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The effect of storage period on hemolysis levels in packed red cells (PRC) at the PMI blood transfusion unit in Bandung city

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ABSTRACT

Introduction: The Blood Transfusion Unit of PMI Bandung City during January - May 2023 has processed blood components with a total of 150,118 bags. The Packed Red Cells (PRC) were the most consumed blood components, accounting for 43% of total consumption. To obtain quality PRC components, one of the factors that must be considered is the level of hemolysis. The longer the storage period of blood in PRC, the more hemolysis levels will change. This study aimed to examine the effect of the shelf life of PRC on hemolysis levels at PMI Bandung City.

Methods: A descriptive experimental design was chosen for this study. PRC samples were randomly selected and examined for hemoglobin and hemolysis levels within a time series at 15 and 28 days of storage (n=30 bags). Data were statistically analyzed using a simple regression test.

Result: There was a strong correlation between the storage period and hemolysis levels (Multiple R-value of 0.831). Moreover, a significant increase in hemolysis levels during storage of 15 and 28 days was also found from an ANOVA test ($p < 0.05$).

Conclusion: It can be concluded that there was a significant effect of the storage period on erythrocyte hemolysis levels.

Keywords: hemolysis, packed red cells, storage.
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INTRODUCTION

The blood transfusion unit is responsible for providing safe, quality, and effective blood transfusion. Safe blood can be interpreted as coming from healthy voluntary blood donors, free from infections that are harmful to the recipient and processed with secure methods of testing, component production, storage and transportation.[1]

Between January and May 2023, the PMI Bandung City Blood Transfusion Unit processed 150,118 bags of blood components. The largest consumed blood component, Packed Red Cells (PRC), accounted for 43% of total consumption. One of the elements to consider while obtaining excellent PRC is the amount of hemolysis. The hemolysis levels will fluctuate as the blood is stored in PRC for a longer period of time.

The purpose of this study is to observe how the shelf life contributed to hemolysis levels at PMI Bandung City.

METHODS

Types of research

This research used a descriptive experimental design to describe the situation objectively and further explain it.

Population and sampling technique

In this study, PRC samples were examined for hemoglobin and hemolysis levels with a time series, namely at a shelf life of 15 days and 28 days. Based on Baile's law, the number of bags examined in this study was 30. A random sampling technique was utilized.

Data Analysis

Furthermore, to determine the significance of the effect of PRC storage on hemolysis levels, the data from the examination results were processed statistically using a simple regression test. Simple linear regression (SLR) is a statistical approach for determining the strength of the causal link between a causal factor variable and an effect variable. The causative factor is often denoted by X, also known as the Predictor, and the effect variable is represented by Y, also known as the response. SLR is another statistical tool used in manufacturing to produce forecasts or predictions regarding quality and quantity characteristics. SLR is a method for modeling the connection between a single dependent variable and a single independent variable.

The following is a form of simple linear regression analysis:

$Y = a + bX$

Annotation:

Y = Response Variable or Dependent Variable
X = Predictor Variable or Causal Factor Variable (Independent)
a = constant
b = regression coefficient (slope); the amount of Response caused by the Predictor.

RESULTS

The table and graphs below show the increase in hemolysis levels in the 30

samples evaluated after 15 and 28 days of storage.

The table below shows the data processing findings to indicate the storage period's effect on hemolysis levels in PRC using simple regression test statistics.

The multiple R-value of 0.831 indicates that the relationship between storage time and hemolysis levels is very strong (0.80-1.00). Additionally, the ANOVA table shows a significance value of 1.246E-08, less than the alpha value of 0.05 (1.246E-08 <0.05). Results indicate a significant effect of shelf life on hemolysis levels. From the constant table, the regression equation was obtained: Y = 0.018 + 0.494X. This suggests that when the storage period (X) increases, so will the value of hemolysis levels (Y) (Table 3).

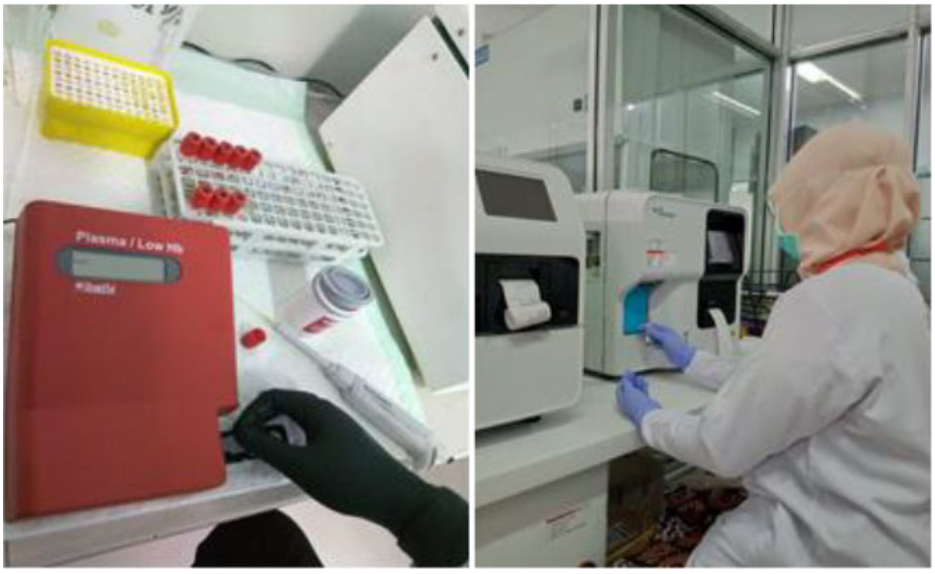

Figure 1. Hematology Examination and Hemolysis Level Examination.

Table 1. Hemolysis Examination Results

Bag Number	Bag Types	VOLUME (mL) (179-257)	Day 15 Hemolysis <0.80%	Day 28 Hemolysis <0.80%
1	A	229,3	0,10	0,12
2	A	233,7	0,16	0,31
3	B	216,0	0,28	0,47
4	A	211,3	0,15	0,25
5	C	184,5	0,10	0,12
6	B	207,9	0,39	0,55
7	D	199,5	0,26	0,38
8	D	195,8	0,13	0,29
9	A	219,9	0,26	0,34
10	B	197,4	0,15	0,20
11	A	205,7	0,28	0,40
12	B	173,6	0,10	0,17
13	B	200,7	0,34	0,76
14	B	191,5	0,16	0,34
15	C	219,5	0,52	1,06
16	C	227,4	0,13	0,40
17	A	217,5	0,24	0,82
18	E	267,6	0,76	1,09
19	E	218,4	0,15	0,45
20	E	195,6	0,15	0,36
21	E	227,0	0,16	0,21
22	A	206,2	0,30	0,43
23	A	208,5	0,10	0,41
24	A	193,3	0,39	0,50
25	E	213,7	0,17	0,24
26	A	222,5	0,16	0,57
27	B	225,0	0,20	0,27
28	B	210,3	0,15	0,43
29	A	214,3	0,10	0,29
30	A	222,1	0,10	0,12
Inspection Result (Percentage)		**100%**	**100%**	**93%**
Acceptability of PMK No. 91 Th 2015		**75%**	**75%**	**75%**

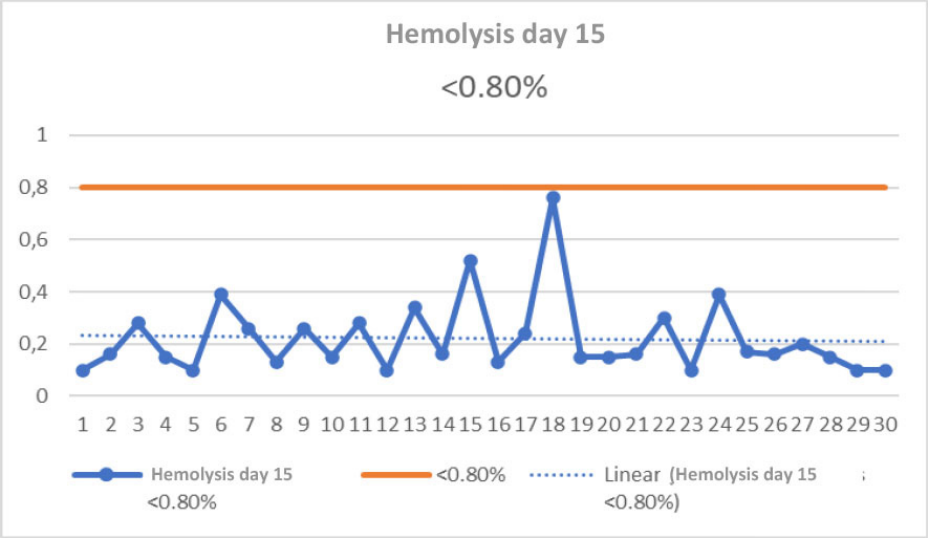

Figure 2. Graph of Hemolysis Test Results on Day 15 (Number of hemolysis the bags with values <0.80%); 100% of the bags with hemolysis level below 80% at the storage period of 15 days.

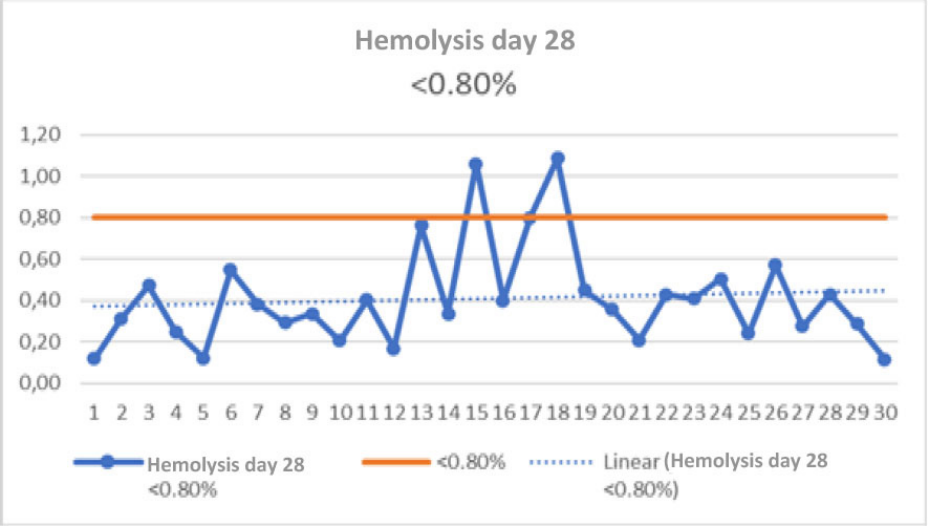

Figure 3. Hemolysis Result Chart Day 28 (Number of hemolyzed bags with value <0.80%); 93% of the bags with hemolysis levels below 80% at a storage period of 28 days.

Table 2. Simple Regression Table

Regression Statistics	
Multiple R	0.831632532
R Square	0.691612668
Adjusted R Square	0.680598834
Standard Error	0.082324514
Observations	30

DISCUSSION

The absence of visual evidence of contamination or hemolysis is one aspect of assessing blood components.[1] The findings in this study, after data collection and analysis, indicate that there was a statistically significant effect of PRC storage on erythrocyte hemolysis levels at PMI Bandung City.

The findings of this study are consistent with other research that found a positive, weakly significant association between the hemolysis index and the storage period to PRC potassium levels. This necessitates the episodic inspection of storage lesions in blood bags to control the quality of blood storage in the hospital blood bank and evade transfusion issues.[2]

Other research found similar findings, specifically that hemolysis increased with storage time in all preserved red cell units. This results in hemolysis, a critical metric for determining the quality of stored red blood cells.[3]

The results of this study might be attributed to the imbalance between production and destruction in blood storage in blood bags. In this case, destruction increased without production. Erythrocyte survival decreases proportionally to storage time. Erythrocytes killed 1-5% at the moment of tapping, 10% after 2 weeks in acid-citric-dextrose (ACD), and 25% after 4 weeks.[4]

The findings in this study also contribute to a decrease in adenosine triphosphate (ATP) levels, which is the source of increased hemolysis levels. ATP levels decline during storage, causing lipid membranes to become stiff and retain plasma. Changes in pH to acid affect the action of enzymes involved in cell metabolism, causing cell metabolism to be disrupted and cells to lyse.[5]

CONCLUSION

From this research, it can be determined that the storage period has a significant effect on erythrocyte hemolysis levels. This study hopes to improve the quality of PRC storage to guarantee availability, safety, and ease of access to blood and blood products, which are important national health service objectives.

DISCLOSURES

Funding

The research team funded this study entirely and received no other funding.

Conflict of Interest

The authors state that there is no conflict of interest.

Author Contribution

Each author contributed equally to conceiving, designing and supervising the manuscript.

Table 3. ANOVA analysis and the constant

ANOVA	df	SS	MS	F	Significance F
Regression	1	0,42558155	0,42558155	62,79490971	1,2464E-08
Residual	28	0,189765117	0,006777326		
Total	29	0,615346667			

Constant Table

Coefficients	
Intercept	0,018391458
X	0,494127887

Ethical Considerations

This study's research publishing ethics adhere to ICMJE and COPE guidelines.

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