ID Design Press, Skopje, Republic of Macedonia
South East European Journal of Immunology
Volume 2017; Article ID 20012, 6 pages
https://doi.org/10.3889/seejim.2017.20012
Clinical Immunology

Factors Associated With Successful Mobilization and Collection of Peripheral Blood Hematopoietic Stem Cells in Autologous and Allogeneic Donors

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Citation: Grubovic R, Georgievski B, Cevreska L, Genadieva-Stavric S, Grubovic MR. Factors Associated With Successful Mobilization and Collection of Peripheral Blood Hematopoietic Stem Cells in Autologous and Allogeneic Donors. SEE J Immunol. 2017 Dec 26; 2017:20012. https://doi.org/10.3889/seejim.2017.20012

Keywords: peripheral blood stem cells; hematopoietic stem cells; apheresis collection; mobilization strategy; stem cell harvesting.

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Received: 23-Oct-2017; **Revised:** 08-Nov-2017; **Accepted:** 10-Nov-2017; **Published:** 26-Dec-2017

Funding: This research did not receive any financial support.

Competing Interests: The author has declared that no competing interests exist.

Abstract

BACKGROUND: Peripheral blood hematopoietic stem cells (PBSC) have largely replaced bone marrow derived stem cells in autologous transplantations, and have become the preferred source of stem cells in the majority of allogeneic transplantations. Sufficient number of mobilized and collected hematopoietic stem cells (HSC) is needed for successful hematopoietic stem cell transplantation.

MATERIAL AND METHOD: This study was performed in the Institute for Transfusion Medicine of RM and the University Clinic of Hematology from 2008 till 2016. There were 30 allogeneic and 90 autologous donors that underwent mobilization and collection of PBSC. The association between possible predictive factors such as demographic characteristics, laboratory parameters and collection parameters in both groups, and mobilization strategy and clinical characteristics in autologous donors and number of collected PBSC was analyzed.

RESULTS: There were 226 apheresis, 182 in autologous donors (mean 2, range 1-3) and 44 apheresis in 30 allogeneic donors (mean 1.5, range 1-2). The mean number of collected MNC in autologous donors was 3.09 x 10^8/kg and 2.85 x 10^6/kg CD34+ cells, and 3.23 x 10^8/kg MNC and 3.20 x 10^6/kg CD34+ cells in allogeneic donors. Significantly larger number of MNC and CD34+ cells was collected with the WBC set. There was a statistically significant correlation between the total number of collected MNC in autologous donors and platelet count before mobilization, the number of cycles in one apheresis procedure, quantity of collected graft and the number of collected MNC and CD34+ cells on the first day of harvestration. There was a statistically significant correlation between the total number of collected MNC in allogeneic donors and platelet count before mobilization, the number of cycles in one apheresis procedure, quantity of collected graft and number of MNC on first day of harvestration. There was a strong correlation between the number of collected MNC and CD34+ cells on the first harvest and the total number of collected MNC and CD34+ cells in poor mobilizers, and inverse correlation with the number of apheresis procedures. Donors who donated MNC ≤ 0.7 x 10^8/kg and/or ≤ 0.7 x 10^6/kg CD34+ cells on the first harvest (84.6%) were strong predictors of poor mobilizers.

CONCLUSION: Determining the proper level of baseline and preaheresis laboratory parameters for initiating mobilization and apheresis procedure which is safe for donors and greatly efficient in collection of PBSC is needed for optimization of these procedures, as well as for early intervention in poor mobilizers.

Introduction

Hematopoietic stem cells transplantation (HSCT) has been used as a curative treatment in variety of congenital and acquired hematological and non-hematological benign and malign diseases [1-8]. Transplantation of peripheral blood stem cells (PBSC) provides complete and long-term reconstitution of the hematopoietic system of the patients and may result in remission or cure in a proportion of cases [8-9]. Given the numerous advantages such as, lower rates of morbidity and mortality, shorter hospitalization, lower costs of treatment and the possibility of applying high-dose chemotherapy to an older group of patients, mobilized peripheral blood stem cells have largely replaced the use of bone marrow derived stem cells as the preferred source of hematopoietic stem cells in autologous and allogeneic transplantation [1, 4, 8-13]. There is no consensus on the amount of progenitor

cells to be infused to achieve adequate cell recovery yet. However, a minimum of 2-5×10^6 CD34+ cells per kilogram in adults have shown good results [14, 15]. Worldwide 99% of autologous hematopoietic stem cell transplantations and 75% of allogeneic are performed with PBSC. Progenitor stem cells are rare and they primarily reside in the bone marrow and in extreme small amounts (0.01-0.5% nucleated cells) in the peripheral blood [16, 17].

Mobilization of these cells in the peripheral blood with growth factors only or in combination with chemotherapy results in multiplying the number of circulating hematopoietic stem cells, makes it easier to be harvested from the peripheral blood [17, 18]. Proper timing of collection of PBSC following mobilization is crucial for maximization of harvest. Few different parameters were investigated as possible predictive factors for apheresis harvest, such as number of platelets [4, 19, 20], total leukocyte count [20], lymphocyte count [20], monocyte count (20,21) and percentage of circulating immature granulocytes [22]. Number of CD34+ cells in the peripheral blood is accepted as best indicator for initiation of apheresis. Although the technics used for calculating the number of CD34+ cells are highly specialized and expensive, they are not universally available and it takes longer to obtain results [20, 23-27]. Therefore, parameters that are more available were investigated as potential predictive factors. It is still not clear which protocol is optimal for maximal harvesting of PBSC.

The aim of this study is to analyze the association between the mobilized and collected PBSC and possible predictive factors, such as demographic characteristics, laboratory parameters and collection parameters in both autologous and allogeneic donors and the mobilization strategy and clinical characteristics in autologous donors.

Material and Methods

This is a retrospective-prospective study performed in the Institute for Transfusion Medicine of RM and the University Clinic of Hematology in Skopje, Macedonia from 2008 till 2016. The investigated group consisted of 90 autologous donors/hematologic patients - 30 patients diagnosed with acute myeloid leukemia (AML), 30 with lymphoma and 30 with multiple myeloma (MM), and 30 allogeneic donors. The study was approved by the Ethical Committee for Biomedical Research at Medical Faculty in Skopje. All subjects in the study gave their written consent for performing the research, mobilizing strategy, apheresis collection of peripheral blood hematopoietic stem cells, cryopreservation and transplantation (according to Recommendations of WMA Revision of Declaration of Helsinki). Mobilization of PBSC was performed with the granulocyte colony-stimulating factor (G-CSF) 10μcg/kg/day (as single mobilizing strategy) or in combination of G-CSF + chemotherapy depending on diagnosis and disease status. The collection of PBSC was performed by the apheresis procedure with the cellular separator COBE Spectra Version 6.1 (TerumoBCT) in the Institute for Transfusion Medicine of RM. Collection target was ≥2x10^8/kg MNC and/or ≥2x10^6/kg CD34+ cells during the first three days of apheresis. The following parameters were analyzed: demographic characteristics, laboratory parameters and collection parameters in both autologous and allogeneic donors; and the mobilization strategy and clinical characteristics in autologous donors.

Table 1: Characteristics of autologous and allogeneic donors

Donors characteristics	Autologous (Number / %)	Allogeneic (Number / %)	p < 0.05
Gender			
Male	56 (62.2%)	21 (70.0%)	
Female	34 (37.8%)	9 (30.0%)	
Age			
(mean, range)	45±13.0 (18-65)	34.3±12.2 (19-63)	
< 20	3 (3.4%)	2 (6.7%)	
20-29	11 (12.2%)	12 (40.0%)	
30-39	15 (16.7%)	4 (13.3%)	
40-49	21 (23.3%)	7 (23.3%)	
50-59	31 (34.4%)	5 (16.7%)	
>=60	9 (10.0%)	/	
Weight (kg) (mean, range)	78.5±15.5 (51-136)	75.9±14.1 (56-105)	
Height (cm) (mean, range)	170.8±9.6 (150-190)	173.8±7.1 (160-190)	
ABO blood type			
O+	33 (36.7%)	13 (43.3%)	
O-	4 (4.4%)	/	
A+	25 (27.8%)	8 (26.7%)	
A-	3 (3.3%)	/	
B+	18 (20%)	3 (10.0%)	
B-	2 (2.2%)	3 (10.0%)	
AB+	5 (5.6%)	1 (3.3%)	
AB-	1 (1.1%)	1 (3.3%)	
Parameters before mobilization (mean, range)			
WBC (x10^9/l)	5.6±2.3 (1.9-14.1)	8.1±5.6 (3.9-29.1)	p=0.001198
Hgb (g/dl)	12.1±1.7 (8-15.5)	14.7±1.5 (11.8-18)	p=0.000000
Plt (x10^9/l)	254±117.0 (78-649)	216±46.0 (130-306)	NS
Parameters before harvestration (mean, range)			
WBC (x10^9/l)	21.5±12.6 (2.95-61.8)	29.6±8.2 (13.3-42.8)	p=0.000170
Hgb (g/dl)	12.0±1.3 (9.7-16)	14.4±1.5 (11.1-17.5)	p=0.000000
Plt (x10^9/l)	167.9±95.0 (40-381)	201.2±61.2 (140-305)	p=0.032651
Hct (%)	36.0±4.3 (15.6-48)	43.6±3.9 (36.1-49.7)	p=0.000000
RBC (x10^9/l)	3.9±0.5 (3.1-7.73)	4.8±0.4 (3.98-5.7)	p=0.000000
Monocytes (%)	9.7±4.9 (1.3-25.1)	5.4±2.4 (1.4-10.5)	p=0.000001
Lymphocytes (%)	12.2±6.1 (3.2-28.8)	11.8±3.5 (6.6-20.6)	NS
LymMon (%)	21.8±9.4 (7-53)	17.5±4.5 (10-26)	p=0.027808
Transfusion before harvestration (number of units, mean, range)			
Erythrocyte transfusion	21 (23.3%) 3.8±2.8 (1-11)	/	
Platelet transfusion (RD)	20 (22%) 16.3±17.6 (1-66)	/	
Platelet transfusion (SD)	7 (7.8%) (1-2)	/	
Mobilization strategy			
G-CSF	64 (71.1%)	30 (100%)	
G-	26 (28.9%)	/	
CSF+chemotherapy			
Adverse events			
Yes	14.4%	43.3%	p=0.0009
No	85.6%	56.7%	

RD – random donor, SD – single donor.

Statistical analysis

Statistical analysis was done in the statistical program Statistica 7.1 and SPSS 17.0. The following

methods were used in this study: the percentage of structure (%) was determined in series with attributive marks; descriptive statistics (Mean ± S.D., Minimum, Maximum, Median) was used in series with numerical marks; differences between the autologous and allogeneic donors in the parameters with attributive and numerical marks were tested with Mann-Whitney U test. The association between the investigated variables and the number of collected mononuclear cells (MNC) was assessed with Spearman rank order correlation. The accepted level of significance was $p < 0.05$.

Results

Donors' characteristics and laboratory parameters of autologous and allogeneic donors are shown in Table 1.

Clinical characteristics of autologous donors are shown in Table 2.

Table 2: Clinical characteristics of autologous donors

Clinical characteristic of autologous donors	Number (%)
Diagnosis	
AML	30 (33.3%)
MM	30 (33.3%)
HD	19 (21.1%)
NHL	11 (12.3%)
Disease stadium	
CR	46 (51.1%)
PR	23 (25.6%)
Active disease (relapse)	21 (23.3%)
Chemotherapy cycles	
0	/
1-4	45 (50%)
5-8	21 (23.3%)
9-12	13 (14.4%)
13-16	7 (7.8%)
≥ 17	4 (4.4%)
Previous radiotherapy and/or HSCT	
Radiotherapy+HSCT	2 (2.2%)
Radiotherapy	12 (13.3%)
HSCT	7 (7.8%)
No radiotherapy and/or HSCT	69 (76.7%)
Period from diagnosis to harvestration (months) – mean, range	16.8 ± 27.8 (1-148)

AML-acute myeloid leukemia, MM-multiple myeloma, HD-Hodgkin disease, NHL-non-Hodgkin lymphoma, AA-aplastic anemia, ALL-acute lymphoblastic leukemia, MF-myelofibrosis, CML-chronic myeloid leukemia, CR-complete remission, PR-partial remission, SCT-stem cell transplantation.

There were 226 apheresis procedures, 182 performed in 90 autologous donors and 44 procedures performed in 30 allogeneic donors. The mean number of apheresis procedures in autologous donors was 2.0 ± 0.6 (range 1-3) and 1.5 ± 0.5 (range 1-2) in allogeneic with significant difference between two of them ($p < 0.05$). Seventy six autologous donors (66.7%) had two apheresis procedures, sixteen autologous donors (17.7%) had three procedures and fourteen autologous donors (15.6%) had one procedure, while eight allogeneic donors (53.3%) had one procedure and twenty two allogeneic donors (46.7%) had two procedures. All donors tolerated well mobilization and collection procedures, with minor side effects in 14.4% of autologous and 43.3% allogeneic donors. The mean number of collected MNC in autologous donors was 3.09 ± 1.1 (range 0.8-6.2) and 3.23 ± 1.03 (range 2.0-7.3) in allogeneic, respectively. There was not a statistically significant difference between the number of collected MNC in autologous and allogeneic donors for $p>0.05$ (Mann-Whitney U test $Z = -0.46364$, $p = 0.642909$). The mean number of collected CD34+ cells in autologous donors was 2.85 ± 1.1 (range 0.7-5.9) and 3.20 ± 1.01 (range 2.0-7.3) in allogeneic. There was not a statistically significant difference between the number of collected CD34+ cells in autologous and allogeneic donors for $p > 0.05$ (Mann-Whitney U test $Z = -1.53091$, $p = 0.111631$). Characteristics of PBSC collection are shown in Table 3.

Table 3: Characteristics of PBSC collection

Characteristics of PBSC collection	Autologous donors	Allogeneic donors
No. of apheresis procedures	182	44
No. of procedures per donor	2.0	1.5
No. of donors collecting < $2x10^8$/kg MNC	13 (14.4%)	/
No. of donors collecting ≥ $2x10^8$/kg MNC	77 (85.6%)	30 (100%)
with 1 apheresis	14 (15.6%)	16 (53.3%)
with 2 apheresis	60 (66.7%)	14 (46.7%)
with 3 apheresis	16 (17.7%)	/
Type of set used for apheresis		
WBC set	34.1%	22.7%
AutoPBSC	65.9%	77.3%
No. of collected MNC $x10^8$/kg - total (mean, range)	3.09 (0.8-6.2)	3.23 (2.0-7.3)
1 apheresis	1.7 (0.2-5.8)	2.4 (0.7-4.8)
2 apheresis	1.5 (0.14-3.9)	1.7 (0.4-5.0)
3 apheresis	1.1 (0.2-3.7)	/
No. of collected CD34+ cells $x10^6$/kg – total (mean, range)	2.85 (0.7-5.9)	3.20 (2.0-7.3)
1 apheresis	1.6 (0.2-5.5)	2.3 (0.6-3.9)
2 apheresis	1.3 (0.14-3.7)	1.6 (0.4-4.8)
3 apheresis	1.0 (0.2-3.4)	/
Total processed volume (ml)	9475.6	9502.3

All allogeneic donors (100%) and 77 (85.6%) autologous donors donated the wanted number of MNC and CD34+ cells. There were 13 autologous donors (14.4%) who could be marked as poor mobilizers, of which 11 donors (84.6%) had less than ≤ 0.70 x 10^8/kg MNC yield on the first day of harvestration (Table 4).

Table 4: Number of collected MNC – 1 day yield and total number of collected MNC < 2 x 10^8/kg

Autologous donors *Number of collected MNC – 1 day yield*	*Number of donors*	*%*	*Total number of MNC < $2x10^8$/kg Number of donors/(%)*
≤ 0.70 x 10^8/kg	19	21.1	11 (84.6%)
0.71-1.40 x 10^8/kg	18	20.0	2 (15.4%)
1.41-1.99 x 10^8/kg	20	22.2	/
2.00-2.99 x 10^8/kg	21	23.3	/
3.00-3.99 x 10^8/kg	10	11.1	/
≥ 4 x 10^8/kg	2	2.2	/
Allogeneic donors			
≤ 0.70 x 10^8/kg	1	3.3	/
0.71-1.40 x 10^8/kg	5	16.7	/
1.41-1.99 x 10^8/kg	4	13.3	/
2.00-2.99 x 10^8/kg	12	40	/
3.00-3.99 x 10^8/kg	7	23.3	/
≥ 4 x 10^8/kg	1	3.3	/

Poor mobilizers were defined as donors that could not donate ≥ 2 x 10^8/kg MNC and/or ≥ 2 x 10^6/kg CD34+ cells in three consecutive harvestrations. Although Auto PBSC set was used in 65.9% autologous and 77.3% allogeneic donors, significantly larger number of MNC and CD34+ cells was collected with WBC set. There was a statistically significant correlation between the total number of

collected MNC in autologous donors and baseline platelet count, the number of cycles in one apheresis procedure, quantity of collected graft and the number of MNC and CD34+ cells on the first day of harvestration (Table 5).

Table 5: Correlation between investigated parameters and total number of collected MNC in autologous donors

Total number of collected MNC Autologous donors	Spearman	t(N-2)	p-level
Age	0.091901	0.86577	0.388968
Body weight/kg	-0.023559	-0.22106	0.825556
Mobilization strategy	-0.071293	-0.67049	0.504300
Day of mobilization/beginning of harvestration	-0.014276	-0.13393	0.893762
Baseline Hgb (g/dl)	0.007265	0.06816	0.945814
Baseline WBC (10^9/l)	0.175445	1.67175	0.098126
Baseline Plt (10^9/l)	0.230993	2.22714	0.028490*
Preapheresis WBC (10^9/l)	0.164005	1.55962	0.122438
Preapheresis Hct (%)	-0.024281	-0.22785	0.820294
Preapheresis Hgb (g/dl)	0.008486	0.07961	0.936732
Preapheresis RBC (10^9/l)	0.053234	0.50009	0.618258
Preapheresis Plt (10^9/l)	0.169979	1.61809	0.109222
Preapheresis Lymphocytes (%)	0.105166	0.99204	0.323896
Preapheresis Monocytes (%)	0.126103	1.19247	0.236283
Preapheresis LymMon (%)	0.124428	1.17638	0.242616
Type of set for apheresis	0.203019	1.94499	0.054969
Total blood volume	-0.045936	-0.43137	0.667251
Number of apheresis procedures	-0.158539	-1.50628	0.135576
Number of cycles in one apheresis procedure	0.304611	3.00007	0.003510*
Duration of harvestration (min)	0.083736	0.78829	0.432648
Processed blood (ml)	-0.014854	-0.13935	0.889489
Used ACD-A (ml)	0.054621	0.51316	0.609128
Quantity of collected graft (ml)	0.270566	2.63647	0.009902*
MNC ($x10^9$/kg) – 1st apheresis yield	0.524850	5.78426	0.000000*
CD34+($x10^6$/kg) cells – 1st apheresis yield	0.383858	3.89966	0.000188*
Diagnosis	0.139693	1.32342	0.189125

There was a statistically significant correlation between the total number of collected MNC in allogeneic donors and baseline platelet count, the number of cycles in one apheresis procedure, quantity of collected graft and the number of collected MNC on the first day of harvestration (Table 6).

Table 6: Correlation between investigated parameters and total number of collected MNC in allogeneic donors

Total number of collected MNC Allogeneic donors	**Spearman**	**T (N-2)**	**p-level**
Age	0.138293	0.73888	0.466130
Body weight – donor	-0.284884	-1.57263	0.127037
Body weight – recipient	-0.113395	-0.60393	0.550755
Day of mobilization/beginning of harvestration	-0.040943	-0.21683	0.829910
Baseline Hgb (g/dl)	-0.188177	-1.01385	0.319334
Baseline WBC (10^9/l)	0.053765	0.28491	0.777811
Baseline Plt (10^9/l)	**0.366233**	**2.08261**	**0.046539***
Preapheresis WBC (10^9/l)	0.036352	0.19248	0.848754
Preapheresis Hct (%)	-0.211665	-1.14599	0.261498
Preapheresis Hgb (g/dl)	-0.077438	-0.41100	0.684202
Preapheresis RBC (10^9/l)	-0.290003	-1.60346	0.120056
Preapheresis Plt (10^9/l)	0.337906	1.89978	0.067807
Preapheresis Lym (%)	-0.013612	-0.07203	0.943088
Preapheresis Mon (%)	-0.029668	-0.15706	0.876328
Preapheresis LymMon (%)	-0.106831	-0.56855	0.574193
Total blood volume (ml)	-0.234613	-1.27710	0.212057
Number of apheresis procedures	0.100588	0.53498	0.596890
Number of cycles in one apheresis procedure	**0.422963**	**2.46992**	**0.019873***
Duration of harvestration (min)	0.174423	0.93733	0.356606
Processed blood (ml)	0.009368	0.04957	0.960816
Used ACD-A (ml)	0.066719	0.35383	0.726115
Quantity of collected graft (ml)	**0.522832**	**3.24548**	**0.003034***
Adverse reactions	0.007790	0.04122	0.967412
MNC ($x10^9$/kg) – 1st apheresis yield	**0.403175**	**2.33128**	**0.027162***
CD34+($x10^6$/kg) cells – 1st apheresis yield	0.208007	1.12528	0.270022

There was a strong correlation between the number of collected MNC and CD34+ cells on the first day of harvestration and the total number of collected MNC and CD34+ cells in poor mobilizers, and inverse correlation with the number of apheresis procedures. Donors that donated MNC ≤ 0.7 x 10^8/kg and/or ≤ 0.7 x 10^6/kg CD34+ cells on the first harvest (84.6%) were strong predictors of poor mobilizers.

Discussion

There has been a lot of investigations of predictive factors that could influence mobilization and collection of PBSC in order to improve efficacy and safety of mobilization and harvestration [19-27]. There are still a lot of contradictory in the different studies that work on this issue and final conclusions cannot be made, primarily because of heterogeneity of the donors. Baseline platelet count, the number of apheresis cycles, quantity of collected graft and the number of collected MNC and/or CD34+ cells on the first day of apheresis were predictive factors for successful HSC collection in our study in both, autologous and allogeneic donors. These findings are with consistence with our previously published study [28]. Similar to our results, Suzuya et al. [4] found out that younger age, low body mass index, a high leukocyte count before mobilization, a high platelet count before and during mobilization and a low speed of withdrawal were associated with higher CD34+ cell yield in allogeneic donors. Corso et al. demonstrated that WBC count and platelet count correlated significantly with the number of CD34+ stem cell harvested [29]. Collection of stem cells based on the rising WBC and platelet count increases the number of CD34+ cells in leukapheresis product in comparison to collection on fixed day as shown by Krieger et al. [30]. Leucocyte count was the best predictor of collection efficacy of CD34+ cells in the studies of Ford et al. [31] and Verlinden et al [32], too. Ketterer et al. [33] reported that a platelet value higher than 150 x 10^9/l correlated significantly with successful mobilization in patients with lymphoid malignancies. Zubair et al. showed that platelet count before growth factor administration significantly correlated with the total CD34+ cell yield (Spearman r = 0.38, p < 0.001). With a multiple linear regression model (adjusted R2 = 0.31, AIC = 63.1), it has been determined that the baseline platelet count significantly correlated with total CD34+ cell yield in treated plasma cell disorder patients in their study [19]. Although there was no significant association between CD34+ cell × 10^6/kg and blood parameters in the study of Garicoa et al., they found out that leukocyte count higher than 30 × 10^9/L and monocyte count higher than 1.8 × 10^9/L could be predictive factors of efficient collection. However, these values cannot be considered absolute factors because patients with lower counts also had satisfactory collections [20]. Likewise to our study, some studies suggested [34, 35] that there was no correlation between the hematocrit and the wanted number of HSC, while another study showed inverse correlation between the two parameters [31]. Study of Mehta et al. [35], although did not show correlation between the wanted number of HSC and hematocrit in

autologous donors, pointed out that it would be favorable harvestration to start when hematocrit is at least 25-30%. Autologous donors are often anemic and there is a need for transfusion of blood components before harvestration, which is frequently the case with the platelets too, if their number is less than 30 x 10^9/L [2]. Mobilizing strategy and the number of prior cytotoxic chemotherapy cycles had been reported to adversely affect the yield of PBSC in autologous donors in our [28] and some other studies [31, 36-38]. There had been a lot of other factors that had been investigated and similar results had been revealed. These investigations included gender [31, 34], disease stadium [31], chemotherapy regimen [31], invasion of disease in bone marrow [31, 39], use of alkylating agents [40] and etc. Factors influencing apheresis procedure were investigated as well. Our study showed that the number of cycles in one apheresis procedure in autologous and allogeneic donors, and the type of set used in apheresis procedure in autologous donors, significantly influenced the collection of MNC and CD34+ cells. Zenga et al. [41] showed that number of collected MNC was positively correlated with the use of Auto PBSC set, while number of CD34+ cells was positively correlated with the use of WBC set in allogeneic donors. In other study [42], WBC set was superior to Auto PBSC set for collection of HSC in patients with multiple myeloma mobilized with G-CSF+ chemotherapy. One of the factors that did not show association with collection efficacy in our study, but had been presented in other studies as significant was processed volume of blood during apheresis [32, 34]. Ikeda et al. [39] found out in their study that mobilizing cytokines, timing of apheresis, characteristics of cellular separator and operative software influenced collection of HSC in autologous and allogeneic donors, while donor's age and gender influenced the number of collected HSC in allogeneic donors. Pastore et al. showed that lower number of CD34+ cells on the first day of collection correlated with poor mobilizers in acute leukemia patients [36]. Donors that donated MNC ≤ 0.7 x 10^8/kg and/or ≤ 0.7 x 10^6/kg CD34+ cells on the first day of apheresis were strong predictors of poor mobilizers (84.6%) in our study. Similarly to our findings Duong et al. determined a cut point of ≤ 0.7 x 10^6/kg CD34+ cells for the first day of apheresis as a predictor of inadequate CD34+ collection [43]. Early precise prediction of the likelihood of achieving adequate stem cell collection in autologous and allogeneic donors could prevent unsuccessful apheresis and permit appropriate mobilization alteration intended to improve collection of HSC.

In conclusion, baseline platelet count might be considered as an accurate indicator of PBSC mobilization and collection in autologous and allogeneic donors. However, further studies should be conducted, including a larger number of donors in each group. Determining the proper level of preaheresis laboratory parameters for initiating mobilization and apheresis procedure which is safe for donors and greatly efficient in collection of PBSC is needed for optimization of these procedures, as well as for early intervention in poor mobilizers.

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