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Can platelet yield be predicted before the donation in plateletpheresis? A study on the impact of donors' and procedural parameters on platelet yield

Running title: Impact of **Donors' and Procedural Parameters on Platelet Yield**

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Abstract:

Background: Platelet transfusion plays a critical role in thrombocytopenic patients. Platelet concentrate was prepared by using apheresis technique (SDP), and its efficacy as platelet yield was correlated with donors' demographic variables. **Objectives:** To analyze the impact of donors' demographic variables and machine-related parameters on platelet yield and to evaluate the relation between run time and anticoagulant infused to the donor as it is related to the donor's safety. **Material and Methods:** A retrospective observational study on plateletpheresis from July 2019 to December 2022 was carried out in a blood bank of Khandwa region (MP), India by using Trima Accel automated blood collection system. Donors were selected based on guidelines laid by the Drugs and Cosmetic Act. Pre-donation parameters and procedural characteristics were noted and the correlation of these variables with platelet yield was analyzed.

Results: Platelet yield varied from 2.0 to 4.5x 1011. Pre-donation platelet count (PC), platelet distribution width (PDW), and volume processed had a significant positive correlation with platelet yield whereas mean platelet volume (MPV) had a significant negative correlation with platelet yield. Run time was also positively correlated with AC infusion to the donor.

Conclusion: Patient recovery in thrombocytopenic patients is dependent on the quantity and quality of platelet transfused which is related to platelet yield. Pre-donation variables like Platelet count, and other parameters affecting the platelet yield. Thus, by this study, we conclude all these parameters can be considered by blood banks to obtain high yields in lesser time and to ensure donors' safety.

Keywords: Plateletpheresis, platelet yield, Body mass index, Platelet count**,** Trima Accel

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Introduction:

Platelet transfusion priorities over the last few years in India have taken a huge step forward. It is primarily indicated in patients who are diagnosed with thrombocytopenia or/and have platelet dysfunction or bleeding tendency.[1] The success rate of platelet transfusion depends upon platelet yield which in turn depends on various parameters of donors and influence patient recovery.

Platelet transfusion can be done by two methods; either one unit of single donor platelet by apheresis (SDP) or a pool of 6-8 units of random donor platelets.[2] Platelet transfusion is similar to whole blood transfusion and is also associated with various reactions like alloimmunization, sepsis, and febrile non-hemolytic transfusion reaction (FNHTR) which are mainly because of leucocytes. Such reactions are less with SDP as it is leuko-reduced and obtained from a single donor.[3,4] Trima Accel cell separator is an automated apheresis machine that is based on the principle of continuous flow centrifugation.[3] The efficiency of SDP is mainly depending on platelet yield which in turn depends on the donor's platelet count and hemoglobin.[3] Some past studies were conducted to explore the influence of donor demographic parameters, hemoglobin (HB), hematocrit (HCT), and platelet count (PC) on yield. [1,4-5] Some of the studies [6,7] explored the relation of PC, mean platelet volume (MPV), and platelet distribution width (PDW) with yield, and very few studies[8-10] explored the relation of blood group with yield.

The present study was conducted to analyze to impact of donor's demographic variables (such as age, and gender); pre- donation complete blood count (CBC) parameters (such as HB and PC), and procedural parameters (such as total volume processed and run time) with the platelet yield. The current study also tried to evaluate the relationship between run time and anticoagulant (AC) infused to the donor because this parameter is related to the donor's safety.

Material and Methods:

A retrospective observational study on plateletpheresis was conducted in Deep Blood Bank; Khandwa, India from July 2019 to December 2022 by using Trima Accel's automated blood collection system for platelet separation. Written informed consent was taken from donors before donation.

Donor selection criteria: All donors were replacement donors and selected based on guidelines laid by the Drugs and Cosmetic Act, Ministry of Health and Family Welfare, Government of India.[11] The selection criteria for apheresis were:

- Age: 18-60 years
- Weight: 50 Kg
- Hb: >12.5 gm/dl
- Platelet count : > 1.5 lacs/cumm
- A time interval of at least 90 days after the last whole blood donation and at least 48 hours interval after platelet/plasma–apheresis donation.
- No consumption of non-steroidal anti-inflammatory drugs and acetylsalicylic acid in the last 3 days.
- Negative for Human Immunodeficiency Virus (HIV), Hepatitis B and Hepatitis C Viruses (HBV and HCV), malaria and syphilis.

Data collection: The donor's demographic characteristics, pre-donation CBC parameters, and procedural characteristics were collected from the plateletpheresis (SDP) register.

Statistical analysis:

All collected data was entered in a Microsoft Excel sheet and the mean with standard deviation (SD) was calculated for each parameter. The correlation of platelet yield with variables was analyzed by using the Pearson correlation coefficient(r). The association of run time with AC to the donor was also analyzed with the Pearson correlation coefficient. One-way analysis of variance was

used to compare the platelet yield among different ABO blood groups. Student t-test was applied to know the association of platelet yield with Rh status.

Result:

A total of 442 plateletpheresis donations done in the Trima accel separator were included in the study. All the donors were male and replacement donors. Female donors were deferred mainly due to low hemoglobin and difficulty in obtaining venous access. The age range was 18 to 50 years. The maximum donation (59.3%) was done by the 21 to 30 years age group individuals. Donor's demographic characteristics, pre-donation CBC parameters, and plateletpheresis procedural characteristics were depicted in Table -1. A majority (312; 70.6%) of donors were Rh-positive. The maximum number of donors belonged to blood group B (45.7%) followed by O (34.2%).

Platelet yield varied from 2.0 to 4.5 $x10^{11.}$ Their distribution among donors is summarized in Table -2.

Correlation of platelet yield and different parameters:

No statistical association was found between the age (r=-0.06,p=0.18) and BMI (r=0.09,p=0.05) of the donor and platelet yield.

Predonation PC, PDW and volume processed had a significant positive correlation with platelet yield whereas MPV had a significant negative correlation with platelet yield. Other CBC parameters and procedural parameters were not statistically correlated with platelet yield (Table 3). Run time was also positively correlated with AC infusion to the donor (r=0.68, p<0.001). The mean platelet count and platelet yield with different blood group are depicted in Table 4. The current study did not show any statistical association between platelet yield among different ABO and Rh blood groups (p>0.05).

Table -1: Donor's and procedural characteristics of Plateletpheresis (n=442)

Parameter	**Range**	**Mean ±SD**
Age (Years)	18-50	30.71±6.78
BMI (Kg/m^2)	14.3-43.3	26.31±3.90
HB (gm/dl)	11.0-17.6	14.38±1.21
HCT (%)	33.2-52.3	42.76±3.24
Platelet count (10^5/cumm)	1.9-6.15	2.85±0.53
MPV (fl)	7.6-12.1	9.2±1.43
PDW (%)	9.2-16.2	11.8±1.63
TLC (10^3/cumm)	4.5-10.8	7.74±1.08
Volume processed (ml)	1774-2870	2180.42±157.40
Platelet Yield (X 10^{11}/unit)	2.0-5.5	3.88±0.58
Run Time (min)	35-56	40.98±2.83
AC infusion to donor (ml)	156-252	192.69±33.85

Table -2: Platelet yield distribution of Plateletpheresis donors

Platelet Yield (10^{11}/Unit)	No of Donors	%
<2.5	04	0.9
2.5-3.5	193	43.9
>3.5	245	55.7
Total	442	

Table -3: Correlation between various parameters and platelet yield.

Parameters	r (Pearson coefficient)	P value
Age	-0.06	0.182
BMI	0.09	0.051
HB	0.08	0.093
HCT	0.05	0.321
PC	0.41	0.000**
MPV	-0.13	0.005**
PDW	0.10	0.035*
TLC	0.03	0.465
Volume processed	0.35	0.043*
Run Time	-0.01	0.803

** Correlation is significant at the 0.01 level (2-tailed)
* Correlation is significant at the 0.01 level (2-tailed)

Table -4: Mean platelet yield and result of ANOVA test among the ABO blood group and T-test among the Rh blood group.

ABO Blood Group	**Platelet Yield (10^{11}/Unit) Mean ±SD**	**95 % CI For mean Platelet Yield**		**F test (p-value)**
		Lower Bound	**Upper Bound**	
O (n=151)	3.91±0.61	3.82	4.01	0.685 (0.562)
A (n=67)	3.81±0.51	3.68	3.93	
B (n=202)	3.90±0.62	3.81	3.98	
AB (n=22)	3.98±0.42	3.79	4.16	
Rh blood group	**Platelet Yield (10^{11}/Unit) Mean ±SD**	**95 % CI For mean Platelet Yield**		**T-test (p-value)**
		Lower Bound	**Upper Bound**	
Rh positive (n=312)	3.93±0.58	3.86	3.99	1.67 (0.094)
Rh negative (130)	3.83±0.56	3.73	3.92	

Table -5: Pearson value (r-value) and correlation of donor and procedural factors with platelet yield in various studies.

Studies	Hb	HCT	TLC	PC	MPV	PDW	Volume processed	Run time
Enein et al.[4] (2007)	-0.306	-	-	0.512	-	-	**0.404 (<0.05)**	-
Patel J et al.[18] (2013)	-0.001 (>0.05)	-0.018 (>0.05)		**0.302 (< 0.001)**			**0.158 (<0.05)**	-0.047 (>0.05)
Sachdeva P et al.[7] (2014)	- 0.004, (0.954)			**0.446 (< 0.001)**	**- 0.447 (<0.001)**	**- 0.396 (<0.001)**		
Mangwana et al.[15] (2014)	0.022 (>0.05)	-	**0.095 (<0.05)**	**0.577 (<0.001)**	-	-	**-0.648 (<0.001)**	**-0.516 (<0.001)**
Patel AC et al.[6] (2015)	-	-	-	-	-0.224	-0.045	-	-
Bahadur et al.[19] (2015)	**(0.003)**	-	**(0.217)**	**(0.001)**	**(0.001)**	**(0.001)**	-	-
Geetha et al.[8] (2017)	**0.482 (<0.05)**	-	**0.258 (<0.05)**	**0.425 (<0.001)**	-	-	**0.327 (<0.05)**	**0.299 (<0.05)**
Chatterjee et al. [10] (2021)	- (0.573)	- (0.807)	-	- **(<0.001)**	- **(0.036)**	- **(0.027)**	-	-
Tejaswi et al.[12] (2021)	0.098 (0.204)	0.005 (0.944)	- (>0.001)	**0.327 (<0.001)**	-0.051 (0.512)	**-0.166 (0.032)**	-	-
Kanungo et al.[9] (2022)	0.04 (0.66)	0.05 (0.55)	-	**0.61 (<0.001)**	-	-	**0.18 (0.02)**	0.03 (0.73)
Fateen T et al.[20] (2022)	-0.214 (0.096)	-0.022 (0.447)	0.196 (0.116)	**-0.297 (0.033)**	-	-	**0.269 (0.043)**	-0.243 (0.068)
Present study (2022)	0.08 (0.093)	0.05 (0.321)	0.03 (0.465)	**0.41 (0.000)**	**-0.13 (0.005)**	**0.10 (0.035)**	**0.356 (<0.05)**	-0.01 (0.803)

p-value indicated in the bracket.

Discussion:

The present study evaluated the effect of the donor's demographic and hematological characteristics and procedural parameters on the platelet yield.

Correlation with Age, gender, BMI, ABO, and Rh blood group :

The mean age in the present study was 30.71 years which was comparable with a study by Arun et al.[1] (28.7 years) and Kanungo et al.[9] (28.9 years) who included 130 and 159 donors respectively in their plateletpheresis study. Our study did not find any correlation between age and platelet yield similar to other studies.[10,12-13] Whereas Arun et al.[1] found a significant negative correlation and Geetha et al. [8] found a significant positive correlation between the age of the donor and platelet yield. This difference could be due to variations in the study population.

We could not evaluate the effect of gender on platelet yield as all donors were male in the present study. However, some previous studies [5,14] revealed that females had higher yield because of more prevalence of iron deficiency anemia among females with a consequent rise in platelet count and thus yield.

Many previous studies [1,8,15] observed a positive correlation between BMI (or weight) and yield. They stated that greater body weight individuals have greater blood volume for the processing, thus have higher platelet yield. However, the current study is similar to that of Chatterjee et al.[10] and Karim et al.[16] did not find any correlation between BMI and yield.

The present study revealed the highest platelet count and thus yield in AB blood group individuals and the lowest in A group individuals. This finding was not with Vala NH et al.[17] who found the highest platelet count in B-positive and lowest in AB-positive individuals. There was no association found between platelet yield and ABO blood grouping in the present study similar to the Kanungo et al.[9] and Chatterjee et al. [10] However, Chatterjee et al. found maximum yield in O-negative blood group donors. The present study also evaluated the influence of the Rh status of donors on platelet yield but not found any significant difference in yield among Rh-positive and negative donors ($p>0.05$). There was no difference in processing time in the current study among Rh-positive and Rh-negative donors ($p>0.005$) in contrast to Chatterjee et al.[10] who reported shorter processing time for Rh negative donors as compare to Rh positive.

Correlation with CBC parameters:

Various studies across the world were conducted to determine the factors affecting the platelet yield in plateletpheresis, but none of the study evaluated all these parameters with yield to the best of our knowledge. The observations of various studies with the present study were summarized in Table -5. The most consistent and significant parameter affecting the platelet yield was pre-donation platelet count. All studies found a direct positive correlation between them means higher the platelet count of the donor, higher will be the yield. In the current study, the mean pre-donation platelet count was 2.85±0.53 per cumm which resulted in a yield of 3.88±0.58. The rest of the other parameters showed controversial results. The present study found a negative significant association of MPV and a positive significant association of PDW with yield. Patel AC et al.[6] and Tejaswi et al.[12] found in their study that MPV (in fL) and PDW (in %) had a significant negative correlation with platelet yield. They stated that lower MPV (small-sized platelets) contributed to higher platelet yield. However, Chatterjee et al.[10] found a statistically significant positive correlation of both MPV and PDW with yield. This controversial observation may be because of difference in sample size and in the separation mechanism of apheresis machines used in these studies.

Correlation with procedural parameters:

Platelet yield also depends upon processing time (run time), total volume processed, and AC infusion rate. The present study also found a significant correlation between total volume processed and yield ($r=0.35$, $p=0.043$) similar to other studies.[5,9,15,20]

Run time or processing time is an important parameter not only for yield but also for donor retention as it is inversely related to comfort of donor. Run time is directed correlated with AC infusion to donor ($p<0.005$). Longer run time is associated with more AC infusion in donors and having more chances of citrate-related adverse effects. Longer run time is also related to more apprehension in the donor.[9] The mean run time and mean AC infusion to the donor in present study was 40.98 minutes and 192.69 ml respectively which was lower as compared to the Kanungo et al.[9] Run time was not correlated with yield in the current study similar to Kanungo et al.[9] and Fateen et al.[20] and whereas, Geetha et al.[8] in their study

revealed a positive significant association between run time and yield.

Thus, a multicentric prospective study with a large sample size is required to evaluate the effect of all these factors on platelet yield for better selection of donors in plateletpheresis.

Conclusion:

The recovery of platelets in thrombocytopenic patient is mainly dependent on the quantity and quality of platelets transfused. Routinely, the number of platelets in the apheresis product is equivalent to 6-8 random platelet concentrates. The total number of platelets collected in a bag after apheresis is measured in terms of platelet yield. Thus, better yield is directly related to less number of transfusions, so less exposure to multiple donors, and thus lessening the economic burden and giving good outcomes in thrombocytopenic patient. The present study observed platelet count, MPV, PDW, and volume processed as significant parameters affecting the platelet yield. Donor's age, gender, BMI, Blood group, pre-donation HB, HCT, TLC, and procedural time were not associated with the platelet yield in the current study. However, run time is significantly associated with AC infused to the donor.

Thus considering all these parameters blood banks can select donors for plateletpheresis to obtain higher yield in lesser time and can ensure the donor safety.

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Conflicting Interest: Nil

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