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Research Article

Serum Ferritin analyses as a tool to estimate iron stores in blood donors at the Regional Blood Center in Montes Claros, Brazil

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Abstract

Repeated blood donors may have iron stores diminished as a result of the reduction of the levels of serum ferritin (SF) a reliable indicator in measuring the reserves of this mineral. The aim of this study was to evaluate the use of erythrocyte analyses (EA) and determination of SF as tools to estimate iron store in blood donors. We conducted a study with 3 types of donors: Group 1 (G1)-first time donors, Group 2 (G2)-repeated donors and Group 3 (G3)-sporadic donors. Blood samples were submitted to EA, determining the level of SF and hemoglobin (Hb). The Mann-Whitney and Chi-square tests were used for statistical analysis of the characteristics and laboratory variables. The iron depletion was found at 5.7% in G1 and 13.2% in G2. Hb levels between the two groups showed statistically significant difference among donors of G1 compared to the G2 (*p-value* < 0.05). There was a reduction in the level of SF of 50%, 75% and 85% in G2 with respectively one, three and five donations in 12 months period. We conclude that the EA and Hb failed to detect or exclude donors with depletion of iron store being the reverse result for the determination of SF.

Keywords: Iron depletion, blood donors, serum ferritin, hemoglobin.

INTRODUCTION

Several studies have shown a correlation between iron deficiency and repeated blood donation (Røsvik, 2009; Cançado, 2012) For blood banks, it is more effective and less expensive to collect blood from repeated donors than to recruit new ones. However, this strategy has its price; iron depletion in these donors (Cançado, 2012; Figueiredo, 2012). The impact of blood donation on iron levels of donors can be determined through analysis of the concentration of hemoglobin (Hb) and serum ferritin (SF) (Røsvik, 2009). However, there seems to be no consensus among the eligibility criteria for blood donors in regarding the value of hemoglobin. For example, all countries under the European Council have adopted Hb value of 12.5 g/dL or higher for female and 13.5 g/dL or above this value for male blood donors. In the United States, regardless of gender, the permissible value Hb is no less than 12.0 g/dL. In Hong Kong, the blood transfusion service has been adopting different criteria to select Chinese blood donors, that is, 11.5 g/dL for female and 13.0 g/dL for male donors (Lee, 2013) In Brazil, the Ministry of Health (decree 1353 of 6/13/2011) establishes as eligible value of Hb ≥ 12.0 g/dL and ≥ 13.0 g/dL for male and female donors, respectively (Brasil, 2011).

Several works suggest that the determination of serum ferritin levels may also be a sensitive and reliable indicator to assess the iron deficiency at an initial stage. Its dosage is, therefore, directly proportional to body iron reserves and the concentration < 12, 0 ng/mL reflects the stage of depletion of iron reserves of the organism (Paiva, 2000; Passos, 2005). Several researchers have documented that the reduction in the levels of serum ferritin is in close association with blood donation and that repeated whole blood donors have decreased serum ferritin levels when compared to first-time blood donors (Popovsky, 2012; Djalali, 2006).

Although, many studies indicate that repeated blood donation induces iron deficiency and depletion, most blood banks still use only the determination of hemoglobin and/or hematocrit as selection criteria of donors, without evaluating the blood serum ferritin concentration in blood (Mozahed, 2011).

The Regional Blood Center of Hematology on Hemotherapy, located in Montes Claros, a Brazilian city situated in the North of the State of Minas Gerais, is a reference center in blood donation, serving patients with hemoglobinopathies, coagulopathies, and transfusion procedures for patients in ambulatory conditions. In 2012 it received 22.173 candidates for blood donation from Montes Claros and its vicinities (unpublished data, Regional Blood Center of Montes Claros, 2012). Due to the works of loyalty made with these candidates, 16.746 were able for donation, with percentage of 29.6% new candidates and 70.4% loyal i.e., repeat donors (unpublished data, Regional Blood Center - Montes Claros, 2012).

Given that the number of blood donations may result in reduction of iron stores in donors, it is desirable that Blood Centers seek to minimize or eliminate the risk of health problems derived from blood donation. The aim of this study was to evaluate the determination of serum ferritin and erythrocyte analyses as tools to estimate iron stores in blood donors of Regional Blood Center in Montes Claros-MG. Considering the need to improve the quality of the blood donated and at the same time preserving the health of the donor, we believe that this study may provide additional data which might lead to a revision of the criteria currently adopted for blood donations.

MATERIALS AND METHODS

Study Design and Research Subjects

This is a prospective study of experimental character. The minimum sample size (n) of 173 blood donors was calculated according to the formula: $n = \frac{Z^2\ x\ p\ x\ q\ x\ N}{\xi^2\ x\ (N-1) + Z^{2\ x\ p\ x\ q}}$ where: Z = 1.96 (95% confidence interval); p = 0.13 as frequency of low iron in the population; q = 0.87 as frequency for healthy donors (1-p); N = 22,000 blood donors per year as population size and ξ = estimated error (0.05 or 5%). This work involved 246 individuals (139 men and 107 women) selected as suitable blood donors registered in the Regional Blood Center in Montes Claros-MG, from January 2012 to May 2013. All donors were subjected to hematological screening prior donation. We included in the study only participants who fulfilled all the legal criteria for blood donation as established by the Ministry of Health decree number 1353 of 13.06.2011 (Brasil, 2001) and in accordance with internal procedures of blood donation. Among the legal criteria for blood donation are the hematocrit value up to 39% for men and 38% for women and/or hemoglobin ≥ 12 g/dL for female and ≥ 13.0 g/dL for male donors. According to the number of donations, donors were divided into three groups (G): G1, first time-donors (n =35), G2, repeated donors (n=174) and G3, sporadic donors (n=37). A primary donor was considered the individual who donated for the first time at the hemotherapy service. Repeated donor was the donor that had performed two or more donations during a period of 12 months. A sporadic donor was the individual who had donated not more than one time during a period of 12 months, according to current legislation.

Ethical Consent

The study was approved by the Research Ethics Committee of Hemominas Foundation (number 282/2010) in accordance with the Declaration of Helsinki. After complying with an informed consent, volunteers filled in a form in order to evaluate possible variables that could interfere with the result of the intended analyses. During blood donation procedure it was also made the whole blood collection for further hematological analysis.

Laboratory Tests

The eligibility of donors was determined by estimation of hemoglobin and/or hematocrit blood samples collected as part of standard procedure for blood donors in Brazilian Blood Centers. The determination of hemoglobin was obtained by an electronic counter ABX Micro 60 (ABX, Diagnostics, Montpellier, France), which uses the methodology of electrical impedance; the counter was calibrated regularly with internal (supplied by Minotrol 16 - R&S Systems, USA) and external controls (provided by Control Lab and the Brazilian Society of Clinical Pathology-SBPC) held at the Immunohematology Laboratory of Regional Blood Center in Montes Claros-MG.

Serum iron concentration was analyzed by direct colorimetric method through an automated system WIENER-LAB BT 3000 plus, Rosario, Argentina. Serum ferritin was determined by electric-chemoluminescence assay, Elecsys analyzer model COBAS and 411, ROCHE, Hitachi. The reference value for determining iron depletion in this work was from 12 to 20 ng/mL as suggested by the World Health Organization (WHO, 1972). Total iron-binding capacity was measured by calculating the sum of the value of the latent iron-binding capacity and serum iron according to instructions of the manufacturer of the kit. The latent iron-binding capacity was measured by colorimetric method through the automated system WIENER-LAB 3000 plus BT, Rosario, Argentina and transferrin saturation was obtained by dividing the values of serum iron by total iron-binding capacity, expressed as a percentage, according to manufacturer's instructions. Every enzymatic and biochemical analyses were performed at the Laboratory of Clinical Analyses of University Hospital Clemente Faria in Universidade Estadual de Montes Claros/MG.

Statistical analyses

The characteristics and laboratory variables of the blood donors were statistically analyzed using the Minitab Program ® version 16.0 (Minitab Inc.). For quantitative statistics variables were calculated the median, quartiles and the standard deviation, and the qualitative variables calculated absolute and relative frequencies. The test used for comparing the medians was the Mann-Whitney test and the test used to measure the association between two variables was the chi-square test and/or Pearson Correlation, both with a significance level of 95%.

RESULTS

The demographic characteristics, hematological and iron profiles of the 246 blood donors are shown in table 1. The median age of the donors of all groups was between 20 to 30 years. The number of male donors (56.7%) was higher than that of the female ones. Both male and female blood donors of the Group 2 showed significant iron depletion based on indexes of FS when compared with first time-donors (p-value <0.05) (Table 1).

Table 1. Demographic characteristics, hematologic profile and iron status of the blood donors in three groups

	Group 1 (first time blood donors)		Group 2 (repeated blood donors)		Group 3 (sporadic blood donors)	
Variable	Male	Female	Male	Female	Male	Female
Number	10	25	106	68	23	14
Age (years)	31.0 (22.0, 38.0)	27.0 (23.0, 36.0)	34.5 (28.0, 42.0)	31.5 (24.0, 37.0)	30.0 (28.0, 32.0)	31.0 (27.0, 36.0)
Hb (g/dL)	15.1 (14.6, 15.9)	13.7 (13.0, 14.5)	15.1 (14.6, 16.0)	13.0(12.5, 14.1)*****	15.6 (15.2, 17.0)	13.4 (12.9, 14.2)
Hct (%)	45.6 (44.6, 47.2)	41.5 (38.3, 22.6)	46.6 (44.4, 48.9)	39.4 (37.9, 42.4)	47.5 (45.5, 49.7)	41.0 (38.3 – 42.2)
MCV (fL)	89.0 (86.8, 90.2)	87.0 (84.0, 89.0)	86.0 (82.0, 89.0)*****	86.0 (83.0, 89.0)	88.0 (85.0, 89.0)	87.0 (81.5, 88.2)
MCH (pg)	29.4 (28.6, 30.3)	28.5 (27.8, 30.0)	28.4 (26.9, 29.4)*****	28.4 (27.1, 29,6)	29.3 (27.6, 30.2)	28.6 (27.1, 29.8)
MCHC(g/dL)	33.0 (32.4, 34.3)	33.7 (32.6, 34.0)	32.8 (32.3, 33.4)	33.0 (32.0, 33.6)*****	33.8 (32.0, 34.6)	33.4 (32.5, 34.0)
RBC ($x10^{12}$) /L	5.3 (4.9, 5.4)	4.9 (4.4, 5.1)	5.4 (5.2, 5.7)	4.7 (4.5, 4.9)	5.5 (5.2, 5.8)	4.8 (4.4, 5.0)
Ferritin (ng/mL)	158.8(99.5, 303.5)	76.2 (40.0, 147,2)	73.5 (46.6, 127,4)*****	38.3 (16.6, 75.5)*****	199.0 (120.0, 271.9)	74.2 (40.4, 124.3)
Iron (µmol/L)	80.5 (64.0, 91.2)	68.0 (57.0, 91.0)	80.0 (65.0, 96.0)	68.0 (51.2, 88.0)	87.0 (20.0, 108.0)	65.0 (50.5, 91.8)
TIBC(µmol/L)	363.0 (332.5, 417.0)	414.0 (331.5, 469,5)	456.0 (428.0, 508.0)*****	483.0 (443.0, 551.0)	380.0 (324.0, 455.0)	423.0 (383.0, 452.1)
LIBC (mg/dcL)	282.5 (253.3, 352.5)	346.0(263.0, 405.0)	382.0 (340.8, 419.2)*****	430.0 (379.0, 465.0)	297.0 (206.0, 349.0)	349.0 (316.3, 388.5)
Tf saturation (%)	20.8(15.4, 25.6)	17.2 (12.1, 22.4)	17.6 (14.0, 21,0)	13.5 (10.3, 17.9)	22.0 (18.0, 35.0)	16.1 (10.0, 21.0)

[1] Values are expressed as median (25th, 75th percentiles). * p-valor < 0,05
MCV= mean corpuscular volume; MCH= mean corpuscular Hb; MCHC= mean corpuscular hemoglobin concentration; RBC count = red blood cell ; TIBC= total iron-binding capacity; LIBC= latent iron binding capacity; Tf= transferrin saturation.

Table 2. Stratification of levels of ferritin depending on the type of blood donor

Blood Donor type	**Ferritin (ng/mL)**								**Total**
	< 12 ng		12 |--- 20		20 |--- 200		>=200		
	N	%	N	%	N	%	N	%	
First time	1	2.9	1	2.9	26	74.3	7	20.0	35
Repeated	9	5.2	14	8.0	139	79.9	12	6.9	174
Sporadic	0	0.0	0	0.0	24	64.9	13	35.1	37
Total	10	4.1	15	6.1	189	76.8	32	13.0	246
p-value < 0.0001									

Table 3. Distribution of ferritin in first time and repeated blood donors as number of donations during the period of 12 months

Number of donation	Ferritin (ng/mL)								Total
	< 12 ng/mL		12|--- 20		20|--- 200		>=200		
	N	%	N	%	N	%	N	%	
1x	1	2.9	1	2.9	26	74.3	7	20.0	35
2x	2	3.8	4	7.7	41	78.8	5	9.6	52
3x	1	1.9	2	3.7	46	85.2	5	9.3	54
4x	5	11.9	7	16.7	30	71.4	0	0.0	42
5x ou +	1	3.8	1	3.8	22	84.6	2	7.7	26
Total	10	4.8	15	7.2	165	78.9	19	9.1	209
p-value < 0.031									

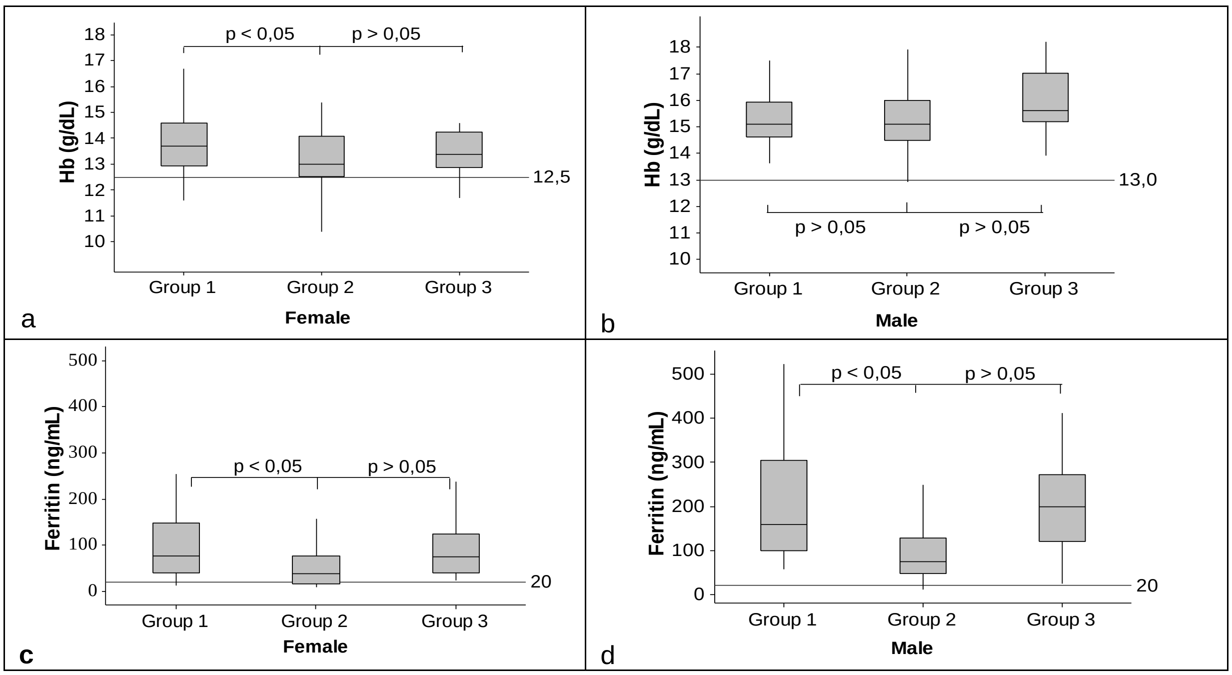

Figure 1. Distribution of different groups of donors as levels of hemoglobin and ferritin. **(a)** and **(b)** distribution of the results of the analysis of hemoglobin among female and male blood donors respectively; **(c)** and **(d)** distribution of the results of the analysis of the levels of ferritin between female and male blood donors respectively. The lines represent the cut-off points of 12, 5 g/dL and 13 g/dL for Hb and 20ng/L for serum ferritin. The rectangles represent the medians, 25 and 75 percentiles. The square brackets indicate the p-value calculated by the Mann-Whitney test with a statistical significance level of 95%

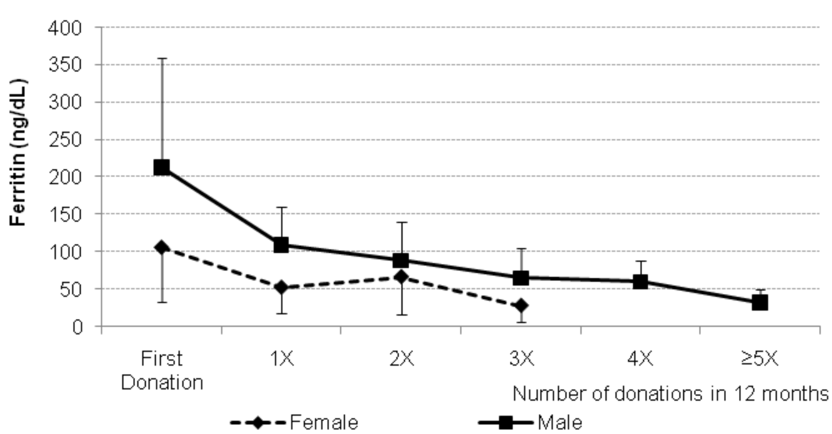

Figure. 2 Average of ferritin observed in repeated blood donor group (male and female), in relation to the number of donations in the interval of 12 months

Although, within the limits considered suitable for female blood donors (Hb ≥ 12 g/dL), repeated donor showed Hb levels decreased when compared to the Group 1 (Figure 1a). There was also a significant difference (p-value < 0.05) between the indicator of blood counts values MCHC (mean corpuscular hemoglobin concentration) in women of the repeated group when compared to G1 (Table 1). The level of hemoglobin among male donors remained within the limits specified; there was no statistically significant difference (p-value > 0.05) (Figure 1b). However, even if considered eligible blood donors in accordance with hematocrit, hemoglobin and/or male repeated donors showed a statistically significant difference (p-value < 0.05) when compared to G1 when considering the following variables: MCV (mean corpuscular volume), MCH (mean corpuscular Hb), TIBC (total iron binding capacity), LIBC (latent iron binding capacity). The same variables showed no significant difference among the other groups here studied (Table 1).

Blood donors of both genders of the repeated group showed a statistically significant difference for the variable serum ferritin compared to first time-donors (p-value < 0.05) (Figure 1c and 1d). The depletion of the iron deposits, defined by levels of FS under 20ng/mL, was found in 5.8% [2/35] of first time-donors and 13.2% [23/174] in repeated blood donors. Critical levels (lack of iron with serum ferritin < 12ng/mL) were found in 2.9% [1/35] of first time blood donors and 5.2% [9/174] repeated blood donors (Table 2). Considering the variable gender, the prevalence of depletion of iron store found in female blood donors was 19.6% [21/107] and in male blood donors 2.9% [4/139].

The relation between the depletion of iron store and the frequency of the number of donations was also analyzed in this work. There was a reduction of serum ferritin level of 50%, 75% and 85% in repeated blood donors with one, three and five donations in 12 months, respectively (Figure 2).

To stratify the number of consecutive twelve (12) months donations in one (first time-donor), two, three, four, five or more times considering levels of serum ferritin < 12ng/mL it is found the following distribution: 2.9% [1/35] with only a donation; 3.8% [2/52] with two donations; 1.9% [1/54] with three donations; 11.9 [5/42] with four donations and 3.8% [1/26] with five or more donations (Table 3). Considering proportionally the number of donors in this stratification, it may conclude that serum ferritin levels decreased with increasing frequency of donations.

DISCUSSION

Iron deficiency in the body often develops slowly and gradually. Initially, the gradual decrease of iron stocks is followed by a reduced supply of iron erythropoiesis, accompanied by decreased hemoglobin concentration stock until the installation of the anemia itself (Cançado, 2007).

Serum ferritin is a parameter used to assess body iron reserves being considered easily available from peripheral blood and presents strong correlation with iron deposits in the tissues (Wheby, 1980; Passos, 2005; Araujo, 2006). It is also readily evaluated by methods with high accuracy (radioimmunoassay, enzyme immunoassay or chemo-luminescence) (Paiva, 2000). Serum Ferritin levels may also mobilize and provide reliable measurements to determine the iron deficiency in an early stage (Passos, 2005; Mousinho-Ribeiro, 2008). The dosage is, therefore, directly proportional to body iron stores and the concentration, < 12 ng/mL, reflects a stage of depletion of iron reserves of the organism (Paiva, 2000; Passos, 2005; Mousinho-Ribeiro, 2008).

The effect of blood donation on iron metabolism has been object of study since the 1970s. The chance of a blood donor to develop or not iron deficiency depends on several factors, among them: gender, age, prevalence of iron deficiency in the population studied, gastrointestinal absorption capacity of dietary iron, abnormal blood loss, frequency of donations, oral iron supplementation. These factors have been considered responsible for the observed differences in hematological responses in blood donors (Cançado, 2007). The deleterious effect of multiple donations in the balance sheet of iron has been reported on several occasions, and the iron replacement drug, to prevent or treat iron deficiency without anemia in those donors, has been subject of several investigations (Passos, 2005).

Interesting reports demonstrated decreased serum ferritin concentration at levels below 15 ng/mL after ten repeated donations of blood in an inversely proportional relationship to blood donation frequency (Passos, 2005).

Through this study, it was possible to assess the prevalence of iron deficiency among blood donors, namely: 10.2% of the total number of blood donors with deficiency, 2.9% in men and 19.6% in women. The observed results are consistent with data obtained by other authors that showed that the frequency of blood donors with iron deficiency is high, ranging from 1.8% to 8.4% in men and from 4.5% to 34.8% in women (Cançado, 2001) and which depend more on the frequency of donations than others factors.

A Brazilian study showed that through the dosage of serum ferritin in blood donors, different levels of iron depletion were found in the country (Passos, 2005). Cançado et al. conducted investigations in 2001 in the Blood Center of Santa Casa, São Paulo, with 300 donors and showed iron deficiency in 11% of donors, reaching 5.5% of male and 31.7 percent of female donors. For female donors, 18.5% of first time-donors and 41.5% of repeat donor showed iron deficiency. Among male donors, these rates ranged from 0 to 7.6%, respectively. Also, the frequency of iron deficiency was highest in repeated donors (Cançado, 2001). Nadarajan et al. observed that 7.4% of first time-donors and 17.4% of repeated donors had iron deficiency (Nadarajan et al., 2002). In our study we reported a 2.9% deficiency in first time-donors and 5.2% in repeat donors when a more stringent criterion was used, i.e. serum ferritin values < 12ng/mL. When considering levels of serum ferritin under 20ng/mL, we obtained 5.8% in first time-donors and 13.2% in repeated blood donors.

Piedras et al. analyzed the iron levels of a group of donors from the National Center for Blood Transfusion of Mexico and observed that iron deficiency was found in 23% of 296 female blood donors and among them, 14.2% showed anemia, the average Hb (8.3 -13.4 g/dL), and 8.8 % without anemia, the average Hb (13.5-15.8 g/dL). In contrast, 1.1% of 635 male donors showed iron deficiency (Piedras et al., 1993).

Javadzadeh et al. studying the occurrence of iron deficiency in blood donors of Yazd (Iran) observed iron deficiency in 7% of first time-donors and 41% among repeated ones being 7.5% men and 33.3% women (Javadzadeh et al., 2005). In the study conducted by Norashikin et al. it was also reported a statistical difference between first time and repeated blood donors. The depletion of iron store was 11.54% among repeated blood donors. When comparing the concentration of hemoglobin and serum ferritin levels no correlation was found (Norashikin et al., 2006). In the present study the concentration of hemoglobin among male blood donors remained within the specified limit and there was no significance statistical difference among the groups (G1; G2 and G3). Many studies have shown that hemoglobin is not a sensitive indicator to detect iron deficiency; however, it is used as a parameter of the depletion in most blood donors in Blood Centers (Norashikin et al., 2006; Mital et al, 2006). In this study the first-time female blood donors, 8.0% [2/25] presented iron depletion when compared to repeated ones whose depletion was found in 27.95% [19/68]. Although 77.9% [53/68] of female repeated donors have submitted a value of hemoglobin within the default limit, 30.2% [16/53], were close to the lower specified limit ($12.5 \leq X < 13.0$ g/dL) showing that consecutive donations lead to a condition of iron deficiency. Cançado et al. in 2007, observed that among 38 first-time blood donors, 10.5% showed iron deficiency, while this frequency in repeated donors was 17.7% (p-value=0.02) (Araujo, 2006) and the frequency of donors with iron deficiency was 16%. Five blood donors showed Hb values less than 12 g/dL, and among these, all of them had serum ferritin less than 12ng/mL (Araujo, 2006). Women of childbearing age are more susceptible to this depletion due to menstrual cycle losses, resulting in the depletion of the reserves of iron.

Hematological rates such as the MCV and MCH were reported as significant for identification of iron deficiency. Alexander et al (2000) have shown there is a correlation between reduced MCV and MCH rates and increased frequency of donations. This trend was present among male and female blood donors even without statistical significance difference within the studied groups. It was also presented strong evidence for the role of hematological profile as early indicators for iron depletion in repeat blood donors, since upon iron depletion. First of all, there is the depletion of the body's iron, followed by decreased erythropoiesis and iron-dependent enzymes. Only in a final stage, the level of hemoglobin drops resulting in microcytic hypochromic anemia development (Alexander, 2000).

The accuracy and precision of hematology electronic analyzers allowed the detection of such changes in course before the individual becomes anemic (Alexander, 2000). In the presented study, it is pointed out a statistical significance difference between some hematological rates in the male repeated blood donor group when compared to male first-time blood donors. Jeremiah et al. compared several hematological parameters among them SF (serum ferritin), SI (serum iron), TIBC, TS (transferrin saturation) - and Hb with blood donors categories and found out that the average values were more significantly lower in the repeated blood donors than other categories of donors (Badar, 2002); which is in line with our results.

When in ours studies the depletion was correlated with the frequency of the number of donations, there was a reduction of serum ferritin level of 50% in repeated blood donors being, 75% with three and 85% with five donations over a time span of 12 months (Figure 2). Badar et al. subdivided the repeated blood donor groups into eight groups according to the number of donations and considered the first time blood donors group as the control group. They observed a decrease of serum ferritin as a function of the increase in the number of repeated donations, being more significant among blood donors with four or more donations within two years period (Badar et al., 2002).

Boulton et al. observed that 8% of male blood donors and 36% of female blood donors had reduction of iron stores after five donations in a year, confirming that the depletion of iron is an inevitable consequence of the blood donation (Boulton et al., 2000).

The results of this study are in accordance with data from the literature: an observed decrease in the levels of serum ferritin ($p < 0.001$) both in first time blood donors as well as in the repeated blood donor group. Also, we showed high prevalence of iron deficiency among repeated blood donors when compared to first time-donors ($p < 0, 0001$).

When stratified the number of consecutive donations within a 12 months and compared them with the level of serum ferritin < 12ng/mL, it was possible to observe that with the increase in the number of donations there was a significant drop of serum ferritin, with a strong correlation with the number of consecutive donations, which is also in agreement with the literature (Passos, 2005). This shows there is a close correlation between the number of donations and the amount of iron in the body per period but not on the amount accumulated in the number of donations (Cançado, 2012).
Although there is clinical evidence identified a few years ago, and it has been the subject of multiple publications, the

fact is that there are no legal rules or recommendations for the problem of blood donors and iron (Gomes, 2008).

Aiming at the protection of the donor of the harms that may compromise their health, as well as the quality and donation safety, we conclude that our results reinforce the literature data. They become effective prophylactic action and to assess the possible depletion of iron store in blood donors. The modification of the values of Hb for donors would be one of those actions. It should be emphasized that the hematological screening held prior to donation to detect anemia in donors is not able to detect and exclude donors with iron depletion, because anemia is the last stage of iron depletion. Moreover, the isolated dosage of hemoglobin and/or hematocrit is not enough to exclude donors with iron deficiency without anemia.

CONCLUSION

It is also possible to conclude that there is a reduction in iron store with increasing the frequency of repeat blood donations. It suggests that the intervals between donations should be larger than those recommended by the current legislation, especially women of childbearing age, who is the high-risk group by presenting the highest rates for iron deficiency.

According to literature and our results, the most appropriate test to evaluate iron stores is the determination of serum ferritin and it should be used as a criterion to determine the suitability of donors and highly recommended for donors with more than one donation per year. As preventive action for those that have more donations oral iron supplementation must be include in the diet. As demonstrated here, erythrocyte analyses and hemoglobin have failed to detect or exclude donors with iron store depletion, but not by the determination of serum ferritin. The development of protocols for the administration of oral iron supplementation plus analytical tests that can analyze iron reserves can be done in order to avoid the loss of blood units, as well as the loss of available donors.

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