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The Effect of Storage Duration on Hemoglobin and Hematocrit Levels of Packed Red Cell (PRC) Products

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ABSTRACT

Packed Red Cell is derived from Whole Blood which is precipitated by high-speed centrifugation during the storage period.In general, the indications for using PRC are for patients with hemolytic anemia, acute leukemia, chronic leukemia, malignancy, thalassemia, and chronic kidney failure. This study aims to determine the average hemoglobin and hematocrit levels of Packed Red Cell (PRC) blood products during the 1-day and 35-day storage period which was carried out at Indonesian Redcross, Padang region. This researchwas a quasi-experimental study. The research design uses a modified time-series design or Time Series Design with Non-Randomized one-group pretest-posttest design. The results showed that the average level of hemoglobin on day 1 was 55.38g/unit and Hematocrit 69.40%.While the average levels on day 35 for hemoglobin are 59.72 g/unit and hematocrit is 74%.Independent T-test revealed mean different of the levels of hemoglobin and hematocrit on the storage period of Packed Red Cell (PRC) blood products on day 1 and day 35 are 0.00 (<0.05), means that there is a significant effect of duration of storage on the levels of hemoglobin and hematocrit in PRC.

Keywords: *Packed Red Cell (PRC), Quasy Experiment, storage period.*

1. BACKGROUND

Blood transfusion service is a health service that utilizes human blood as a basic need for humanitarian purposes. Blood transfusion services as one of the health efforts in the context of healing diseases and restoring health require the availability of blood or its components that are sufficient, safe, easily accessible, and affordable by the community. Blood and its products play an important role in health services; the availability, safety, and ease of access to them must be guaranteed [1].

Blood transfusion is usually conducted by giving Whole Blood (WB), Packed Red Cell (PRC), or blood components as needed. Based on the annual report of the Blood Transfusion Unit (UTD) of the Indonesian Red Cross (PMI) Padang City in 2019, the use of Packed Red Cells (PRC) blood components was 32,228 (59%) out of 64,676 all requests for blood for transfusion[2]. It shows that the need for Packed Red Cell (PRC) products in blood transfusions was higher.

Packed Red Cells are derived from Whole Blood deposited by high-speed centrifugation during the restoration period.Most of (>65%) of the plasma is removed. In general, PRC is widely used for anemic with no decrease in blood volume, for example, patients with hemolytic anemia, acute leukemia, chronic leukemia, malignancy, thalassemia, chronic kidney failure [3].

PRC is the most important blood product that can be stored for about 35-42 days in the blood bank and is the most widely administered therapy in the world.The quality of PRC during storage must be maintained even though there are changes in morphology, biochemistry, and metabolism called storage lesions. Oxidative damage is thought to be the most important factor in storage lesions caused by free radicals and reduces the quality of stored erythrocytes [3].

Blood stored outside the body (in the blood bag) conditions are very different from conditions in the body. During restoration, erythrocytes will undergo biochemical and structural changes that will affect their viability

and function after transfusion. The longer the blood is stored, the bigger amount of red blood cells destroyed and the smaller the number of erythrocytes that can survive resulting in the decreasing number of hemoglobin levels due to the hemolysis process in erythrocytes. The loss of vitality of stored erythrocytes can be caused by the stiffness of the erythrocyte membrane and loss of lipids in the erythrocytes, leads the membrane to becomes stiff and changing of its shape from disc to spherical, because erythrocytes are damaged, the hemoglobin in erythrocytes will be released into the surrounding fluid (plasma) resulting in hemolysis[4].

To maintain the quality of blood, the blood storage process must meet the requirements set by the Ministry of Health of Indonesia, which is stored in a refrigerator with a temperature of 2-6 C and this temperature must be controlled every day by the officers 3 times a day.Blood is stored with the First in First Out (FIFO) system, which is a system that regulates expenditure where the first blood that enters is the first to be used [5].

Research conducted by Dr. Saragih concluded that there was an insignificant increase of hemoglobin and hematocrit levels in Packed Red Cell (PRC) during seven days of storage [3]. Based on the foregoing, the effect of storage duration on hemoglobin and hematocrit levels in Packed Red Cell (PRC) at the beginning and end of the restoration (on day 1 and 35) and using more samples of PRC is still insufficiently represented in the literature.

2. METHODS

This study is a quasi Experimental research with Time Series Design and Non-Randomized one-group pretest-posttest design.Samples used in this study were obtained by using the Federer formula using the purposive sampling technique. A total of 16 PRC products were, inspected 2 times each, on day-1 and day-35 of the restoration.

This study using the automatic analyzer method. Erythrocytes were lysed using cell lysis, this process will allow hemoglobin to react with SLS reagents to become SLS Hb, the SLS Hb absorption will be measured by a spectrophotometer inside the device and automatically compared to the calibrator curve, the results will be displayed on the device screen.The data were collected from the measurement tools counted hemoglobin and hematocrit levels before being stored, on the first day of blood collection. The blood samples were then stored for 35 days in the Cooler room with a temperature of 2-6 C and then examined using the Sysmex XP100 tool. the research was conducted in the Blood Transfusion Unit of Indonesia Red Cross in Padang City, Indonesia. Data were analyzed using a t-test to seek the effect of PRC storage time on changes in hemoglobin and hematocrit levels.

3. RESULT

3. 1 Average Levels of Hemoglobin and Hematocrit of PRC Blood Products During the restoration of Day-1.

Table 1 Average Hemoglobin and Hematocrit Levels of PRC Blood Products in Day-1 restoration

	N	Max	Min	Mean
hemoglobin level	16	59.92	50.54	55.38
hematocrit level	16	71.50	67.30	69.40

Based on table 1, the results showed that the average hemoglobin level on day 1 was 55.38 g/unit, hematocrit level was 69.40%, maximum and minimum value of hemoglobin level on day 1 was 59.92 g/unit and 50.54 g/unit. The maximum value of hematocrit was 71.50% and the minimum was 67.30%.

3.2 Average Hemoglobin and Hematocrit Levels of PRC Blood Products Day-35 of restoration.

Table 2 Average Hemoglobin and Hematocrit Levels of PRC Blood Products at day-35 of restoration

	N	Max	Min	Mean
hemoglobin level	16	67.12	54.20	59.72
hematocrit level	16	75.00	72.50	74.00

Based on table 2, the results showed that the average hemoglobin level on day 35 was 59.72 g/unit, hematocrit level was 74.00%. These levels are considered to be within normal limits (hemoglobin level is 45 g/unit, the hematocrit level is 65-75%). The maximum and minimum value of hemoglobin level on day 35 was 67.12g/unit and 54.20 g/unit. The maximum value of hematocrit was 75.00% and the minimum was 72.50%.

3.3 Effect of restoration on hemoglobin and hematocrit levels at the beginning and end of storage.

Table 3 hemoglobin and hematocrit levels at the beginning and end of storage

	Storage period	Mean	SD	T-Test	
				Degrees of Freedom (df)	Sig
Hemoglobin Level (≥45 g/unit)	Day-1, Day-35	39.55	15.43	32	0.00
Hematocrit Level (65-75%)	Day-1, Day-35	53.7	14.96	32	0.00

Based on table 3, it is found that the p-value of hemoglobin and hematocrit levels on the shelf life of Packed Red Cell (PRC) blood products on day 1 and day 35 is 0.00 (p-value < 0.05), which means there is a difference in the effect of storage duration on hemoglobin and hematocrit level. However, the difference is not too significant confirming that the blood products (PRC) are still safe to be used.

4. DISCUSSION

4.1 Average Levels of Hemoglobin and Hematocrit of PRC Blood Products During the restoration of Day-1

the average hemoglobin level on day 1 was 55.38 g/unit, hematocrit level was 69.40%. This result is in corresponding with the established standards where the hemoglobin level is 45 g/unit and the determined hematocrit value is in the range of 65-75%. The current research found that hemoglobin and hematocrit levels on the day-1 restoration were within normal limits, indicating the blood products were still fresh and[6].

4.2 Average Hemoglobin and Hematocrit Levels of PRC Blood Products Day-35 of restoration

The average hemoglobin level on day 35 was 59.72 g/unit, hematocrit level was 74.00%. These levels are considered to be within normal limits (hemoglobin level is 45 g/unit, the hematocrit level is 65-75%) and still available to be restored[7]. It is can be assumed that there is a slight increase in the hemoglobin and hematocrit levels during storage, even though the values are relatively small and do not exceed normal limits. This phenomenon could be caused by the decrease in ATP levels. During the storage period, the decrease in ATP levels result in damage to membrane lipids, causing the membrane to become rigid and resulting in the entrapment of plasma.

4.3 Effect of restoration on hemoglobin and hematocrit levels at the beginning and end of storage

there is a difference in the effect of storage duration on hemoglobin and hematocrit levels on day 1 and day 35 (p-value 0.00(<0.05)). Changes in hemoglobin levels towards the storage time in the PRC showed fluctuations. Hemoglobin values which tended to increase on day 35 proven that there was no destruction of erythrocytes during the storage process. This condition also occurs in hematocrit because hematocrit is a function of hemoglobin concentration [8].

The increase in hemoglobin and hematocrit levels during storage may be due to a decrease in ATP levels[9]. During storage, decreased ATP levels result in damage to membrane lipids, causes the membrane to become stiff and reads to plasma entrapment.

The findings of the current study are consistent with previous studies by Karon et al., and Spinelli et al., United States which proved that an increase in free Hb and F2α-isoprostane levels occurred during PRC storage[10]. This fact is predicted due toa contributing factor to poor outcomes in PRC transfusion recipients although the underlying mechanism is not fully known.

5. CONCLUSION

The restoration of PRC and blood products have a significant effect on the levels of hemoglobin and hematocrit. Therefore, it is required to save the blood products based on the storage guideline. It is suggested that the blood products be used at the early phase of the storage period. However, with the best procedures of restoration, the 35 days of restoration are still considered to be safely used.

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