not achieved by a household refrigerator.

Keywords: home transfusion, red blood cell solution, hemolysis

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Letter to the editor

In Japan, the required temperature during storage of red blood cell (RBC) solution is 2-6°C. We have previously reported that an active transport refrigerator (ATR) (FUJIFILM Toyama Chemical Co. Ltd., Tokyo, Japan) is optimal for the long-distance transportation of RBC solution from Tokyo to the Ogasawara Islands by ship.[1] Cross-matching tests are usually performed before transfusion; however, small medical institutions lack testing laboratories.[2] Therefore, it takes a few days to match the results, and the RBC solution is stored in small medical institutions. In this study, we compared the preservation of RBC solution using an active transport refrigerator (ATR), a blood-only refrigerator (Blood Bank refrigerator; Sanyo, Tokyo, Japan), and a common household refrigerator (Mitsubishi Co. Ltd., Tokyo, Japan). Irradiated RBC solution samples (280 mL) obtained from the Japan Red Cross Society were each divided into two bags (experiments 1–8). We assessed and compared the quality of these solutions after being stored in an ATR (control group) and a blood-only refrigerator or a household refrigerator (study group). While the ATR and blood-only refrigerator have a system of recording the inside temperature, the household refrigerator has an electronic watch logger (TR-5i, T&D Co. Nagano, Japan), which records the temperature. The RBC solution was always taken from the refrigerator to perform the cross-matching test for a short time, and 10 min at room temperature was determined in this study.

This study included 10 trial and blood tests. The study was approved by the Institutional Review Board of the Tokyo Metropolitan Bokutoh Hospital.

We compared the quality of the stored blood in the control and study groups based on the levels of lactate dehydrogenase (LD), aspartate aminotransferase (AST), potassium, blood sugar, lactate (LA), ammonia, and hematocrit. These were measured by Biomedical Laboratories Company (Tokyo, Japan). Because only LD measurements were specific and sensitive for comparison,[3] we showed the LD and LA, and the other measurements were not significantly different between the control and study groups (data not shown). We calculated the LD ratio (LDR) as follows:

(LD level after storage or filtration – mean LD level before storage or filtration) ÷mean LD level before storage or filtration × 100 (%).

LA ratio also was shown using the same calculation. Table 1 shows the hemolytic effects of storage in an ATR with/without 10-min storage at room temperature and filtration through a transfusion set (Terumo Co. Lt., Tokyo, Japan) on the LDR of the RBC solutions. Furthermore, we examined the LDR of the RBC solutions stored for several days in an ATR (control group), a blood-only refrigerator, and a household refrigerator (Table 2). In experiments 9–10, two bags of RBC solution (experiment 9: irradiated RBC solution; experiment 10: non-irradiated RBC solution) collected from in-house whole blood waste were stored in an ATR (control group) and a household refrigerator (study group).

First, we examined the effects of storage for 10 min at room temperature on the LDR after storage or filtration (experiments 1–4), as shown in Table 1. Compared to the control group, the LDR of the RBC solutions stored for 10 min at room temperature did not increase post-stored LDR; however, it increased the post-filtered LDR (LDR post-filtered significantly increased slightly among four bags, experiments 1–4).

Similar results were seen in a comparison of the LDR after storage or filtration between ATR control group and blood-only refrigerator group (Table 2, experiments 5–8). RBC solutions were stored in a place that dropped to -10°C to 7°C to cool the entire air

in the household refrigerator. The LDR of RBC solutions stored in the household refrigerator significantly increased than that of RBC solutions stored in the ATR; however, LDR of the RBC solutions after filtration did not increase (Table 2, experiments 9–10).

Table 1 Effects of storage for 10 min at room temperature on the lactate dehydrogenase and lactate ratio of the red blood cell solution

Experiment no. (storage day#)	Blood type	Storage for 10 minutes at room temperature	% increase of LD after two days	Post-filtered % increase of LD	% increase of lactate after two days
Exp. 1 (Day 7-9)	A RhD (+)	Yes (study group) No (control group)	−10±2* 27±1	40±1* 30±2	30±4* 18±1
Exp. 2 (day 8-10)	B RhD (+)	Yes (study group) No (control group)	57±0 69±1	57±1* 50±1	16±1 19±1
Exp. 3 (day 8-10)	B RhD (+)	Yes (study group) No (control group)	-4±2* 5±1	58±1* 44±1	10±2 15±4
Exp. 4 (day 8-10)	B RhD (+)	Yes (study group) No (control group)	11±2 17±1	65±3* 43±1	20±2* 9±3

Day means from phlebotomy to the experiment. LD: Lactate dehydrogenase

Data (n = 4) are expressed as group mean±standard error. All statistical calculations were performed using JMP version 8.0 software (SAS Institute, Inc., Cary, NC). We tested for differences in the baseline characteristics between the control group and the study group using Wilcoxon' s test. A *P*-value of <0.05 was considered statistically significant (*)

Table 2 Comparison of lactate dehydrogenase and lactate ratio in the red blood cell solution between the active transport refrigerator and the household refrigerator

Experiment no. (storage day)	Blood type	group	% increase of LD after storage	Post-filtered % increase of LD	% increase of lactate after storage
Exp. 5 (Day 6-8)	A RhD (+)	ATR (control) Blood-only refrigerator	−3±1* 9±2	50±2* 31±1	18±4 18±2
Exp. 6 (day 4-6)	A RhD (+)	ATR (control) Blood-only refrigerator	3±2 8±1	42±1* 57±4	28±1 32±1
Exp. 7 (day 7-9)	B RhD (+)	ATR (control) Blood-only refrigerator	2±1* 8±1	15±1* 21±1	15±2 20±2
Exp. 8 (day 5-7)	O RhD (+)	ATR (control) Blood-only refrigerator	4±2 13±4	29±2* 13±1	17±1* 40±2
Exp. 9 (day 6-8)	A RhD (+)	ATR (control) Household refrigerator	290±2* 400±3	2±2* -2±0	Not examined
Exp. 10 (day 6-15)	A RhD (+)	ATR (control) Household refrigerator	32±1* 108±1	1±1 1±0	Not examined

Day means day from phlebotomy to the experiment. LD: Lactate dehydrogenase

Data (n = 4) are expressed as group mean±standard error. All statistical calculations were performed using JMP version 8.0 software (SAS Institute, Inc., Cary, NC). We tested for differences in the baseline characteristics between the control group and the study group using Wilcoxon' s test. A *P*-value of <0.05 was considered statistically significant (*)

In conclusion, we have shown that inadequate temperature management during storage in a household refrigerator can increase the risk of hemolysis of RBC solution. Additionally, ATR is optimal for storage in small medical institutions and its efficiency is similar to that of the blood-only refrigerators. We have also previously reported that transportation by drones and cars can increase the LD levels in RBC solutions in the ATR.[3–5] Therefore, RBC solutions should be stored in an ATR in medical institutions for home transfusion.

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Conflicts of interest

The authors have no conflicts of interest to declare.

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