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ORIGINAL ARTICLE

Platelet Yield and Some Donor-Related Predictors in a Single Donor Apheresis: Report from a Nigerian Tertiary Hospital

Rendement Plaquettaire et Certains Facteurs Prédictifs Liés au Donneur dans une Aphérèse Avec un Seul Donneur : Rapport d'un Hôpital Tertiaire Nigérian

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ABSTRACT

BACKGROUND: Single-donor platelet transfusion is the preferred therapeutic option for patients with platelet insufficiency and its effectiveness is partly dependent on the yield.

AIM: To determine the platelet yield and predictors of platelet yield in single-donor apheresis.

MATERIALS AND METHODS: This was a five-year review of the data on single-donor apheresis using the Haemonetics Apheresis machine MCS+ at Alex Ekwueme Federal University Teaching Hospital Abakaliki Ebonyi state. Platelet donor related variable of interest included the pre-donation platelet count, donor's blood group, number of apheresis cycles and yield volume. Analysis was done using Graphpad Prism version 9.1.1.

RESULTS: A total of 153 platelet apheresis were studied. The mean (SD) values for pre-donation platelet count, number of cycles, platelet yield and volume of platelet concentrate were 279 ± 47 x 10^9/L, 6 ± 0.3, 4.5± 0.8 X 10^{11}/L, and 320 ± 78 mL respectively. In this study, volume of platelet concentrate predicted 61% of platelet yield while platelet count of donor predicted 41%. Neither ABO nor Rh blood groups was a determinant of platelet yield.

CONCLUSION: Pre-donation platelet count and volume of platelet concentrate are important predictors of platelet yield. There is need for proper platelet donor selection. **WAJM 2022; 39(12): 1280–1284.**

Keywords: Platelet apheresis, Platelet count, Platelet volume, Platelet yield.

RÉSUMÉ

CONTEXTE: La transfusion de plaquettes d'un seul donneur est l'option thérapeutique privilégiée pour les patients souffrant d'insuffisance plaquettaire et son efficacité dépend en partie du rendement.

OBJECTIF: Déterminer le rendement plaquettaire et les prédicteurs du rendement plaquettaire dans l'aphérèse à donneur unique.

MATÉRIEL ET MÉTHODES: Il s'agissait d'un examen quinquennal des données sur l'aphérèse à donneur unique utilisant l'appareil d'aphérèse Haemonetics MCS+ à l'hôpital universitaire fédéral Alex Ekwueme d'Abakaliki dans l'État d'Ebonyi. Les variables d'intérêt liées au donneur de plaquettes comprenaient la numération plaquettaire avant le don, le groupe sanguin du donneur, le nombre de cycles d'aphérèse et le volume de rendement. L'analyse a été effectuée à l'aide de Graphpad Prism version 9.1.1.

RÉSULTATS: Au total, 153 aphérèses plaquettaires ont été étudiées. Les valeurs moyennes (écart-type) de la numération plaquettaire avant don, du nombre de cycles, du rendement plaquettaire et du volume du concentré plaquettaire étaient respectivement de 279 ± 47 x 109/L, 6 ± 0,3, 4,5 ± 0,8 x 1011/L et 320 ± 78mL. Dans cette étude, le volume du concentré plaquettaire prédisait 61 % du rendement plaquettaire, tandis que la numération plaquettaire du donneur prédisait 41 %. Ni le groupe sanguin ABO ni le groupe sanguin Rh n'ont été des facteurs déterminants du rendement plaquettaire.

CONCLUSION: La numération plaquettaire pré-don et le volume de concentré plaquettaire sont des facteurs prédictifs importants du rendement plaquettaire. Il est nécessaire de sélectionner correctement les donneurs de plaquettes. **WAJM 2022; 39(12): 1280–1284.**

Mots clés: Aphérèse plaquettaire, Numération plaquettaire, Volume plaquettaire, Rendement plaquettaire.

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Abbreviations:

INTRODUCTION

Platelet is an essential component of coagulation system.[1] It functions by sealing vascular injury with primary haemostatic plug. Together with coagulation factors, it forms a stable clot thereby maintaining haemostasis. The two main methods of harvesting platelets are single donor platelet (SDP) apheresis and pooled random donor platelet.[2] The SDP apheresis refers to the method of collecting platelet from a single donor using an apheresis machine. The machine harvests platelets from the potential donor and return other blood components to the donor. SDP transfusion has become a standard practice for patients with platelet insufficiency.[3] It has some advantages over pooled random donor platelet which include fewer inventories and pooling, reduced exposure to foreign antigens, leucocyte reduction during collection, and easier platelet cross matching or HLA matching for refractory patients.[4] In addition, one donor is required, leading to less alloimmunization and bacterial contamination.[4]

One unit of SDP concentrate is expected to contain a minimum of 3.0 x 10^{11}/L according to the American Association of Blood Bank (AABB) guidelines or a minimum of 2.0 x 10^{11}/L based on the European guidelines.[5] One unit of platelet concentrate from SDP is expected to increase the recipient's platelet count by 30–60 x 10^9/L.[6] This is not always the case as there are reports of higher or even lower platelet counts in recipients. The platelet yield and recipient's platelet increment depend on the patient-related, procedure and donor-related factors.[3] Patient-related factors determine mainly the platelet recovery after platelet transfusion. Procesure-related factors include number of cycles per apheresis session and the caliber of intravenous access used. We set to determine the donor-related factors which influence the platelet yield in our environment.

Platelet recovery from the recipient is influenced by parameters like fever, splenomegaly, refractoriness and platelet storage factors like number of days, platelet bag and agitation.[5,7] Single donor platelet has a better quality and yield that enhances platelet recovery in the recipient.[8,9] Platelet shelf life is about 5 days when stored in temperature controlled incubators (20–24^{o}C) under constant agitation.[7,10] Even though platelet shelf life is regarded as 5 days, platelet recovery after 5 days is important[7] because of the problem of contamination which significantly increases after 5 days.[6,11]

Platelet has been transfused to individuals for both prophylactic and therapeutic reasons.[10,12] Prophylactic platelet transfusion is for a patient that is neither bleeding nor undergoing invasive procedure.[10] The recommended triggers for platelet prophylaxis is platelet count less than 10 x 10^9/l or platelet count less than 20 x10^9/l with fever.[2,13] Therapeutic platelet transfusion is indicated in bleeding patient as a result of thrombocytopenia or when an invasive procedure is anticipated.[2,12] Thrombocytopenic patients are at increased risk of bleeding and bleeding into the central nervous system may be fatal.

Platelet transfusion can be a life-saving procedure in prevention and treatment of bleeding resulting from thrombocytopenia and thrombocytopathy.[2,4] A quality platelet yield and recovery play a vital role. Therefore, this study aims to determine the platelet yield from our apheresis procedure and evaluate some donor-related predictors of platelet yield.

METHODOLOGY

This was a descriptive retrospective study conducted in a tertiary health institution in south-east Nigeria. It was a 5-year review of the apheresis practices of the blood bank of the institution between May 2016 to April 2021. Donors were selected based on the Hospital Transfusion Protocol. For our platelet donors, only group-specific donors (donors that have same blood group with the recipient) were used. Prior to donation, details of the procedure were explained to the donors and informed consent was obtained. Donors were excluded if the platelet count was < 200 x 10^9/L, haematocrit of < 36%, mean cell volume of <70fL, and weight of < 45 kg. Donors were given 2 g of calcium in water and were well-hydrated before the procedure. All platelet donations were carried out using the Haemonetics apheresis machine MCS+ USA which is a one-way system that uses closed system kits.

Apheresis technology is a procedure where the required component is collected and the rest of the blood is returned to the donor.[6,14] The working principle of apheresis equipment is either by centrifugation or filtration.[8, 13]

Heamonetics apheresis machine works by centrifugation. It is an intermittent working apheresis because it uses single vein access for both collection and return. About 450 mls of blood is collected from the donor into a bowl called extracorporal volume (ECV).[11] The whole blood in ECV is centrifuged and separated into different components. The platelet component is collected into a collection bag fitted with leucocyte filters. The plasma is collected in the plasma bag on the weigher and the red cell remains on the bowl. Both the plasma and red cell are returned to the donor during each cycle.

One cycle of intermittent working apheresis consists of collection of one ECV of whole blood, centrifugation to separate components based on their difference in specific gravity and size, collection of the required component (platelet) through a valve-controlled channel into a collection bag and return of other components back to the donor.[6] This cycle is repeated 4–7 times per session till therapeutic dose is attained. The therapeutic dose of a single session of 4–7 cycle ranges from 30 x 10^9/L to 60 x 10^9/L of platelet depending on donor parameters and procedural factors.[11,15]

Donors' data collected include sociodemographic variables, pre-donation platelet counts, and ABO and Rh blood groups. Subsequently, the volume of the harvested platelets and number of cycles were recorded. Platelet yield was automatically generated by the machine from donors' parameters.

Data were analysed using Graphpad Prism version 9.1.1 (225). Results were presented in tables as mean and range. Predictors of platelet yield were evaluated using linear regression. Pearson was used to test for correlation.

RESULTS

We reviewed data on 153 single donor platelet apheresis from adult males. Their median (range) age was 22 (18–34) years. They were grouped into five based on the pre-donation platelet count. Group 1 was between 200–249 x 10^9/L, group 2: 250–299 x 109/L, group 3: 300–349 x 10^9/L, group 4: 350–399 x 10^9/L, group 5: 400–449 x 10^9/L. Majority (44.8%) of the donors had pre-donation platelet count of 250–299 x 10^9/L, slightly above one-quarter (28.8%) had platelet counts of 200–249 x 10^9/L. The remaining 15.7% and 8.5% of donors had platelet counts of 300–349 x 10^9/L and 350–399 x 10^9/L respectively. Only 4 (2.6%) of the donors had platelet count between 400–449 x 10^9/L. The mean pre-donation platelet count was 279 x 10^9/L. The mean and range values of donors' pre-donation platelet count, apheresis platelet yield and platelet volume are as seen in Table 1.

The mean platelet yield was 4.5 x 10^{11}/L. A little more than half (51.6%) of the donors had a platelet yield between 4.1–5.0 x 10^{11}/L. Slightly below one-quarter (24.8%) had platelet yield between 3.1–4.0 x 10^{11}/L, and 15.7% had platelet yield between 5.1–6.0 x 10^{11}/L. About 5.2% and 2.6% had platelet yield greater than 6.0 x 10^{11}/l and less than 3.1 x10^{11}/L respectively as in Table 2. It showed high statistical significance with pre-donation platelet count ($p<0.0001$) as shown in Table 3.

The mean of platelet volume was 320 ± 70.86 mLs, for an average number of 6 ± 0.3 cycles. The number of sessions correlated positively with platelet volume ($p<0.001$) as seen in Table 3. When Pearson's correlation was applied, pre-donation platelet count of donors and platelet volume were found to be predictors of platelet yield. While donors'platelet count predicts by 41% and platelet volume predicts by 60%, number of sessions was not found to be a predictor. (See Table 3 and Figure 1).

Of the 153 platelet apheresis, 99 (64.7%) were of the O blood group, 25 (16.3%) A blood group and 29 (19.0%) B blood group. Again, majority (141, 92.2%) were Rh-positive. Both ABO- and Rh-blood groups showed no correlation with platelet yield, p value = 0.329 and 0.499 respectively.

Table 1: Mean and Range Values of Platelet Count of Donors, Platelet Yield, Platelet Volume and Number of Cycles

	Platelet Count of Donors (10^9/L)	Platelet Yield (x 10^9/L)	Platelet Volume (mL)	Total Cycles
Minimum	206	2.0	140	4
Maximum	423	7.4	549	7
Mean	279	4.5	320	6.0
Std. Deviation	47	0.8	70.86	0.3
95% CI of mean	271–286	43–46	308–331	5.9–6.0

Table 2: Apheresis Platelet Yield Distribution

Platelet yield x 10^{11}/L	Number of donors	Percentage
<3.1	4	2.6
3.1 – 4.0	38	24.8
4.1 – 5.0	79	51.7
5.1 – 6.0	24	15.7
>6.0	8	5.2

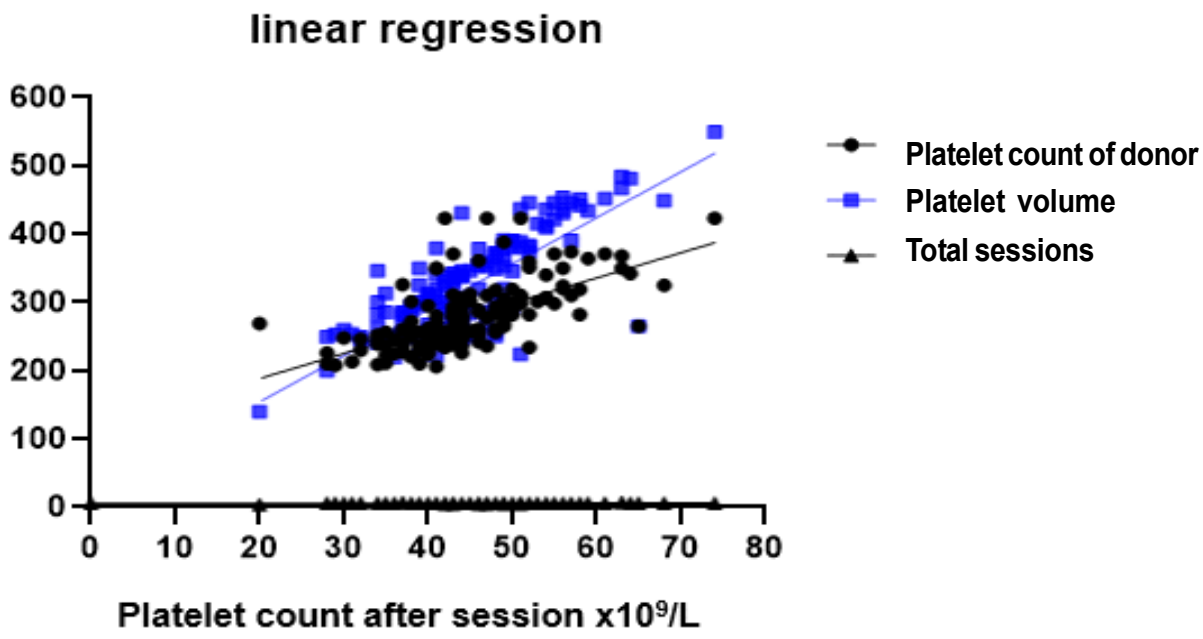

Fig. 1: Predictors of Platelet Yield after Sessions.

Table 3: Correlation of Platelet Yield with some Variables

	Mean values	r	R^2	P value
Donors' platelet count	2.79 x 10^{11}/L	0.64	0.41	<0.0001
Platelet volume	320.00mL	0.78	0.61	<0.0001
Total cycle	6.20	0.09	0.01	0.25

DISCUSSION

Single Donor Platelet (SDP) has become the gold standard for platelet concentrate preparation.[3,16] SDP has increased platelet yield and fewer bacterial contaminations. Platelet yields are affected by donor factors. Donors for SDP pheresis must be carefully selected based on physical and laboratory parameters to maximize yield.[11,15,17] We focused on some of the donor-related parameters that affect platelet yield.

In this study, the mean pre-donation platelet count was 279 x 10^9/L. This was

higher than that reported by Bahadur *et al* and Arum *et al* whose mean pre-donation platelet counts were 247 x 10^9/L and 269 ± 65 x 10^9/L respectively.[3,5] We also reported a high mean platelet yield of 450 x 10^9/L when compared to those of previous researchers who recorded 320 x 10^9/L and 316 x 10^9/L respectively.[3,5] These may be a reflection of the higher pre-donation platelet count in our study. The platelet yield is markedly increased if the pre-donation platelet count is > 250 x 10^9/L. While the American blood transfusion guideline requires pre-donation platelet count not less than 150 x 10^9/L,[11,13] our institution protocol recommended a minimum of pre-donation platelet count of 200 x 10^9/L and this may contribute to the higher platelet yield recorded. However, this minimum requirement for platelet donation will disqualify a lot of potential donors impacting on our already limited donor pool.[18] Consequently, we observed a direct linear correlation between pre-donation platelet count and platelet yield and our study showed that pre-donation platelet count predicts 41% of platelet yield.

Out of 153 platelet apheresis done in our institution over 5 years, 149 (97.4%) platelet apheresis had a platelet yield > 3.1 x 1011/L which met the American Association of Blood Bank requirement for SDP yield (AABB > 3.0 x 10^{11}/L).[14] All (100.0%) the 153 platelet apheresis had a platelet yield that met the European guideline for single donor platelet yield (European guideline > 2.0 x 10^{11}/L).[15,16] Our result may be a consequence of careful selection of donor based on pre-donation platelet count and easily accessible intravenous access on the ante-cubital fossa, which gave a better platelet yield while avoiding platelet activation and aggregation.[19] In a related study done by Arum *et al,*[5] majority (93%) met European guideline but only 66.1% met the AABB criteria. Furthermore, Geetha *et al,*[4] in their study documented that only 19.2% of platelet yield met AABB criteria for platelet donation. Majority of the platelet yield did not meet both AABB criteria and European guidelines unlike our study. The reason ours met both criteria may be because of a higher pre-donation platelet counts in our study subjects as evidenced by a higher mean pre-donation platelet count. The more the platelet count, the more it is available for collection.[4] There is a strong correlation between the calibre of intravenous access, the processing time and volume of blood processed.[4] The larger the calibre of the intravenous access, the better the yield because there will be less contact activation of platelets and hence aggregation.[19] Also, the higher the processing time and the more the blood volume processed, the higher the platelet yield.[4]

Even though platelet volume is an output of SDP, we observed that platelet volume was a predictor of platelet yield. The mean platelet volume was 320 ± 70.86mLs and mean platelet yield was 450 ± 80 x 10^{19}/L in our study. These were positively correlated. Platelet volume predicted 60% of the platelet yield in our study. This can be explained by the inverse relationship found by other authors between platelet yield and pre-donation haematocrit.[4] Bahadur *et al* found a negative correlation between pre-donation haemoglobin concentration/ haematocrit and platelet yield that the less the haemoglobin concentration of the donor the more the platelet yield.[4] This can be explained by the fact that the ECV is about 450 mls and the more the haemoglobin concentration or the more the haematocrit measured of the fixed ECV the less the plasma and consequently, the platelets to harvest. The more the plasma component the more the platelet volume and platelet yield. Haemonitics MC+ requires a minimum haemotocrit of 37% for the donor.

Mangwana *et al* reported a negative correlation between pre-donation platelet count and processing time.[20] They also showed that increasing the processing time increases the platelet yield. However, it should be noted that increased processing time may be due to poor access and not necessarily increase processed volume. In addition, increasing the processing time will increase the volume of ACD anticoagulant infused on the donor, which may cause citrate toxicity (side effects).

In conclusion, we recorded a high platelet yield in our study. All the SDP apheresis yield from our centre met the European guideline on apheresis. A high pre-donation platelet count as well as volume of platelet concentrate are important predictors of platelet yield. There is need for proper platelet donor selection for optimal platelet yield.

Note: *The abstract of this work was presented at the 2021 scientific conference of the West African College of Physicians, Nigeria chapter.*

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