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Research article

Analysis of Packed Red Cell (PCR) storage time against changes in routine blood values in the blood donor unit of Indonesian Red Cross Society Medan City

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Abstract

Background: Unit for Blood Donors, The Indonesian Red Cross Society of Medan City has established a two-day maximum storage period for PRC that has been processed from Whole Blood (WB). The quality of the blood is affected by how long the PCR is stored. **Objective**: To analyze the effect of Packed Red Cell (PRC) storage time on changes in routine blood values. **Method**: This type of research is a quantitative analytical study with comparative numerical more than two groups to analyze the storage time of PRC blood on changes in routine blood values. **Result**: 40 study participants participated in the investigation. Leukocytes, hemoglobin, and haematocrit were the measured parameters. The value of the erythrocyte decreases with storage time. The value of the erythrocytes was lower when compared to the storage of erythrocytes on day 11 than it was on day 1 of storage. When the haemoglobin examination findings have a p-value of less than 0.05, this means that the haemoglobin against PRC storage on day 1 and day 1 differ significantly. If the storage time is prolonged, the haemoglobin value will rise. P-value 0.05 for the findings of the analysis of haematocrit levels shows a significant difference between PRC storage on days 1 through day 11 and haematocrit, with the haematocrit value rising as storage duration increases. **Conclusion**: Haemoglobin and haematocrit levels, there was a significant increase in changes and erythrocytes during the eleven-day storage process, a significant decrease but still within normal limits.

Introduction

In today's modern health service, blood transfusion is an important part. Blood transfusion is transferring blood or blood components from one person (donor) to another person (recipient). Blood that was transferred can be whole blood and blood components. Blood transfusion currently plays an essential medical role in emergency therapy and particularly diseases requiring continuous transfusion therapy [1].

The concentrated red blood cells, commonly called Packed Red Cells (PRC), are derived from Whole Blood, which is precipitated during storage or by high-speed centrifugation. Most (2/3) of the plasma is removed. One PRC unit from 450 ml of whole blood has a 200-250 ml volume with a hematocrit level of 70-80%, plasma volume of 15-25 ml, and an anticoagulant volume of 10-15 ml. The storage time for this PRC is the same as for WB. In general, the use of PRC for anaemia patients who are not accompanied by a decrease in blood volume, for example, patients with hemolytic anaemia, acute leukaemia, chronic leukaemia, malignancy, thalassemia, chronic kidney failure [2].

Blood storage is still carried out in the blood donation unit because the blood donation unit cannot provide fresh blood to meet the patient's needs. Plasticized Polyvinyl Chloride (PVC) bag with Diethyl hexyl phthalate (DEHP) is the standard container for storing donor blood. The DEHP bag reduces hemolysis during blood storage by intercalation to the RBC membrane [3].

Based on previous research, it was found that the shelf life of PRC for several days days showed an increase in haemoglobin levels but not so significantly, and this shows

that there is no destruction of erythrocytes during the storage process [4]. This condition also occurs in hematocrit because hematocrit is a function of haemoglobin concentration. The reason why haemoglobin and hematocrit increase during storage is unclear [5].

Requests for patient needs that come in through Hospital Blood Banks (HBB) requests to the Indonesian Red Cross Society Medan Blood Donor Unit cover 70% of the PRC components, while the rest are other blood components. Several HBB in collaboration with Blood Donor Unit Indonesian Red Cross Society of Medan City impose a maximum time limit for storing PRC that has been processed from Whole Blood (WB), which is two days from processing PRC, but some ask for a maximum of 7 days from processing. HBB imposes a time limit on the shelf life of PRC in order to prevent harmful side effects from occurring. The blood bags used at Blood Donor Unit Indonesian Red Cross Society Medan City use the anticoagulant citrate phosphate dextrose adenine (CPDA1). Blood stored using this blood bag can be stored for up to 35 days at a temperature of 2-6˚C.

Blood Donor Unit Indonesian Red Cross Society Medan City cannot always provide new PRC requests as requested by HBB because it is not every day that donors come to the building or hold mobile unit events. For this reason, researchers want to research the actual storage time of PRC to what extent it is still feasible to use by looking at changes in normal blood values.

Material and Method

This type of research is a quantitative analytical study with numerical comparatives of more than two groups to analyze the storage time of PRC blood on changes in normal blood values. The research location was conducted at the Blood Donor Unit of the Indonesian Red Cross Medan City, held in March – April 2021.

Population and Samples

The population of this study was all volunter donors who came to Blood Donor Unit Indonesian Red Cross Society Medan City in for 30 days in March 2021. 40 donors were collected as samples who meet inclusions criteria without sex criteria. The sample in the study can be divided into two, namely inclusion criteria and exclusion criteria. The sample criteria in this study are:

A. Inclusion criteria

1. Voluntary donors who come to Blood Donor Unit Indonesian Red Cross Society Medan City.
2. Donors who meet the criteria for blood donation.
3. Voluntary donors who are willing to become respondents by signing informed consent.
4. Whole bloodstock < 24 hours.
5. Whole blood free from infectious infections through blood transfusions, namely HIV, Syphilis, Hepatitis B, and Hepatitis C.

B. Exclusion criteria

1. Donors from the patient's family who came to Blood Donor Unit Indonesian Red Cross Society Medan City.
2. Donors who are not willing to participate in the study.

Sampling method

Sampling with purposive sampling technique. Purposive sampling is sampling based on specific considerations made by the researcher himself, based on the characteristics or characteristics of the population that have been known previously [6]. The number of samples to be studied will be taken from the population, and then samples will be taken according to the type of donor blood group. For the sample size with this method, the sample size will be determined by the researcher [6]. In this study, the researcher will take ten samples for each type of blood group, namely blood types A, B, AB and O. The sample is by considering certain types, characteristics or criteria. The ethical clearance of this research has been approved by Research Ethics Committee, University of Prima Indonesia in 2021.

Research materials and tools

The tools used in this study were: Blood bag with CPDA-1 anticoagulant, Hematology Analyzer SYSMEX XP-300, EDTA tube, Refrigerator, KUBOTA centrifuge, Hand sealer, Plasma extractor, and plastic clamps. Materials were used in this study are whole blood in a blood bag containing anticoagulants

Procedure

1. As an initial screening, the subject must meet the requirements as a donor, namely as follows:
- Minimum age 17 years, maximum 60 years
- Minimum weight 45 kg
- Systolic blood pressure 90-160 mmHg and diastolic 60-100 mmHg. The difference between systolic and diastolic is more than 20 mmHg.
- Pulse 50-100 times per minute and regular
- Body temperature 36.5 – 37.5^{0}C
- Hemoglobin 12.5 – 17 g/dl
- The interval since the last blood donation is two months

2. Take 350 ml of donor blood (whole blood)
3. WB blood to be used will be screened for IMLD (Infectious Infection Through Blood Transfusion) using the Chemiluminescence Immunoassay (CLIA) method.
4. WB blood that is free from IMLTD, which is then processed into PRC.

5. Centrifuge WB at 3000 RPM for 4 minutes at 4˚C, then discard plasma and leave about 2 cm of plasma to obtain PRC.
6. Storage of PRC blood bags according to the FIFO (First In First Out) rules means that blood that is stored earlier according to the date is placed on the front, and the first user is taken at the very front, positioned standing on a shelf with a temperature of 2˚ - 6˚C.
7. Each PRC blood bag before sampling for research is first homogenized to unite plasma and erythrocytes.
8. Perform routine blood examinations with the Sysmex XP-300 device, i.e. approximately 3 ml of blood will be taken for each sample for haematological examination using the Radio Frequency (RF)/Direct Count (DC) detection method to calculate normal blood values, flow cytometer method with laser semiconductor to count the number of leukocytes, red blood cells, haemoglobin, hematocrit, MCH, MCV, MCHC and platelets. It is checked from the first to the 11th day [7].
9. Analyze and record data.

Data analysis

Data analysis was carried out by statistical methods used was the repeat Anova test or General Linear Model to see the effect of PRC storage time on changes in haemoglobin, hematocrit and erythrocytes as a whole if the data were normally distributed. Friedman test is performed when the data is not normally distributed. The analysis was processed using a statistical program with a significance level of $p < 0.05$ and a 95% confidence interval [8].

Results and Discussion

The study was conducted with 40 research subjects. This research is an experimental study (actual experiment design) with comparative numerical more than two groups. The measurement parameters are erythrocytes, haemoglobin, and haematocrit.

Erythrocytes

Testing the normality and homogeneity of the data is not normally distributed, so it is analyzed by testing the Friedman Test. The test results show that there are differences between groups on different days, the data showed in table 1, 2 and 3.

From the results of the Friedman Test above, it was found that the p-value (0.00), which obtained a p-value <0.05, indicates a significant difference between erythrocytes and packed red cell storage. The results show that the erythrocyte value is different between the group with storage time from day 1 to day 11. If the storage time is longer, the erythrocyte value decreases. When compared with the storage of erythrocytes on day 1, it showed a decrease in the value of erythrocytes on the storage of erythrocytes on day 11.

Table 1. Erythrocytes after storage of Packed Red Cell (PRC) Day 1 to Day 11.

Save Time	Erythrocytes (Mean± SD)
Day-1	4.95 ± 0.25
Day-2	4.92 ± 0.27
Day-3	4.94 ± 0.26
Day-4	4.86 ± 0.29
Day-5	5.02 ± 0.40
Day-6	4.97 ± 0.43
Day-7	4.91 ± 0.47
Day-8	4.67 ± 0.43
Day-9	4.64 ± 0.43
Day-10	4.51 ± 0.40
Day-11	4.42 ± 0.39

Table 2. Normality Test for Erythrocytes.

Erythrocytes	n	Shapiro-Wilk
Day-1	40	0.841
Day-2	40	0.498
Day-3	40	0.325
Day-4	40	0.012
Day-5	40	0.120
Day-6	40	0.056
Day-7	40	0.061
Day-8	40	0.215
Day-9	40	0.024
Day-10	40	0.072
Day-11	40	0.300

Shapiro Wilk Test p>0.05

Table 3. Friedman Test for Erythrocytes.

Erythrocytes	(Minimum-Maximum)	p-Value
Day-1	(4.2-5.5)	0.000
Day-2	(4.2-5.8)	
Day-3	(4.1-5.6)	
Day-4	(4.0-5.5)	
Day-5	(3.9-6.0)	
Day-6	(4.0-6.0)	
Day-7	(4.0-6.1)	
Day-8	(3.9-5.8)	
Day-9	(4.0-5.8)	
Day-10	(3.9-5.6)	
Day-11	(3.3-5.5)	

Friedman Test p<0.05

This study showed a decrease in erythrocytes with RBC assessment obtained ($p<0.05$) during eleven days of storage. This shows that during the storage process, there is no destruction of erythrocytes. Erythrocytes stored for more than 14 days can trigger lesions of the microcirculation and cannot increase cell oxygenation, leading to multi-organ dysfunction. Changes in the value of the erythrocyte index are caused by changes in biochemistry and erythrocyte metabolites during storage, which can cause a decrease in the quality and effectiveness of oxygenation to tissues,

reduce efficacy and increase side effects blood transfusion [9, 10].

Haemoglobin

The results of haemoglobin level is presented in table 4, while testing the normality and homogeneity of the data is usually distributed to meet the requirements to be tested for repeat ANOVA shown in table 5 and 6. The test results show that there is a difference between the storage time groups.

Table 4. Haemoglobin after Storage of Packed Red Cell (PRC) Day 1 to Day 11.

Save Time	Haemoglobin (mean± SD)
Day-1	13.33 ± 0.95
Day-2	13.74 ± 0.72
Day-3	13.94 ± 0.76
Day-4	14.02 ± 0.72
Day-5	14.59 ± 1.11
Day-6	14.71 ± 1.04
Day-7	14.75 ± 0.98
Day-8	14.40 ± 0.95
Day-9	14.41 ± 0.94
Day-10	14.34 ± 1.00
Day-11	14.47 ± 1.03

Table 5. Normality Test for Haemoglobin.

Erythrocytes	n	Shapiro-Wilk
Day-1	40	0.105
Day-2	40	0.150
Day-3	40	0.329
Day-4	40	0.421
Day-5	40	0.189
Day-6	40	0.283
Day-7	40	0.837
Day-8	40	0.131
Day-9	40	0.263
Day-10	40	0.144
Day-11	40	0.176

Shapiro Wilk test p>0.05

In the normality test on routine blood values, it was found that there were normally distributed data (p>0.05). So that the repeat ANOVA test is carried out.

From the repeat ANOVA test results above, it was found that the p-value (0.00), which obtained a p-value <0.05, indicates that there is a significant difference in haemoglobin on the storage of Packed Red Cells on day 1 to day 11. The results showed that the haemoglobin value differed between the groups with storage days 1 to day 11. If the storage time was longer, the haemoglobin value increased compared to the storage day one haemoglobin. This study showed an increase in haemoglobin but significantly (p<0.05) during eleven days of storage. The cause of increased haemoglobin and hematocrit during storage is unclear. However, there is evidence that during storage, there is a release of free haemoglobin and F2α-isoprostane. However, it is debatable why haemoglobin and hematocrit are elevated.

Table 6. Repeat ANOVA Test for Haemoglobin.

Haemoglobin	(Minimum-Maximum)	p-Value
Day-1	(10.3-15.5)	0.000
Day-2	(12.5-15.5)	
Day-3	(12.7-15.5)	
Day-4	(12.7-15.4)	
Day-5	(12.8-17.2)	
Day-6	(12.9-17.0)	
Day-7	(12.9-17.0)	
Day-8	(12.9-16.3)	
Day-9	(12.9-16.5)	
Day-10	(12.8-16.7)	
Day-11	(12.8-17.0)	

Repeat ANOVA Test p<0.05

Research conducted by Fitria in 2013 on 14 samples found haemoglobin (gr/dl) in Packed Red Cells was 24.9 ± 1.4 while in donors, 14.7 ± 0.9. Fitria's study showed a significant increase in haemoglobin for 28 days. first, the seventh day, fourteenth day, twenty-first day, and twenty-eighth day [11]. In other cases hemolysis were found of the red cells increases due to processing and during storage and is maximum during the first week. Adequate process control and proper storage facilities should be ensured to minimize the hemolysis of red cells during processing and storage [12].

Hematocrit

The results of hematocrit level is presented in table 7, while table 8 and 9 indicate that normality and homogeneity of the data is not normally distributed, so it is analyzed by testing the Friedman Test ANOVA. The test results show that there are differences between different storage time groups.

Table 7. Hematocrit after Storage of Packed Red Cell (PRC) Day 1 to Day 11.

Save Time	Hematocrit (Mean± SD)
Day-1	38.11 ± 2.54
Day-2	39.29 ± 2.55
Day-3	39.96 ± 2.80
Day-4	40.31 ± 2.87
Day-5	41.46 ± 3.29
Day-6	42.38 ± 3.01
Day-7	43.02 ± 2.70
Day-8	41.57 ± 2.63
Day-9	42.23 ± 2.99
Day-10	42.35 ± 3.10
Day-11	42.49 ± 3.19

Table 8. Normality Test for Hematocrit.

Hematocrit	N	Shapiro-Wilk
Day-1	40	0.078
Day-2	40	0.020
Day-3	40	0.009
Day-4	40	0.274
Day-5	40	0.082
Day-6	40	0.155
Day-7	40	0.234
Day-8	40	0.569
Day-9	40	0.202
Day-10	40	0.188
Day-11	40	0.051

Shapiro Wilk Test p>0.05

In the normality test on routine blood values, it was found that there was data that was not normally distributed ($p<0.05$). So that the Friedman Test is carried out.

Table 9. Repeat ANOVA Test for Hematocrit.

Hematocrit	(Minimum-Maxsimum)	p-Value
Day-1	(30.9-45.0)	0.000
Day-2	(36.0-45.2)	
Day-3	(36.1-45.0)	
Day-4	(34.8-45.8)	
Day-5	(35.1-49.2)	
Day-6	(35.8-50.4)	
Day-7	(35.9-49.1)	
Day-8	(35.9-48.0)	
Day-9	(36.2-49.5)	
Day-10	(36.0-51.4)	
Day-11	(36.1-52.4)	

Friedman Test p<0.05

From the results of the Friedman test above, it was found that the p-value (0.00), which obtained a p-value < 0.05, indicates a significant difference in hematocrit against packed red cells storage on day 1 to day 11. The results showed that the hematocrit value differed between the groups with storage days 1 to day 11. If the storage time was longer, the hematocrit value increased compared to the storage day one hematocrit. This study showed a significant increase in hematocrit ($p<0.05$) during eleven days of storage. This condition occurs in hematocrit because hematocrit is a function of haemoglobin concentration. The result also correlate to a research conducted by Wahyu in 2013, he found that on 14 samples, the mean and standard deviation of the hematocrit (%) on the first day of Packed Red Cell was 36.1 ± 6.9, the fourth day was 37.1 ± 7.0, and the 8th day was 38.6 ± 6.8 [13].

Conclusion

Haemoglobin and hematocrit levels, there was a significant increase in changes and erythrocytes a significant decrease but still within normal limits during the eleven-day storage process.

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Conflict of Interests

The authors declare that there is no conflict of interests regarding the publication of this review article.

Authors Contribution

All the authors have contributed equally in designing, drafting the manuscript as per the journal submission format. All authors read and approved the final manuscript.

References

1. Doyle BJ, Rihal CS, Gastineau DA, Holmes DR. Bleeding, blood transfusion, and increased mortality after percutaneous coronary intervention: implications for contemporary practice. Journal of the American College of Cardiology. 2009; 53(22):2019-27.
2. Shanty WH, Herlambang T. Prediction of Availability of Packed Red Cells (PRC) at PMI Surabaya City Using Ensemble Kalman Filter as Management of Blood Transfusion Management. In Journal of Physics: Conference Series 2019 Apr 1 (Vol. 1211, No. 1, p. 012030). IOP Publishing.
3. Seidl S, Gosda W, Reppucci AJ. The in vitro and in vivo evaluation of whole blood and red cell concentrates drawn on CPDA-1 and stored in a non-DEHP plasticized PVC container. Vox sanguinis. 1991; 61(1):8-13.
4. Ng MS, David M, Middelburg RA, Ng AS, Suen JY, Tung JP, Fraser JF. Transfusion of packed red blood cells at the end of shelf life is associated with increased risk of mortality–a pooled patient data analysis of 16 observational trials. haematologica. 2018; 103(9):1542.
5. Hébert PC, Chin-Yee I, Fergusson D, Blajchman M, Martineau R, Clinch J, Olberg B, Canadian Critical Care Trials Group. A pilot trial evaluating the clinical effects of prolonged storage of red cells. Anesthesia & Analgesia 2005; 100(5):1433-58.
6. Etikan I, Musa SA, Alkassim RS. Comparison of convenience sampling and purposive sampling. American journal of theoretical and applied statistics. 2016; 5(1):1-4.
7. Gessese T, Yalew A, Asrie F. Determination of Hematological Reference Intervals for Healthy Adults in Northeast Ethiopia. Clinical laboratory. 2020; 66(4).
8. Chatfield M, Mander A. The Skillings–Mack test (Friedman test when there are missing data). The Stata Journal 2009; 9(2):299-305.
9. Almizraq R, Tchir JD, Holovati JL, Acker JP. Storage of red blood cells affects membrane composition, microvesiculation, and in vitro quality. Transfusion. 2013; 53(10):2258-67.
10. Sparrow RL. Red blood cell components: time to revisit the sources of variability. Blood Transfusion. 2017; 15(2):116.
11. Fitria R, Rofinda ZD, Desywar D. Correlation of free hemoglobin level and plasma nitric oxide in packed red cell during blood bank storage period. Indonesian journal of clinical pathology and medical laboratory. 2019; 25(1):26-30.

12. Sawant RB, Jathar SK, Rajadhyaksha SB, Kadam PT. Red cell hemolysis during processing and storage. Asian Journal of Transfusion Science 2007; 1(2):47.
13. Wahyu R, Nurulita A, Muhiddin R. Analysis Of Lactic And Hematocrit Levels Of Blood Storage In Dr. Wahidin Sudirohusodo General Hospital Blood Bank. Indonesian Journal of Clinical Pathology and Medical Laboratory 2019; 25(3):318-22.