



EVALUATION OF BIOCHEMICAL PARAMETERS IN STORED CPDA-1 WHOLE BLOOD

Pathology

Dr. Pushpa Batham Associate Professor, Deptt. of Pathology, N.S.C.B Medical College, Jabalpur,MP

Dr. Ranu Tiwari Mishra* Associate Professor, Deptt. of Pathology, N. S. C. B Medical College, Jabalpur, MP
*Corresponding Author

ABSTRACT

Introduction: When blood is stored in liquid medium, the red cells undergo a series of biochemical and structural changes that have major influences on their viability and function after transfusion. These changes are known as the storage lesion. The aim of this study was to evaluate various biochemical changes in CPDA-1 stored whole blood at 4 °C over a period of 35 days. **Material and Methods:** The present study was a prospective study carried out in the Department of pathology, S.S Medical College Rewa on 50 healthy voluntary donors who donated blood in the blood bank of SS medical college. Each sample was analysed for following biochemical parameters- serum albumin, Total protein, serum sodium and potassium on day 1,7,14,21,28 and 35. **Result:** In the present study mean value of potassium increased within the period of 7 days and continued subsequently. Sodium on the contrary slightly reduced. Mean value of serum albumin reduced from 3.72gm/dl on day one to 2.64gm/dl on last day. Total serum protein also show slight reduction. **Conclusion:** Current evidence shows that metabolic, biochemical, and molecular changes occur during the storage of blood products and that these changes may lead to harmful consequences in the recipient.

KEYWORDS

Biochemical Parameters, Potassium, Stored whole blood, CPDA-1

INTRODUCTION

When blood is stored in liquid medium, the red cells undergo a series of biochemical and structural changes that have major influences on their viability and function after transfusion. These changes are known as the storage lesion. During storage, red cells metabolize glucose and produce lactic acid and pyruvic acid. This results in a drop in pH and a decrease in the rate of glycolysis. As glycolysis slows, the red cells become depleted of adenosine triphosphate(ATP). Because human red cells contain no enzymes with which to synthesize adenine or other purines de novo, the nucleotide pool gradually becomes exhausted. In the presence of adenine, ATP may be regenerated. Understanding this has led to methods for prolonging red cell storage by addition of exogenous adenine and inorganic phosphate, both of which improve the cell ability to regenerate ATP. Red cell lose potassium and gain sodium during storage. This is because the Na-K gradient is normally maintained by a Na-K ATPase that does not function well at 4 °C[1]. Gamma- irradiation of blood components to prevent transfusion associated graft-versus-host disease (GvHD) promotes the leakage of potassium from red blood cells[2]. Hall TL et al recommended transfusion of relatively large volume of RBCs to be limited to fresh packed RBCs or to packed RBCs that have been saline washed to minimize the complications of electrolyte disturbances[3].

The aim of this study was to evaluate various biochemical changes in CPDA-1 stored whole blood at 4°C over a period of 35 days.

MATERIAL AND METHOD

The present study was a prospective study carried out in the Department of pathology, S.S Medical College Rewa on 50 healthy voluntary donors who donated blood in the blood bank of SS medical college. All subjects were serologically examined for hepatitis B virus, HCV, HIV I and II, Syphilis and Malaria parasite and found negative. Blood bags containing 49 ml of CPDA-1 anticoagulant was used for collection of 350 ml of blood. A blood sample of about 50 ml is taken from each blood bag and blood bags were carefully stored in a quarantine shelf of the blood bank refrigerator maintained at 4-6°C. Each sample was divided into 6 portions, each portion consisting of 7 ml of blood was added into plain test tube. One of these tubes was analysed immediately, which was regarded as day 1. The other five tubes were kept in the blood bank refrigerator at 4-6 °C to be analysed later on 7th day, 14th day, 21st day, 28th day and 35th day intervals. Each sample was analysed for following biochemical parameters- serum albumin, Total protein, serum sodium and potassium. Serum albumin and total protein were measured using Fully automatic A25 Biosystems. The concentration of the electrolytes; sodium and potassium in serum samples measured by using AVL 9180 electrolyte analyser.

For statistical analysis, we applied ANOVA (F-test) and Paired t test. P <0.05 was considered statistically significant.

RESULT

Table 1. Change in serum sodium value during storage

S.No.	Storage Days	Mean Value mEq/L
1	1 day	136.74
2	7 day	136.14
3	14 day	135.43
4	21 day	134.57
5	28 day	134.78
6	35 day	134.00

The mean values of sodium on day one were compared to other storage day. It was observed that there was slight reduction only, however by statistical analysis ANOVA (F- test) P<0.0004 and it is significant.

Table 2. Change in serum potassium value during storage

S.No.	Storage Days	Mean Value mEq/L
1	1 day	3.49
2	7 day	5.72
3	14 day	8.21
4	21 day	11.16
5	28 day	14.21
6	35 day	17.18

The mean values of potassium is increased remarkably during storage. By statistical analysis ANOVA (F- test) P <0.0001 and it is highly significant.

Table 3. Change in serum albumin value during storage

S.No.	Storage Days	Mean Value gm/dl
1	1 day	3.72
2	7 day	3.49
3	14 day	3.29
4	21 day	3.07
5	28 day	2.84
6	35 day	2.64

The mean value of serum albumin from day one till the last storage day, showing reduction. By statistical analysis ANOVA (F- test) P<0.0001 and it is significant.

Table 4. Changes in serum total protein value during storage

S.No.	Storage Days	Mean Value gm/dl
1	1 day	6.62
2	7 day	6.59
3	14 day	6.48

4	21 day	6.39
5	28 day	6.31
6	35 day	6.23

The mean values of serum total protein showing slight reduction only, however by statistical analysis ANOVA (F-test) $P < 0.0165$ and it is significant.

DISCUSSION-

In our study, mean values of potassium increased with in the period of 7 days from 3.49 mEq/L to 5.72 mEq/L and continued to rise and reached 17.18 mEq/L on 35th day. This rise in ECF potassium in whole blood stored at 4°C correlates with the other studies[4,5,6]. D.N.Bailey et al 2003 studied chemical and haematological changes in stored CPDA blood also found a rise in potassium concentration with storage and suggested that routine transportation, processing and handling may lead to increased biochemical alteration[7]. Wallas C.H 2003 studied sodium and potassium changes in blood bank stored human erythrocytes[8]. He observed that sodium and potassium did not change when red blood cells with normal ATP content were stored at 20 to 24 °C. This study suggested that a major cause for the development of cation changes in the red blood cell during blood bank storage is the temperature which inhibits membrane ATPase, allowing cations to leak unopposed into and out of the red blood cells. The leakage of potassium from cells into surrounding plasma may be responsible for the drastic progression in potassium level in our study. During blood storage there is a slow but constant leakage of potassium from cells into surrounding plasma. This is because the Na⁺-K⁺ gradient is normally maintained by a Na⁺-K⁺ ATPase that does not function well at 4° C. In severe kidney disease even small amount of potassium fluctuations can be dangerous, so relatively fresh or washed red cells are indicated.

In present study sodium on the contrary slightly reduced, on day 1 serum sodium value was 136.74 mEq/L which reduced to 134.00mEq/L on 35th day suggesting that sodium in stored whole blood may produce adverse effect after transfusion. The increase in potassium value and slight reduction in sodium value simply indicate the preference of component therapy to whole blood transfusion[4,8].

In our study, mean values of serum albumin on the day of donation is 3.72gm/dl and mean value at last day of acceptable storage day is 2.64gm/dl showing reduction. This is similar to the study of Teddy C Adias et al.2012[4]. In present study mean values of serum total protein showing slight reduction only. These result are in agreement with results of Teddy C Adias et al.2012[4]. Study by Ujwal B Upadya et al. 2018 found increase in Total protein and albumin in CPDA-1 stored blood[9]. The rise in albumin and protein concentration in their study was because of optical interference and intracellular leakage of total proteins.

CONCLUSION:

Current evidence shows that metabolic, biochemical, and molecular changes occur during the storage of blood products and that these changes may lead to harmful consequences in the recipient. In cases of Renal diseases, Liver diseases, Neonatal exchange transfusion and major surgical procedure, we should use fresh whole blood (upto Maximum 7 days) to avoid ill effect of high serum potassium level.

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