CORRELATION OF DONOR CHARACTERISTICS AND APHAERETIC PLATELET YIELD USING THE TRIMA ACCEL MACHINE AT THE AGA KHAN UNIVERSITY HOSPITAL, NAIROBI, KENYA

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Abstract

Background: One of the devices dedicated to the collection of leukoreduced single-donor platelets is the Trima Accel cell separator. Improved efficiency of apheresis and increased flexibility in the collection of leukoreduced platelets has been enhanced by the new Universal Platelet protocol. The aim of this study was to determine the correlation between donor characteristics and apheresis platelet yield using the Trima Accel machine at the Aga Khan University Hospital.

Methodology: This was a cross-sectional study carried out at the blood transfusion department of the Aga Khan University Hospital, Nairobi. The study population comprised all persons who came to voluntarily donate platelets and gave informed consent at the hospital and comprised of 120 donors. The first phase was to determine the donors' gender, hemoglobin count, platelet count, weight, and height. Upon qualification, the donors donated platelets through the Trima Accel machine. The platelet count of the donated platelets was determined using the Sysmex XN-1000 then the yield was calculated.

Results: The mean platelet yield was 4.07×10^{11}. The platelet yield correlated with donor pre-platelet count (r=0.413), but did not correlate with age (r=0.096), height (r=0.024), weight (r=0.068), gender (0.096), hematocrit (0.134) and hemoglobin (r=0.134).

Discussion: Variables such as age, height, weight hemoglobin, and hematocrit showed no correlation with the yield while pre-donation platelet count correlated with the yield.

Key words: *Donor Characteristics, Platelet yield, Apheresis, Trima Accel Machine.*

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1. Introduction

Apheresis is a Greek word that means to separate or remove from blood whereby products like platelets, plasma, or packed blood cells can be collected from an individual donor (1). Therapeutic apheresis normally includes the exchange of plasma and cytapheresis. The procedure involves withdrawing blood from a donor or patient in an anticoagulant solution and separating it into components like plasma, packed red blood cell, and platelets. One or more component is retained and the remaining constituents are returned to the individual (2).

The basic principle behind the preparation of components from whole blood is that each component has its specific gravity and by applying centrifugation, each component is separated and removed, thus allowing the transfusion of the desired component according to the need of the patient.

The majority of prophylactic platelet transfusions are given to patients with severe thrombocytopenia in surgical and non-surgical settings. Most data suggest that prophylactic platelet transfusions should be given to non-surgical patients with chronic thrombocytopenia when counts are below 10,000 plts/µl and in the face of active bleeding. Spontaneous bleeding due to thrombocytopenia alone does not occur until the platelet count is below 10,000 plts/µl (3). Patients with heparin-induced thrombocytopenia or chronic thrombocytopenia caused by increased platelet destruction (e.g., idiopathic thrombocytopenic purpura) are not supposed to be administered prophylactic platelets. Transfusion may be ineffective due to refractoriness in a substantial percentage of these patients (4).

Therapeutic platelet transfusions are usually indicated in the non-surgical arena when bleeding reaches the WHO grade 2 level (evidence of hemorrhage not requiring excess red cell transfusions (5).

Platelet apheresis procedure has emerged as one of the most important procedures in determining the outcome of the apheresis product quality. Based on previous studies, this method of platelet collection was able to produce a better platelet yield in terms of volume and concentration. Studies illustrated the possible variations involved in contributions to the outcome of the platelet apheresis yield. There are many factors involved which could be donor-related or machine-related. The factors include the donor's age, gender, height, weight, pre-donation hemoglobin level, and pre-donation platelet count. Previous studies demonstrated that the pre-donation platelet count had a significant influence on the platelet yield (6). Apheresis donors with pre-donation platelet count > 250×10^9/L have been determined to produce a desired hemostatic platelet dose for the recipient. Chaudhary et al, 2006 found no correlation between the pre-donation Hb and the yield ($r = -0.10$, $p > 0.005$). Some donors with Hb above 16 g/dl gave a lower yield compared with those with Hb lower than 16g/dl. Guerrero-Rivera et al., 2003 and Osmanovic (2017) concluded that this could be related to the greater amount of plasma processed in donors with lower Hb.

There is no significant relationship between donor weight and platelet yield (Chaudhary et al.'s, (2006). According to the AABB requirements, 75% of the plateletpheresis products prepared must

contain ≥ 3 x 10^{11} platelets per unit, while the European guidelines recommend a platelet count of ≥ 2×10^{11}/Unit (10).

In another study, one hundred and twenty-seven procedures of apheresis have been considered. Gender, age, volume processed, PLT pre-counts, and Hb were considered as predicting variables. The AC infusion rate, plasma volume, and processing time collected with the PLTs were examined as machine parameters. The researchers then evaluated the post-transfusion effectiveness in patients who had thrombocytopenia, assessing the effect of PLT dose, PLT storage time, and ABO group. The findings from the study showed that females have a higher yield when compared to males. Further, the AC infusion rate and processing time generated a positive influence on the PLT yield. The study also showed that most of the complications related to citrate. Further, PLT increments in patients who had undergone transfusion presented a positive correlation with the units that were transfused and negatively with the storage days for PLT (11). Studies show that donors who have Hb levels that are greater than 12 g/dl can be able to donate safely.

In another study that was assessing the Haemonetics cell separator, researchers noted that the machine was able to collect apheresis platelets effectively with a mean of 3.7×10^{11}, and mean CR of $0.063\pm0.013 \times 10^{11}$/min. Further, in other literature for assessing the Trima cell separator, the machine has been shown to effectively collect the platelets with a median of 3.7×10^{11} (12). In this study it sought to correlate donor characteristics and apheresis platelet yield using the Trima Accel machine at the Aga khan university hospital.

2. Materials and methods

This was a cross-sectional study that involved the collection of data during one point in time. The collection of platelets from the subjects using the Trima Accel machine at Agha Khan University was done at one point in time and the findings used in assessing the variables in the study.

Donor platelet count and yield, laboratory tests, and structured donor questionnaires were used in gathering data. The structured donor questionnaires were developed from a review of tools used in assessing the donor characteristics associated with platelet yield in the platelet apheresis process. Laboratory tests were used to analyze the donor's platelet count and yield while donor questionnaires were used in the assessment of donors.

Laboratory Tests and Techniques

Full Haemogram on donor sample pre-donation.

Blood was collected from the donor before donation and a full haemogram was run using the Sysmex XN-1000 Haematology analyzer for estimation of platelet, hemoglobin, and hematocrit. The full hemogram serves as one way of ensuring the donor meets the minimum qualification for platelet donation. Once the donor qualified i.e. a hemoglobin count of 12 mg/dl for women and 13 mg/dl for men, Haematocrit count of 40% to 52%, and a platelet count of 250×10^9/L they were scheduled for platelet donation through the apheretic machine for platelet collection.

Platelet count after they had been donated.

After donation, the platelets collected in a platelet bag pouch were analyzed using the Sysmex XN-1000 hematology analyzer.

Platelet yield calculation

$$\text{Platelet Yield} = \frac{\text{Platelet count x Platelet Volume}}{100000}$$

Platelet count: The count of platelets in the collection bag done using the Sysmex xn 1000 machine (count$\times10^9$/l)

Platelet Volume: Volume platelets collected in the bag (mls).

$$= \frac{\text{Weight of collected platelets (mgs) - Weight of an empty bag (mgs)}}{1.03}$$

Key

1.03: A Constant for converting weight of blood (mgs) to volume (mls)

100000: A constant for converting count/µl to count/ L .

3 Results

The cases included 120 transfusion donations made during the period of the study. The response rate for the study was therefore 100%.

Demographics

Majority of the respondents were male (95.83%) while female blood donors who participated in the study made 4.17%. The pie chart below presents the distribution in terms of gender in detail.

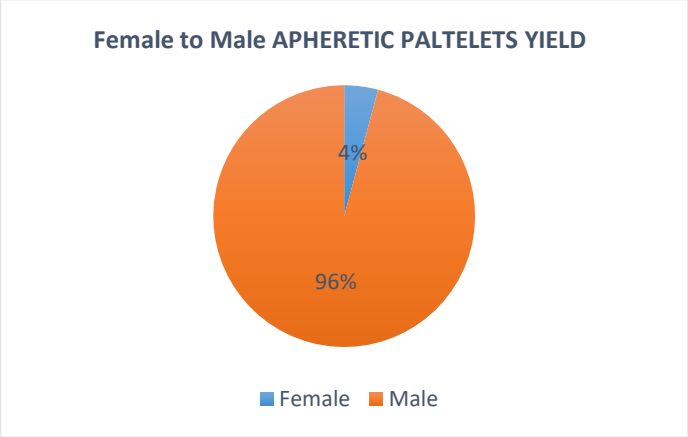

Figure 1: Distribution of donors in terms of gender

Most of the blood donors were aged between 30 and 39 (43.3%) years while those aged between 20 and 29 years were also significant (37.5%). The main focus was on the dependent variables (the yield) and how it was affected by the independent variable that is age, gender, weight, height, hemoglobin, hematocrit, and the pre-donation platelet count. The required age bracket for a person to donate is 18 years to 65 years of age. The ages of the donors varied with the youngest being 18 years, the oldest donor being 61 years and the average being 32.4 years.

Table 1: Basic summary statistics of the Age groups.

	N	
Background characteristics	**120**	**n (%)**
Age-group		
Below 20 years		1 (0.83%)
20 – 29		45 (37.50%)
30 – 39		52 (43.33%)
40 – 49		19 (15.83%)
50 – 59		2 (1.67%)
60 and Above		1 (0.83%)

Source Field Data (2019)

Platelet Yield and Donors Background Characteristics.

a) Objective 1: To determine the effects of platelet count on aphaeretic platelet yield.

Pre-donation platelet count serves as one of the parameters that are tested prior to platelet apheresis. The more the amount, the more there is to harvest and the least the amount the less there is to harvest. The pre-donation platelet average count for female donors was 367×10^9/L with an average yield of 4.59×10^{11} platelets and male donor was 315×10^9/L with an average yield of 4.04×10^{11} platelets, with the highest among the whole group of donors being 484×10^9/L with a yield of 5.0×10^{11} platelets. The combined pre-donation platelet average was 317×10^9/L giving an average yield of 4.07×10^{11} platelets.

b) Objective 2: To determine the effects of hemoglobin count on aphaeretic platelet yield.

Hemoglobin count is a parameter that must be determined before a donor donates because quit a huge amount of blood needs to be processed. Female donors must have a hemoglobin value of at least 12 g/dl while male donors must have a hemoglobin value of at least 13.0 g/dl. The average hemoglobin count was 15.3 g/dl. The highest hemoglobin count was 18.4 g/dl with a yield of 3.3×10^{11} platelets while the lowest hemoglobin count was 13.6 g/dl with a yield of 4.07×10^{11} platelets.

c) Objective 3: To determine the effects of donor height on aphaeretic platelet yield.

Height of donors is done prior to donating and is a parameter that the machine uses to determine the duration of the procedure. The average height was 170.9 cm. The tallest person was 190 cm and donated platelets with a yield of 4.1×10^{11} platelets while the shortest person was 115 cm and donated platelets with a yield of 4.0×10^{11} platelets.

d) Objective 4: To determine the effects of donor weight on aphaeretic platelet yield.

Weight is also another parameter that is used by the machine to determine the duration of the procedure. The average weight was 80.2 Kgs with the lightest donor being 54 Kgs giving a yield of 4.03×10^{11} platelets and the heaviest being 121.42 Kgs giving a yield of 4.2×10^{11} platelets.

e) Objective 5: To determine the effects of hematocrit count on apharetic platelet yield.

Hematocrit was also found not to be significant to the yield. (r= 0.413). The highest level being 53.7% and the lowest levels being 37.8%. In comparison women have an average of 41.6% while men had 45.%.

f) Objective 6: To determine the effects of age and gender of the donors on aphaeretic platelet yield.

The required age bracket for a person to donate is 18 years to 65 years of age. The ages of the donors varied with the youngest being 18 years, the oldest donor being 61 years and the average being 32.4 years. Most of the blood donors were aged between 30 and 39 (43.3%) years while those aged between 20 and 29 years were also significant (37.5%). There were more male (95.83%) than female donors (4.17%). The study findings showed that the average yield for the female donors was 4.59×10^{11} platelets while the average yield for the male donors was 4.04×10^{11} platelets. Further, the results indicated an average yield of both male and female of 4.07×10^{11} platelets. This is an indication that female donors have a higher yield when compared to the male donors even though it is a possible confounding effect of the sample size. Further, an analysis of the platelet yield and donor characteristics was done in order to understand the relationship between the dependent and independent variables. From the analysis, it was determined that there was a correlation between donor characteristics and aphaeretic platelets yield with pre-donation platelet count (r=0.413, CI = 0.0037, 0.0054). The table below presents the findings in greater detail.

Table 2: Platelet yield and donor characteristics

Yield	R	r square	Adjusted r square	Std. Error of the Estimate	95% Conf. Interval	
Donated platelet count	0.413	0.171	0.037	1.361	0.0037	0.0054
Gender	0.096	0.009	0.001	1.387	-.0094053	.0048224
Weight (Kgs)	0.068	0.005	-0.004	1.390	-.0020282	.0065673
Height (cms)	0.024	0.001	0.008	1.393	-.0072412	.0053065
Hemoglobin	0.134	0.018	0.010	1.382	-.02817	.1322787
HCT	0.134	0.018	0.010	1.381	-.0420	.0001667
Age	0.096	0.009	0.001	1.387	-.0094053	.0048224

Source: Field Data (2019)

The analysis reveals that gender, age, height, weight, hemoglobin, and hematocrit show no correlation with the yield while pre-donation platelet count values had an association with the yield.

Anticoagulant Citrate Dextrose is used to prevent blood from clotting ones outside the body. The longer the time it takes for the collection procedure the more the anticoagulant is used and the more the volume of blood is processed. The lowest actual

Anticoagulant to donor in milliliters was 200 milliliters while the highest was 421 milliliters. Looking at the duration of time taken to donate the average was 58.5 mins with the fastest being done in 40 mins while the longest time taken was 92 mins. In terms of blood, volume processed the average was 3361 mls with the least processed being 2130 and the most processed being 5230.

Table 3: Actual Anticoagulant to donor (mls), duration of time (mins) taken to donate platelets and blood volume (mls) processed.

Activity	Volume in ml
Average Actual AC to donor (milliliters)	280.3
The average duration of minutes taken to get yield	58.5
Average blood volume processed (milliliters)	3361

Source: Field Data (2019)

4. Discussions

In this study, the demographics showed that the respondents were between 18 and 61 years. This is a convention for blood donation. The findings from the study showed that the pre-donation platelet count of the donor and the platelet count of the donated platelets had a significant difference but other donor characteristics did not account for the significant difference. Mangwana (13) presents almost similar results noting that weight, height, platelet count, and total leukocyte count do not have a significant correlation with the platelet yield, blood volume, and processing time while hemoglobin particularly in females shows significant correlation (13). Another research shows that platelet yield correlates significantly with pre platelet count of the donor and negatively with the pre-Hb of the donor (14). This is an indication that transfusion centres should have their own plateletpheresis based on hematological and demographic characteristics of the donor target population to ensure safety and quality.

Further, data was analyzed using multiple linear regressions comparing the significance level of each independent variable compared to the dependent variable the yield. Using a 95% confidence interval, results were deduced that variables modeled affect the yield. On the assessment of the donor variables on platelet yields, we found that there is a significant correlation with the pre-donation platelet count (r = 0.434). According to the data, women had more yield compared to men. This could be attributed to the high platelet count in women as well as the fact that women have fewer hemoglobin values hence more plasma volume in women is processed than in men, even though the findings might have been confounded by my sample size. The average hemoglobin count was 15.3g/dl. The r-value for hemoglobin was r = 0.134). This shows that there is no correlation between hemoglobin and the platelet yield. The r-value of age was (r=0.096) and the average age was 32.4. There was no correlation between age and apheretic platelet yield. The r-value for height was (r=0.024) and the average height was 170.9. There was no correlation between Height and the platelet yield.

The average weight was 80.2 Kgs and the r-value was (r = 0.068) showing no correlation between weight and the platelet yield. There were more males (95.83%) than female donors (4.17%). The correlation coefficient value for gender was (r =0.096) showing no correlation between gender and platelet yield.

These results led to the conclusion that gender, hemoglobin, hematocrit, weight, height, and age have no correlation with aphaeretic platelets. Other studies done can confirm this statement showing there is no correlation between the yield and these listed variables. Chaudhary et al, 2006 found no correlation between the pre-donation Hb and the yield (r = - 0.10, p > 0.005). Some donors with Hb above 16 g/dl gave a lower yield compared with those with Hb lower than 16g/dl. Guerrero –Rivera *et al*, 2003 and Landžo & Petrovi (2015) concluded that this could be related to the greater amount of plasma processed in donors with lower Hb. Bahadur et al (16) also studied the effect of donor weight on platelets yield and found no significant correlation. According to the AABB requirements, 75% of the plateletpheresis products prepared must contain $\geq 3 \times 10^{11}$ platelets per unit, while the European guidelines (*Council of Europe publishing, 2006*) recommends platelet count of $\geq 2\times10^{11}$/Unit.

Pre-donation platelet count has a significant linear correlation with the platelet yield (r = 0.413). The higher the platelet count means more platelets are available for collection. Out of the 120 donors assessed for the pre-donation platelet count effect on platelet yield, 24 (20%) had a pre-donation platelet count $<250\times10^{9}$/L. The mean yield of the platelets from these donors was 2.3×10^{11}/Unit. 22(18%) had a pre-donation platelet count of $250\text{-}300\times10^{9}$/L and the mean yield in the product from these donors was 3.9×10^{11}/Unit. 74(62%) had a pre-donation platelet count $>300\times10^{9}$/L and the mean yield in the products was 4.4×10^{11}/Unit. Chaudhary (9), in a study of 94 plateletpheresis procedures, found a mean yield of $2.8\pm0.73\times10^{11}$/Unit and they found that when the pre-donation platelet count was greater $>300\times10^{3}$/µl, the yield was greater than 3×10^{11}/Unit in 80% of the products. They also reported that the mean yield was $2.5\pm0.59\times10^{11}$/Unit when the pre-donation platelet count was $<200\times10^{3}$/µl. The results obtained in this research are in accordance with these observations and the platelet yield correlated linearly with the pre-donation platelet count of the donor. *Goodnough et al, 1999* studied 708 plateletpheresis procedures, and a direct correlation between yield and pre-donation platelet count was observed. In 12% of the procedures, the mean yield was $<3\times10^{11}$/Unit when the pre-donation platelet count was $<200\times10^{3}$/µl.

Hematocrit was also found not to correlate with the yield. (r =0.134). The highest level is 53.7% and the lowest levels being 37.8%. In comparison, women had an average of 41.6% while the men had 45.18%. Elveden (15) concluded that increased values of hematocrit reduce the efficiency of platelet collection hence the platelet yield. He concluded that it's preferable to collect platelets from donors with higher baseline platelet counts and lower Hct counts because they give a higher yield.

5. Conclusion

In conclusion variables such as gender, age, height, weight, and hemoglobin showed no correlation with the platelet yield while pre-donation platelet count had an association with the platelet

yield. HCT values had no association with the yield. The Trima Accel machine is an effective machine at collecting platelets as is was capable of collect platelets with an average yield of 4.07×10^{11}.

6. Recommendation

All transfusion centers should have their plateletpheresis donor data based on demographic and hematological factors. Even though the findings might have been confounded by my sample size, more females than males should be encouraged to donate apheretic platelets because it's evident they produce better quality in terms of yield. Donors with a pre-donation platelet count greater than 250×10^9/L should be targeted as they donate platelets with a higher yield. The media and religious institutions should be used as a medium of enlightening the citizen on the need to donate blood and blood products, aphaeretic platelets being one of them. Kenya National Blood Transfusion Services should use this information to come up with policies and guidelines on aphaeretic platelet donations and technology. More research should be done on this topic on factors such as social-economic factors that would affect platelet yield.

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Conflict of interest

The author declares no conflict of interest.

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