IJPRP

Indian Journal of Pathology: Research and Practice
Volume 11 Number 3, July – September 2022
DOI: http://dx.doi.org/10.21088/ijprp.2278.148X.11322.10

Original Article

Evaluation of the Platelet Parameters Post-Transfusion

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How to cite this article:
Femela Muniraj/Evaluation of The Platelet Parameters Post-Transfusion/Indian Journal of Pathology: Research and Practice 2022;11(3):97–103.

Abstract

Background & Objectives: Platelet transfusion reduces mortality from hemorrhage in patients with thrombocytopenia. Platelet transfusions are given prophylactically or therapeutically for managing patient with various platelet consumptive or destructive disorders. This study evaluates the effect of platelet transfusion over the count and parameters of platelets. The objective of this study is to compare the Platelet count, Mean Platelet Volume (MPV) and Platelet Distribution Width (PDW) before and after platelet transfusion.

Materials and Methods: The platelet parameters of 202 samples with thrombocytopenia, demographic variables including gender, clinical details including indication for platelet transfusion, blood group, Platelet count, MPV, PDW before and after transfusion and additional details such as critical illness, transfusion reaction, stay in ICU etc, were noted. Descriptive statistics such as mean were calculated for descriptive variables such as difference in platelet count, MPV, PDW before and after transfusion.

Results: The rise in platelet count with one unit of platelets was approximately 40000/μL and that with 12 units was 1,00,000/μL.The rise in MPV with one unit of platelets was approximately 2 fL and that with 12 units was approximately 1 fL. The mean rise in PDW after platelet transfusion ranged from 1.2 to 1.8.

Conclusion: Platelet count, MPV and PDW increase after platelet transfusion. The increase in platelet count is disproportionate to the number of units transfused.

Keywords: MPV, PDW, Platelet, Platelet count, Transfusion

Manuscript

Background

Platelet transfusion is used to prevent or treat bleeding in people with either a low platelet count or poor platelet function. Platelet transfusion reduces mortality from hemorrhage in patient. It is an essential part of the treatment of cancer, hematological malignancies, marrow failure and hematopoietic stem cell transplantation.[1] Platelets are usually stored for up to 5 days to transfusion, although in some blood banks, the storage period is extended to 7 days. Changes occur in both platelet activation and dysfunction during the storage. The clinical significance due to these changes remain uncertain.[2]

The role of platelets in hemostasis is significant [3,4] Platelets are tiny in appearance and are highly active metabolically. A number of reactions in platelets contribute to maintaining hemostasis in circulation.[5] Platelet transfusions are given prophylactically or therapeutically for managing patient with various platelet consumptive or destructive disorders. The response of the patient after the platelet transfusion can be variable, due to difference in platelet dose,

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Received on: 01.04.2022

Accepted on: 27.04.2022

source (apheresis vs whole blood platelet pools), donor-recipient ABO compatibility, transfusion interval and duration of the platelet storage. Studies show that many patients received multiple transfusions. Platelet refractoriness is the increment in platelet count after platelet transfusion which is less than expected.[6] This study attempts to evaluate the effect of platelet transfusion over the platelet count and the platelet parameters.

Objective

The objective of this study is to compare the Platelet count, Mean Platelet Volume (MPV) and Platelet Distribution Width (PDW) before and after platelet transfusion.

Materials and Methods

This retrospective study was conducted in the Department of Transfusion Medicine, instead of transfusion medicine, Chettinad Hospital and Research Institute, after getting approval from the Institutional Ethics Committee. Patients (n = 190) who were given platelet transfusion, at Chettinad Hospital and Research Institute, irrespective of the number of units, age and sex were included in the study; of which 129 were males and 61 were females; 38 were in ICU; 18 had undergone surgery. Some of them had multiple transfusions. Patients for whom either one or both platelet counts are not available, that is, before and after transfusion are excluded from the study. The platelet parameters of 202 samples obtained from 190 patients with thrombocytopenia, collected from the automated hematology analyzer (Beckman Coulter LH780), were analyzed in this study. The demographic variables including gender, clinical details including indication for platelet transfusion, blood group, Platelet count, MPV, PDW before and after transfusion were noted. Additional details such as critical illness, transfusion reaction, stay in ICU etc, were also noted. Descriptive statistics such as mean were calculated for descriptive variables such as difference in platelet count, MPV, PDW before and after transfusion. Box plots were used to depict the trends of individual parameters before and after transfusion.

Results

Our study included data from 202 samples, collected from 190 patients. Out of the 202 samples, 65 were from females and 137 were from males (Table 1). The platelet counts before transfusion ranged from 23,000/μL to 54,000/μL and those after transfusion ranged from 52,286/μL to 1,29,000/μL (Table 2, Fig.s 1 & 2). The rise in platelet count with one unit of platelets was approximately 40000/μL and that with 12 units was 1,00,000/μL (Table 3 & Fig. 3). The MPV before transfusion ranged from 8.16 fL to 10.5 fL and that after transfusion ranged from 10.4 fL to 12.0 fL (Table 2, Fig. 4 & 5). The rise in MPV with one unit of platelets was approximately 2 fL and that with 12 units was approximately 1 fL (Table 3 & Fig. 6). The PDW before transfusion ranged from 13.8 to 17.2 and from 15.6 to 18.4 after transfusion (Table 2). The mean rise in PDW after platelet transfusion ranged from 1.2 to 1.8 (Table 3 and Fig. 7).

Table 1: Frequencies of Gender

No. of units of platelets transfused	Female	Male
1	6	8
2	20	42
3	5	5
4	14	44
5	3	7
6	4	9
7	5	2
8	4	14
9	0	1
10	3	4
11	1	0
12	0	1
Total	65	137

Discussion

Transfusion of platelets is indicated in patients with moderate to marked thrombocytopenia for the prevention of bleeding complications.[7] Studies show that 2.2 million platelet doses are transfused annually. Patients undergoing chemotherapy or hematopoietic progenitor cell transplantation treatment need a greater number of platelet units for transfusion, to lower the risk for spontaneous bleeding. Storing the platelets is difficult because of bacterial infection and temperature issues and hence it is transfused within 5 days. Patients receiving platelet transfusion may develop allergic reaction and febrile non hemolytic reaction. The hematology equipment gives information about the quantity of platelets but not about the platelet hemostatic function, that is, the quality.[8]

Table 2: Platelet counts, MPV & PDW before and after platelet transfusion

No. of units transfused	Mean platelet count (/µL)		MPV (fL)		PDW	
	Before transfusion	After transfusion	Before transfusion	After transfusion	Before transfusion	After transfusion
1	44357	84929	8.87	11.2	15.3	17
2	40823	80806	8.87	11.1	16.1	17.6
3	30600	67900	9.06	11.4	16.1	17.7
4	33966	81517	8.98	11.2	16.1	17.5
5	36400	74000	9.19	11	15.7	17.3
6	43615	86154	8.54	11.2	16.3	17.7
7	34571	52286	9.06	10.9	16.6	17.8
8	37833	73778	8.53	10.5	15.2	16.8
9	28000	62000	10.5	12	17.2	18.4
10	36143	68000	8.16	10.4	15.9	17.3
11	54000	63000	9.7	11.5	13.8	15.6
12	23000	129000	10.2	11.6	16	17.6

Table 3: Post-transfusion rise in platelet count, MPV & PDW

No of units transfused	Mean rise in platelet count (µL) (PPI)#	Mean rise in MPV (fL)	Mean rise in PDW
1	40572	2.33	1.7
2	39983	2.33	1.5
3	37300	2.34	1.6
4	47551	2.24	1.4
5	37600	1.81	1.6
6	42539	2.66	1.4
7	17715	1.84	1.2
8	35945	1.97	1.6
9	34000	1.5	1.2
10	31857	2.24	1.4
11	9000	1.8	1.8
12	106000	1.4	1.6

Post-transfusion Platelet Increment

Thrombocytopenia has been found to be the most common among patients who had been admitted in intensive care unit.

Data show that thrombocytopenia was present in 8.3% to 67.6% of adult patients on admission to ICU and ICU stay.[9]

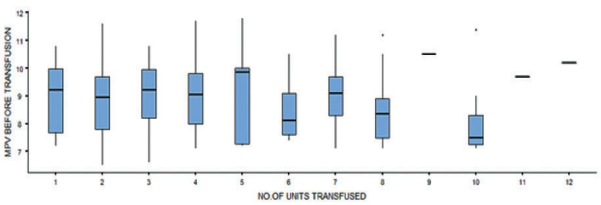

Fig. 1: Box plot representing platelet count before transfusion

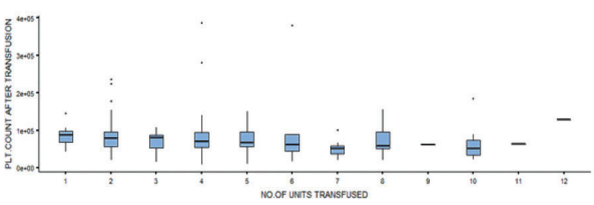

Fig. 2: Box plot representing platelet count after transfusion

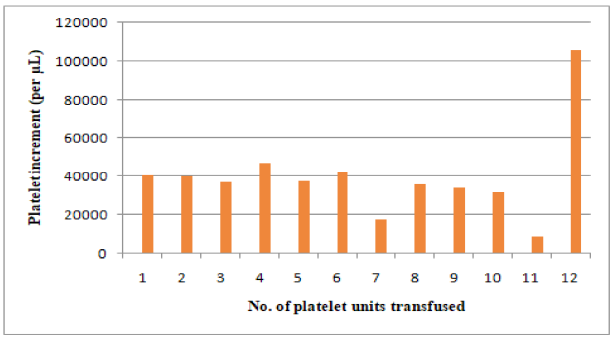

Fig. 3: Rise in platelet count after platelet transfusion

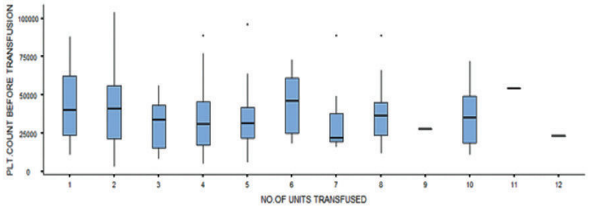

Fig. 4: Box plot representing MPV before transfusion

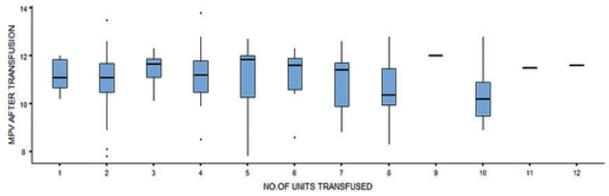

Fig. 5: Box plot representing MPV after transfusion

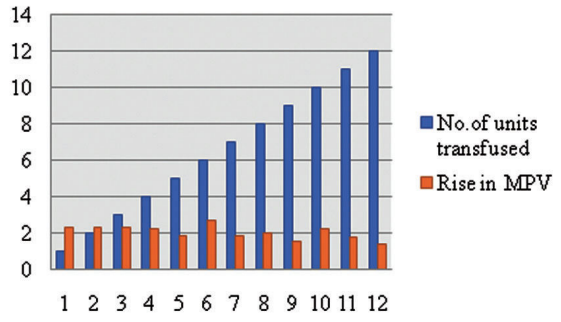

Fig. 6: Rise in MPV after platelet transfusion

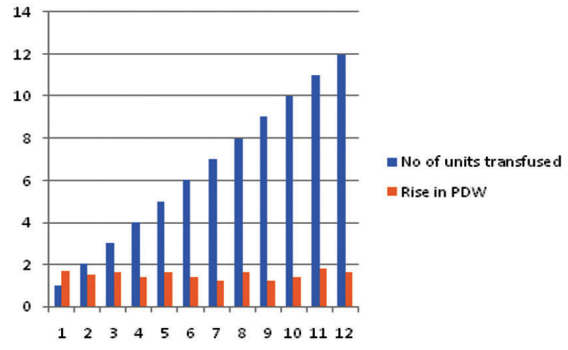

Fig. 7: Rise in PDW after platelet transfusion

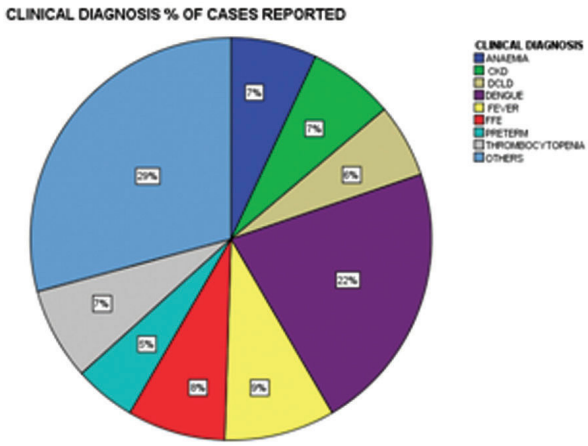

Fig. 8: Clinical diagnoses of the patients who received the platelet transfusion.

In the 1950s, platelet transfusions were found to reduce the mortality in patients with acute leukemia. Since then, platelet transfusions have become an important part of the treatment of malignancies, bone marrow failure, hematopoietic stem cell transplantation, as they significantly reduce the hemorrhagic complications associated with the therapy of these conditions.[3,10]

Studies have shown that prophylactic platelet transfusion given on the basis of platelet count for adults with acute uncomplicated dengue infection is not needed. This approach will save precious blood products and will reduce unnecessary patient exposure to transfusion risks.[11]

Platelet transfusions have been shown to prevent major hemorrhage and improve survival in thrombocytopenic patients. Platelet transfusions were shown to reduce mortality from hemorrhage in patients with leukemia. Platelet transfusions are an essential part of the supportive care of thrombocytopenia patients, such as those with hematological diseases. More than 4 million platelet components are transfused worldwide each year. Platelet can be transfused in order to prevent bleeding (prophylactic indication) or to stop bleeding (therapeutic indication) both in thrombocytopenic patients and in patients with normal platelet count.

Drug induced platelet dysfunctions, such as in patients undergoing major cardiovascular surgery or, less frequently, due to inborn defects, are other indications for platelet transfusions. In patients with thrombotic thrombocytopenic purpura and heparin induced thrombocytopenia, platelet transfusions are, in general, indicated only in the case of severe bleeding. ABO mismatched transfusions have a lower platelet recovery than ABO-compatible platelet transfusions. Platelet

units issued for transfusion should be of the same ABO blood group as the patients.[12]

Platelet transfusion is one of the most crucial therapeutic approaches in medicine. However, severe and fatal adverse reactions may develop. Therapeutic platelet transfusions are widely indicated in patients with severe thrombocytopenia and platelet dysfunction associated with active bleeding. Prophylactic platelet transfusions are indicated in patients with thrombocytopenia due to bone marrow disorders, chemotherapy, or hematopoietic progenitor cell transplantation. Transfusion reactions are more common with platelet transfusions than with red blood cell transfusions. The clinical characteristics of acute reactions may include febrile non-hemolytic transfusion reactions, transfusion associated sepsis, and TRALI.[4]

AABB recommends prophylactic platelet transfusion in patients with platelet count of less than or equal to 10,000/μL to reduce the risk of spontaneous bleeding. It also specifies that larger doses are not more effective and smaller doses equal to one-half of an apheresis unit are equally effective.[3]

Initial management of alloimmunized patients who are refractory to platelet transfusions from random donors is the use of HLA-matched platelet transfusions, which improve responses to transfusions in about 65% of patients. The use of leukocyte depleted blood components in multi-transfused patients has resulted in a reduction in HLA alloimmunization and platelet refractoriness.[13]

Infusion of ABO-mismatched platelets is associated with increased incidence of multi-organ failure and death in stem cell transplants for acute myeloid leukemia. Patients receiving washed, leukocyte reduced ABO identical transfusions required fewer platelet transfusions, despite a 20-30% loss of platelets during the leukoreduction/ washing process.[14]

The post transfusion platelet count is affected by the quality, the number of platelet units transfused and also by the dilution of platelets in the patient's blood volume.[6]

In our study, males who had undergone transfusion outnumbered females. Maximum platelet transfusion had been given in the age group of 11 – 20 years and minimum among 81 – 90 years age group.

Thrombocytopenia with a platelet count of less than 50,000/μL is associated with increased mortality independent of the patient's age, severity of illness and increased consumption of platelets.[15]

In our study, the platelet counts before transfusion were approximately ≤ 50,000/μL and the counts post-transfusion were approximately ≥ 50,000/μL (Table 2, Fig. 1 & 2).

The rise in platelet count was maximum with 12 units of platelets. The rise in platelet count with one unit of platelets was approximately 40000/μL and that with 12 units was 1,00,000/μL.

The rise was found to be disproportionate with the number of units of platelets transfused, that is, the increase in count was more pronounced even with lesser quantity of platelets, in some patients, whereas, the increase was less pronounced even with transfusion of larger quantity (Table 3). This shows the refractoriness of the patients to respond to transfusion. The factors which are responsible for platelet refractoriness are male gender, a minimum of 2 pregnancies, increasing weight, increasing number of platelet transfusions, heparin, presence of lymphocytotoxic antibody, bleeding, splenomegaly, septicemia, DIC, HLA alloimmunization. The platelet increments were more pronounced with splenectomized patients compared to those with normal spleen and with increasing age.[6,13] Pure platelet transfusions are non-immunogenic as platelets express only HLA class I antigens and HLA alloimmunization occurs only with class II antigen bearing cells.[13]

Norol F et al recommend transfusion of high dose of platelets to decrease the number of units required and the exposure to multiple donors, especially in children and patients having platelet consumptive pathology.[16]

Post-transfusion platelet increment (PPI) is calculated using the following formula.[3,6,12]

Post-transfusion platelet increment = Post-transfusion platelet count – Pre-transfusion platelet count

Dengue fever is a known cause for thrombocytopenia.[17,18] In our study, 44 cases had Dengue fever and it was the most frequent indication for platelet transfusion (Fig. 8).

A platelet count of less than 20,000/μL is defined as severe thrombocytopenia.[17] In our study, 44 patients had severe thrombocytopenia.

The MPV was seen to be increased after platelet transfusion; the difference ranging from 1.4 fL to 2.66 fL. In none of the cases, MPV was decreased after transfusion (Tables 2 & 3, Fig. 4, 5 & 6).

PDW also was found increased after platelet transfusion; the difference ranging from 1.2 to 1.8

(Tables 2 & 3, Fig. 7).

The platelet parameters, MPV and PDW have not been studied so far. Our study demonstrates the difference in these parameters, in addition to the platelet counts, pre and post-transfusion.

Conclusion

This study shows the actual effect of platelet transfusion on the parameters of platelets. Platelet count, mean platelet volume and platelet distribution width increase after platelet transfusion. The increase in platelet count is disproportionate to the number of units transfused.

Abbreviations used

- µL - Microliter
- ICU – Intensive care unit
- TRALI – Transfusion related acute lung injury
- AABB – Formerly American Association of Blood Banks
- HLA – human leucocyte antigen
- No. – Number
- MPV – Mean platelet volume
- PDW – Platelet distribution width
- PPI – Post-transfusion platelet increment
- fL – Femtoliter
- DIC – Disseminated intravascular coagulation

Funding

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Conflict of Interest

The authors declare no conflict of interest in preparing this article.

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