

# Initial trial on the transport of blood products using an unmanned aerial vehicle (UAV) in Japan in preparation for a disaster

## Abstract

**Objective:** We determined to examine the effects of transport by unmanned aerial vehicle (UAV) on quality of red blood cell solution.

**Materials and methods:** Two bags of RBC solution (RBC#1 and #2; 1 bag: 280 mL) were supplied from Japan Red Cross Society. RBC solution was separated into two bags (1 bag: 140 mL). UAV group implies the RBC solution in an ATR (FUJIFILM Toyama Chemical Co. Ltd., Tokyo) transported by UAV. Control group implies the RBC solution in another ATR, not flown. In sampling from RBC solution at day 11 (four days before transport), day 16 (day after transport), lactate dehydrogenase (LD), potassium, blood sugar, lactic acid, and pH were measured.

**Results:** We compared the biochemistry between UAV and the control group and observed no significant differences. Although the lactate dehydrogenase (LD) level in the UAV group slightly increased, the LD level post-filtration was very similar between the UAV and control groups.

**Conclusion:** In conclusion, we could fly and transport the ATR containing an RBC solution using a UAV, and the transport by UAV did not significantly affect the quality of the RBC solution.

Volume 7 Issue 3 - 2019

Koki Yakushiji,<sup>1</sup> Fumiatsu Yakushiji,<sup>2</sup> Hiroshi Fujita<sup>3</sup>

<sup>1</sup>Faculty of Policy Management, Keio University, Japan

<sup>2</sup>Department of Internal Medicine, Tokyo Metropolitan Bokutoh Hospital, Japan

<sup>3</sup>Department of Transfusion Medicine, Tokyo Metropolitan Bokutoh Hospital, Japan

**Correspondence:** Hiroshi Fujita, MD, PhD, Director of Department of Transfusion Medicine, Tokyo Metropolitan Bokutoh Hospital, 4-23-15, Koutoubashi, Sumida-ku, Tokyo, 130-8675, Japan, Tel 81-3-3633-6151, Fax 81-3-3633-6173, Email [hiroshi\\_fujit@tmh.jp](mailto:hiroshi_fujit@tmh.jp)

**Received:** November 07, 2019 | **Published:** November 27, 2019

## Dear editor

Transportation of blood products using an unmanned aerial vehicle (UAV) has been reported in America and Africa.<sup>1-2</sup> In Japan, blood products are usually transported by car. However, occasionally, it is not possible to transport the blood products by car due to heavy snowfall or flooding. Therefore, we tried to transport an active transport refrigerator (ATR) containing a red blood cell (RBC) solution, weighing approximately 8 kg, using a UAV.<sup>3</sup> We previously reported the long-distance transport of an RBC solution from Tokyo to Ogasawara islands using an ATR.<sup>4</sup> We could safely move the ATR at a maximum height of 30 m, for moderate distances of up to 1 km.<sup>3</sup>

In this letter, we show the data from the experiment performed in the Fukushima Robot Test Fields.<sup>5</sup> Two bags of RBC solution (day 15) were transported in an ATR, using a UAV for 600 m at the maximum height of 2 m and an average speed of 8 km per hour (Figure 1). The temperature in the ATR was maintained at 4°C during transportation. We compared the biochemistry between UAV and the control group and observed no significant differences (Table 1). Although the lactate dehydrogenase (LD) level in the UAV group slightly increased, the LD level post-filtration was very similar between the UAV and control groups (Table 1).

In conclusion, we could fly and transport the ATR containing an RBC solution using a UAV, and the transport by UAV did not significantly affect the quality of the RBC solution. Therefore, we envisage the possibility that blood products will be transported by UAV in the event of a disaster, such as flooding or heavy snowfall, in Japan.



**Figure 1** Unmanned aerial vehicle (UAV) hung and transported the active transport refrigerator (ATR) containing red blood cell solution in the Fukushima Robot Test Field.

UAV (MI1000, Mazex Co. Ltd. Osaka) safely hung and transported the ATR containing RBC solution in the Fukushima Robot Test Field, where the driving UAV was trained. The ATR was transported by hanging, because the UAV may return after delivering the ATR to the disaster area. The study design was approved by the ethics review board of each institution.

**Table 1** Comparison of biochemistry of red blood cell solution between unmanned aerial vehicle (UAV) and control group

	Day 11		Day 16	
	Control	UAV	Control	UAV
pH (N=3)				
RBC #1	6.623±0.002	6.635±0.002	6.545 ±0.001	6.546±0.002
RBC #2	6.570±0.003	6.553±0.003	6.495±0.003	6.504±0.002
Lactic acid (mg/dL) (N=4)				
RBC #1	155.2±4.4	155.5±2.6	201.2±11.1	201.8±4.1
RBC #2	168.2±5.4	165.0±5.9	185.0±5.4	195.6±6.5
Blood sugar (mg/dL) (N=3)				
RBC #1	337.3±0.6	327.8±2.5	288.7±0.6	287.7±3.8
RBC #2	332.0±3.5	342.3±7.0	295.6±4.9	306.3±6.4
Potassium (mmol/L) (N=4)				
RBC #1	44.5±0.3	44.2±0.2	52.4±1.5	52.4±1.4
RBC #2	49.8±0.1	50.3±0.6	57.1±1.7	57.5±1.8
LD (IU/L) (N=4)				
RBC #1	50.3±6.0	57.0±2.0	77.5±14.5	99.5±10.4
Post-filtration*			96.8±9.8	91.3±4.5
RBC #2	85.8±5.1	72.5±0.6	109.0±6.0	122.5±8.1
Post-filtration*			126.3±4.0	127.8±8.5

\* Post-filtration implies that the RBC solution was passed through a transfusion filter (Terumo Co.Tokyo), used at the transfusion practice. Data are expressed as group mean ± standard deviation of the mean.

## Acknowledgments

None.

## Conflicts of interest

The authors have disclosed no conflicts of interests.

## References

1. Amukele T, Ness PM, Tobian AA, et al. Drone transportation of blood products. *Transfusion*. 2017;57:582–588.
2. Drone delivery of blood products in South Africa. *Transfusion News*. BioRad. June 12, 2019.
3. Clinical research in Tokyo Metropolitan Bokutoh Hospital (in Japanese).
4. Igarashi T, Fujita H, Asaka H, et al. Patient rescue, and blood utilization in the Ogasawara blood rotation system. *Transfusion*. 2018;58(3):788–794.
5. Fukushima Robot Test Field (in Japanese).