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ORIGINAL ARTICLE

# Impact of donor and procedural parameters on platelet yield in plateletpheresis: a retrospective data analysis over a seven-month period

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## ABSTRACT

**Aim** To identify donor and procedural parameters that influence the platelet yield obtained by apheresis.
**Methods** A retrospective observational study of 60 plateletpheresis procedures was conducted at the Blood Transfusion Institute of the Federation of Bosnia and Herzegovina in Sarajevo. Plateletpheresis procedures were performed using Amicus cell separator with platelet collection protocol in accordance with the work procedure of the institution. The demographic and hematologic parameters of donors, as well as procedural characteristics were correlated with their platelet yield. Correlation analysis was also performed between the actual product yield and the software-predicted product yield. The significance of the difference between the actual platelet yield and the software-predicted yield was analyzed using the Mann–Whitney test.
**Results** The mean pre-donation platelet count was 252x10e9/L. Mean platelet yield was 3.5x10e11/unit. In majority of donors, 48 (80%), the amount of >3x10e11/unit was collected. A positive correlation was observed between platelet yield and pre-donation platelet count ($r=0.611$; $p<0.000$), blood volume processed ($r=0.512$; $p<0.000$), body weight ($r=0.525$; $p<0.000$), body height ($r=0.264$; $p=0.042$), and run time ($r=0.514$; $p<0.000$). A positive correlation between actual product platelet yield and the software predicted yield was found ($r_s=0.774$; $p<0,000$) with statistical difference between them ($p<0.000$).
**Conclusion** Pre-donation platelet count, body weight, body height, blood volume processed and run time affected the platelet yield. Optimizing the platelet yield is a matter of identifying the factors that influence the yield and thus the selection of donors, providing better quality platelet products and clinical outcomes.
**Keywords:** donor, plateletpheresis, platelet yield

## INTRODUCTION

Platelet transfusions are used for the treatment of patients with decreased number or function of platelets in the prevention of bleeding (1). Platelet recovery in a patient is influenced by the transfused dose of platelets, which is dependent on the platelet yield (1). Platelets can be derived from whole blood; however, there has been a gradual increase in the utilization of apheresis platelets in recent years (2).

Platelet concentrates prepared by apheresis decrease allogenic blood components exposures, thereby reducing alloimmunization, platelet refractories, transfusion-transmitted diseases and transfusion reactions (2,3).

Platelet collection yield by apheresis is influenced by donor and procedural parameters, as well as with the type of cell separator used (4). Hence, it is important to target donors that are well-suited for maximizing platelet yield needed for the treatment (4). Recently the use of platelet concentrates has grown steadily due to its employment in chemotherapy protocols (5). The possibility of obtaining higher platelet yields has important clinical implication, such as reduces frequency of platelet transfusions and number of donor exposures with important consequent clinical and economic advantages (5). Platelet yield is a measure of quality of donor platelets, and it enhances platelet recovery in the patients requiring frequent platelet transfusions (5,6). The number of donor platelets directly affects the product yield (7). Platelet yield optimization is a developing issue in blood transfusion institutions (8). The quality system used by blood establishments for the collection of blood and blood components should be designed to assure their quality and safety, as well as to ensure donor safety (9). Blood banks can consider various donor- and procedure-related parameters to obtain higher platelet yields in less time while ensuring donor safety (10). Platelet transfusion success depends on the rational use of platelet components and the quality of the component (11).

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There are studies related to donor, procedure and laboratory factors that may influence the number of platelet yield, but none from Bosnia and Herzegovina. Identification of these factors would allow for better selection of donors resulting in higher platelet yield and consequently a lower number of donor exposures to the patients. Optimization of platelet yield is an important issue in blood transfusion services.

The aim of this study was to investigate the influence of donor demographic, procedural and laboratory factors on platelet yield, thus helping in effectively selecting appropriate donor for plateletpheresis.

## PATIENTS AND METHODS

### Patients and study design

A retrospective observation study on 60 plateletpheresis procedures was conducted at the Department of Hemapheresis with Tissue Bank in Blood Transfusion Institute in the Federation of Bosnia and Herzegovina in Sarajevo, from March 2024 to September 2024. There were 58 (97%) male and two (3%) female donors with median age of 38 years (range 20-59 years), median height of 181 cm (range 158-199 cm), and median weight of 96 kg (range 62-130 kg).

Each donor met institutional standard eligibility criteria for blood donation (9) contained in the questionnaire filled out by each donor, including a consent for donation. The donor's demographic characteristics, pre-donation haematological parameters, procedural parameters and platelet yields were collected from the plateletpheresis register of the Department.

Details of plateletpheresis were explained to each donor for blood donation with additional criteria: haemoglobin level ≥12.5g/dL, pre-donation platelet count ≥180x$10^9$/L, avoiding intake of acetylsalicylic acid or nonsteroidal anti-inflammatory drugs for at least 3 days, female donors with no history of previous pregnancy or miscarriage, time interval of at least one month from the last donation, adequate venous access. Procedures containing all necessary data collected during the study period were included in the analysis.

Research was approved by the Expert Council of the Blood Transfusion Institute of the Federation of Bosnia and Herzegovina.

### Methods

All procedures were carried out using continues cell separators Amicus (Fenwal Inc., IL, USA, software version 4.4); Fresenius Kabi, Bad Homburg, Germany, software version 4.4) with platelet collection protocol in accordance with the work procedure of the institution.

All plateletpheresis procedures were performed using closed system apheresis kits (Fresenius Kabi, Bad Homburg, Germany) with a single needle. Donors were connected to the cell separator via a peripheral vein, with the most suitable vein selected to perform the procedure. During the procedure, anticoagulated whole blood entered the separator, where centrifugal separation was used to collect a specified quantity of platelets and plasma, while the remaining blood components were returned to the donor. Using single needle kits, the same line was used to withdraw blood out of the donor and into the separator, and also to return the processed blood back to the donor. Extracorporeal anticoagulation was achieved with anticoagulant citrate dextrose solution A (ACD-A) in the proportion 1:10 (anticoagulant: whole blood). The end point of each procedure was based on the target yield of 2-3x$10^{11}$ platelets per unit of the final product in autologous plasma set by operator. Processed blood volume to attain the target platelet yield was calculated by the cell separator. After the completion of the procedure, product bags were kept undisturbed for one and a half hour, and then placed into a platelet agitator at 22-24 °C under continuous agitation. No additional post-procedural processing or filtration to obtain leukoreduced products was performed.

Whole blood was collected in an ethylenediaminetetraacetic acid (EDTA) vial (3 mL) just before the procedure from a vein that was not used during the procedure. Pre-donation haematological parameters of haemoglobin concentration (Hb), haematocrit (Hct), total leukocyte count (TLC), and platelet count (PLT) were measured using an automated haematology analyser (Sysmex XS 500i, Sysmex Co, Tokyo, Japan).

Procedure-related parameters, including blood volume processed, run time, ACD-A used, saline used, and software-predicted yield, were recorded by the cell separator after each procedure. Platelet products were tested the next day from the sample pouch attached to the parent bag after proper mixing in a closed system using automated haematology analyser (Sysmex XS 500i, Sysmex Co, Tokyo, Japan). The actual platelet yield was calculated using the following formula:

platelet yield per unit (x$10^{11}$) = product volume (mL) x product count (platelets/L)/100.000.

### Statistical analysis

The distribution of data was tested for normality. Data were expressed as arithmetic means±SD (standard deviation) or medians with a range depending on the data distribution. Demographic and hematologic parameters of donors, as well as procedural characteristics were correlated with their platelet yield. Correlation was also done between actual product yield and the software-predicted product yield. The significance of the difference between actual product platelet yield and the software predicted yield was analysed using the nonparametric Mann-Whitney test. For all comparison, the level of statistical significance was $p<0.05$.

## RESULTS

During the study period, a total of 60 donors underwent plateletpheresis procedures. The mean blood volume processed during plateletpheresis procedures was 2031 mL (1499-2531 mL) in the median time duration of 40 min. (36-43 min.).

The mean pre-donation platelet count of donors was 252x$10^9$/L (187-351x$10^9$/L). The mean platelet yield distribution among plateletpheresis donors was 3.5x$10^{11}$/unit (2-4.9x$10^{11}$/unit) (Table 1).

Twenty-three donors had a pre-donation platelet count of 180-239x$10^9$/L and it was observed that the mean yield of the product prepared from these donors was 3x$10^{11}$/unit (2-4.1x$10^{11}$/unit). The pre-donation platelet count was 240-299x$10^9$/L in 32 donors and the product prepared had mean yield of 3.7x$10^{11}$/unit (2.8-4.9x$10^{11}$/unit). In five donors with pre-donation platelet count of 300-359x$10^9$/L, the mean yield of product prepared was 3.9x$10^{11}$/unit (3.5-4.6x$10^{11}$/unit) (Table 2).

In the majority of donors, 48 (80%), amount of >3x$10^{11}$/unit was collected (Table 3).

A positive correlation was observed between platelet yield and pre-donation platelet count ($r=0.611$; $p<0.000$), blood

**Table 1. Donor's and procedural characteristics of plateletpheresis (N=60)**

| Parameter | **Mean±SD** (range/median) |
|---|---|
| Age | 38.2±8.3 (20-59) |
| Height | 181.8±8.9 (158-199) |
| Weight | 96.1±16.5 (62-130) |
| TLC | 5.7-7.6 (median 6.5) |
| Hb | 14.5-15.8 (median 15.2) |
| Hct | 43.1±2.6 (37.1-52.4) |
| Platelet count | 252±36.2 (187-351) |
| Platelet yield | 3.5±0.6 (2-4.9) |
| Blood volume processed | 2031±238 (1499-2531) |
| Run time | 39±4.7 (28-49) |
| ACD-A used | 249±26.1 (178-292) |
| Saline used | 436±16.5 (404-467) |

SD, standard deviation; TLC, total leucocyte count; Hb, haemoglobin concentration; Hct, haematocrit

**Table 2. Effect of pre-donation platelet count on platelet yield**

| **Pre-donation platelet count** ($x10^9$/L) | **No of donors** | **Mean platelet yield ±SD (range)** |
|---|---|---|
| 180-239 | 23 | 3.0±0.6 (2-4.1) |
| 240-299 | 32 | 3.7±0.5 (2.8-4.9) |
| 300-359 | 5 | 3.9±0.5 (3.5-4.6) |

SD, standard deviation

**Table 3. Distribution of platelet yield among donors**

| **Platelet yield** ($x10^{11}$/unit) | **No of donors** |
|---|---|
| 2.0-2.49 | 5 |
| 2.5-2.99 | 7 |
| 3.0-3.49 | 21 |
| 3.5-3.99 | 16 |
| >3.99 | 11 |

**Table 4. Correlation between various parameters and platelet yield**

| **Parameter** | **r** | **p** |
|---|---|---|
| Height | 0.264 | 0.042* |
| Weight | 0.525 | <0.000* |
| TLC | 0.207 | 0.112 |
| Hb | 0.129 | 0.325 |
| Hct | 0.003 | 0.981 |
| Platelet count | 0.611 | <0.000* |
| Blood volume processed | 0.512 | <0.000* |
| Run time | 0.514 | <0.000* |
| Software predicted yield | 0.774 | <0.000* |

*significant correlation;
r, Pearson/Spearman coefficient; TLC, total leucocyte count; Hb, haemoglobin concentration; Hct, haematocrit

volume processed (r=0.512; p<0.000), and run time (r=0.514; p<0.000). Also, height and weight had significant correlation with platelet yield with values of (r=0.264; p=0.042) and (r=0.525; p<0.000), respectively.

No significant correlation was found between platelet yield and other donor parameters (TLC, Hb, and Hct). Also, no significant correlation was found between donor parameters (TLC, Hb, and Hct) and procedural parameters (blood volume processed, and run time).

Positive correlation between actual product platelet yield and the software predicted yield ($r_s$=0.774; p<0.000) with statistical difference between them (p<0.000) was found (Table 4).

The effect of gender on platelet yield was not studied, as only two donors were female.

## DISCUSSION

Platelets are essential for the maintenance of haemostasis (5). Platelet transfusions are needed for either prophylactic or therapeutic purposes in thrombocytopenic patient (5).

The present study evaluated the effect of the donor's demographic and haematological characteristics, as well as procedural parameters on the platelet yield.

The mean body weight of our donors was 96 kg (range: 62–130 kg), while the mean body height was 181 cm (range: 158–199 cm). Our study found a significant positive correlation between body height and weight and platelet yield. Several previous studies have also observed a positive correlation between BMI (or height and weight) and platelet yield (3,4,6–8). It has been reported that individuals with higher body weight have a greater blood volume available for processing, and therefore achieve a higher platelet yield (6). On the other side some other studies found no significant correlation between them (5,10-13).

Analysis of other donor-related parameters on platelet yield revealed that pre-donation platelet count has a significant positive correlation with platelet yield. Donors having pre-donation platelet count in the higher range yielded products with higher platelet count. In the 60 procedures, the mean yield obtained was 3.5 x $10^{11}$/unit. In the majority of donors, 48 (80%), amount of >3x$10^{11}$/unit was collected. According to the FDA (14) and AABB criteria (15), 75% of the plateletpheresis products prepared must contain ≥3x$10^{11}$ platelets per unit, while the European guidelines recommend platelet count of ≥2x$10^{11}$ platelets per unit (9). This will give an increment of 30.000 to 60.000/μL (5). Other authors (1,3–8,10–13,16–21) have also reported a positive correlation between them, meaning that the higher the donor's platelet count, the higher the platelet yield.

In present study we found no statistical correlation between platelet yield and haemoglobin, nor between platelet yield and haematocrit and total leucocyte count. No correlation between Hb and Hct and platelet yield was reported (1,3,5). Some studies reported significant positive correlation of pre-apheresis Hb with yield (6,19). On the other side, inverse relationship between pre-donation haemoglobin and yield was reported, i.e., the lower the haemoglobin concentrations, the higher the platelet yield (17). The inverse relationship between haemoglobin and platelet yield is likely due to the higher plasma volume processed in donors with low haemoglobin concentration (11). Reportedly, a negative correlation with donor pre-apheresis Hb and platelet yield was found (12,18). Some studies reported that the total leucocytes count of donors correlated positively with platelet yield (3,6,7), while others found no statistically significant impact of pre-donation total leucocyte count on platelet yield (18).

The present study also found a significant correlation between total blood volume processed and yield similar to other studies (10,20,21).

Run time or processing time is an important parameter not only for yield but also for donor comfort and retention (10). Longer

run time is associated with more anticoagulant infusion in donors and having more chances of citrate-related adverse reactions (10). The mean run time for plateletpheresis in our study was 39 minutes; also, a significant correlation between run time and platelet yield was found. Run time was not correlated with yield in some studies (10,20,21), while others revealed a significant positive correlation between them (6).

In our study, no significant correlation was found between donor parameters (TLC, Hb, and Hct) and procedural parameters. However, another study reported that the donor's total leukocyte count correlated positively with blood volume processed, while TLC correlated negatively with processing time and total blood volume processed (7). Studies also reported that haemoglobin correlated significantly with processing time and blood volume processed (6,7).

We could not evaluate the effect of gender on platelet yield as only two donors were female in the present study. However, some previous studies found that females had higher yield because of more prevalence of iron deficiency anaemia among females with the consequent rise in platelet count and thus platelet yield (10). Hormonal influence could also play a role (11).

The present study observed a statistically positive correlation between the actual product platelet yield and the software-predicted yield ($r_s$=0.774, p<0.000) with statistical difference between them (p<0.000). Some other authors (4,22) described similar results as well. Considering that in plateletpheresis we are mostly guided by the software-predicted platelet yield, a statistically significant difference between them represents important information for us to pay attention to the amount of platelets we collect from donors and to look for the causes that lead to this. This would aim to obtain the most accurate amount of platelets in the products and, above all, to protect the donor from possible thrombocytopenia.

By examining the factors that can affect the platelet yield we could get information that helps us select donors in order to provide the highest quality product and thus support patients more efficiently.

The limitation of the study was that we conducted our study on 60 data. A greater sample size would provide a more representative picture and would be required to evaluate the effects of all these factors on platelet yield for better selection of donors.

Pre-donation platelet count, body weight, body height, blood volume processed and run time affected platelet yield. Optimizing the platelet yield is a matter of identifying the factors that influence the yield and thus the selection of donors, providing better quality platelet products and clinical outcomes. The impact of different parameters on platelet yield has to be studied more closely.

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## TRANSPARENCY DECLARATION

Competing interest: None to declare.

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