Original Article

Insights into Blood Donors' Iron Status: Current Practices and Future Directions

S Susmitha[1,*], Basavaraj P Bommanahalli[1]

[1]Department of Pathology, Gadag Institute of Medical Sciences, Mallasamudra, Gadag, Karnataka, India

***Correspondence:** susmitha.scrt@gmail.com

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Abstract

Background: A well organised and properly planned blood transfusion service (BTS) is a crucial component of health care system. According to Drugs and Cosmetic Act, 1940, in India, the minimum acceptable hemoglobin level for blood donation is 12.5 g/dl. Approximately 10% donors are deferred from donation for their low hemoglobin concentration. Regular long term donation is one of the important causes for iron deficiency. The pre-donation iron levels help to address and prevent iron depletion state among the donors. We sought to estimate serum ferritin levels among the voluntary blood donors and its effects on iron pool due to regular donations in our blood centre.
Methods: This cross-sectional study was conducted for a period of 6 months from January 2024 to June 2024 in the blood collection centre. 110 voluntary blood donors were selected after appropriate counseling. Pre-donation hematological profile was checked; those with satisfactory values were taken for donation. Simultaneously tested for serum ferritin, and then they were divided into four groups based on the serum ferritin for further analysis.
Result: The donors were between 19–49 years of age. Out of which 10 (9%) were females and 100 (91%) were males donors. 13 (11.8%) donors were having iron deficient state. The mean Hb concentration, MCV, and MCH of donors in group I, group II, group III, and group IV were statistically significant with p-value 0.011, 0.033, and <0.001 respectively.
Conclusion: There was significant correlation between red cell indices and serum ferritin levels; thus, serum ferritin levels estimation in between the donations helps the donors to take appropriate measures.

Keywords: Voluntary blood donors; Serum ferritin; Iron status; Regular donation

Introduction

A well organised and properly planned blood transfusion service (BTS) is a crucial component of health care system [1]. Blood donors are healthy subjects who donate either whole blood or its components. A regular voluntary blood donor is the one who has donated three times, the last donation being within the previous year. Further, should continue to donate regularly at least once a year [2]. According to Drugs and Cosmetic Act, 1940, in India, the minimum acceptable hemoglobin level for blood donation is 12.5 g/dl [2].

Approximately 10% of donors are deferred from donation for their low hemoglobin concentration [3]. In one complete whole blood donation (450 ml), approximately 250 mg of iron is lost from the body. Regular long term donations may be one of the important causes for iron deficiency [2]. High frequency repeated donations increase the risk of depletion of iron stores [4]. Screening the donors for hemoglobin concentration (Hb) is an integral part of donor selection process [2]. However, these Hb levels do not reflect the donor's iron status. World Health Organisation advises the monitoring of serum ferritin to detect iron deficiency among blood donors [4].

The iron levels in the donors depend on various factors such as nutritional iron intake, prevalence of iron deficiency in the defined population, capacity of iron absorption, frequency of blood donation, use of supplemental iron intake, and menstrual

loss of iron in females [1]. It is of paramount importance for blood collection centres to have more knowledge about the donor's iron status and further the management of the same [5].

Moving in the path of National drive to protect and retain regular voluntary blood donors, iron status of the donors needs to be identified [1]. The pre-donation iron levels help to address and prevent iron depletion state among the donors [1]. Considering all these factors and retaining the pool of repeated donors, we sought to estimate the level of serum ferritin levels among the voluntary blood donors and understand the effects on iron pool due to repeated donations in our blood collection centre.

Materials and Methods

This is a cross-sectional study with universal sampling technique conducted for a period of 6 months from January 2024 to June 2024 in the blood collection centre, Gadag Institute of Medical Sciences, Gadag, Karnataka. 110 voluntary blood donors visiting the blood collection centre for donation were selected after appropriate counseling.

After obtaining Instituitional ethical approval, written consent was taken from all the donors and were examined physically and medically as per the requirements. Pre-donation hematological profile (complete blood count) was checked using hematology analyser, Sysmex XN1000. Those donors with satisfactory values were taken for donation, and the subjects with less Hb were deferred from donations. Simultaneous venous blood sample was also collected in plain bulb from all subjects to test serum ferritin using enzyme immunoassay sandwich method with final fluorescent detection (Minividas, by Biomerieux) after clearing the quality control kit.

All the subjects were divided into four groups based on the serum ferritin for further analysis and comparison of the hematological parameters [6].

- Group I: Serum Ferritin $<$ 12 ng/ml: Iron deficient state
- Group II: Serum Ferritin 12–15 ng/ml: Iron depleted state
- Group III: Serum Ferritin 15–30 ng/ml: Iron reduced state
- Group IV: Serum Ferritin $>$ 30 ng/ml: Normal

Statistical analysis: For continuous variables, mean $\pm$ standard deviation (SD) were used. For categorical data, the number and percentage were used in the data summaries and diagrammatic presentation. If the p-value was < 0.05, then the results were considered to be statistically significant; otherwise, it was considered as not statistically significant. Data were analyzed using SPSS software v.23.0 and Microsoft office 2007.

Results

110 voluntary blood donors between the age group of 19–49 years were included in the present study. Demographic details were further analyzed. Out of which 10 (9%) were females and 100 (91%) were males donors. Among the male donors, 19 (95%) were below the age of 20 years, 51 (85%) donors were in the age group of 21–30 years, 20 (100%) donors were 31–40 years, and 10 (100%) donors were between 41–50 years. Among the female donors, 1 (5%) was within 20 years of age, 9 (15%) were between 21–30 years (Table 1).

Table 1: Age wise distribution of donors according to their serum ferritin levels.

Serum ferritin groups	**≤20 years**		**21-30 years**		**31-40 years**		**>40 years**	
	N	**%**	**N**	**%**	**N**	**%**	**N**	**%**
Group I (<12 ng/ml)	1	5.0%	8	13.3%	2	10.0%	2	20.0%
Group II (12-15 ng/ml)	0	0.0%	5	8.3%	0	0.0%	1	10.0%
Group III (15-30 ng/ml)	9	45.0%	12	20.0%	5	25.0%	2	20.0%
Group IV (>30 ng/ml)	10	50.0%	35	58.3%	13	65.0%	5	50.0%
Total	**20**	**100.0%**	**60**	**100.0%**	**20**	**100.0%**	**10**	**100.0%**

Distribution of the donors on the basis of their serum ferritin levels into four groups (Table 2). 13 (11.8%) donors were in group I with serum ferritin levels below 12 ng/ml. 6 (5.5%) donors were in group II with serum ferritin level in the range of 12–15 ng/ml. 28 (25.5%) donors were in group III with serum ferritin level in the range of 15–30 ng/ml and 63 (57.3%) donors were in group IV with serum ferritin level more than 30 ng/ml.

Table 2: Distribution of donors into the serum ferritin groups.

Serum ferritin groups	Number of donors	Percentage (%)
Group I (<12 ng/ml)	13	11.8
Group II (12-15 ng/ml)	6	5.5
Group III (15-30 ng/ml)	28	25.5
Group IV (>30 ng/ml)	63	57.3
Total	**110**	**100**

Distribution of the donors according to the number of previous donation showed that 60 (54.5%) were first time donors. However, 6 (10%) among them were in group I, 4 (6.7%) donors were in group II, 17 (28.3%) were in group III. Only 33 (55%) first time donors were having adequate serum ferritin levels (Table 3).

Table 3: Distribution of donors into serum ferritin groups and their frequency of donations.

Serum ferritin groups	First timers		1-2 times		3-4 times		≥5 times	
	N	%	N	%	N	%	N	%
Group I (<12)	6	10.0%	2	7.7%	3	21.4%	2	20.0%
Group II (12-15)	4	6.7%	1	3.8%	1	7.1%	0	0.0%
Group III (15-30)	17	28.3%	6	23.1%	3	21.4%	2	20.0%
Group IV (>30)	33	55.0%	17	65.4%	7	50.0%	6	60.0%
Total	**60**	**100.0%**	**26**	**100.0%**	**14**	**100.0%**	**10**	**100.0%**

Among the donors with previous 1–2 times donations, 2 (7.7%) were in group I, 1 (3.8%) were in group II, 6 (23.1%) were in group III, 17 (65.4%) were in group IV. Donors with previous 3–4 times donations, 3 (21.4%) were in group I, 1 (7.1%) in group II, 3 (21.4%) were in group III, and 7 (50%) were in group IV. Among donors with five or more than five donations, 2 (20%) were in group I, none were in group II, 2 (20%) in group III, and 6 (60%) were in group IV.

The mean Hb concentration of the donors in the group I was 14.6 g/dl, group II was 13.9 g/dl, group III was 15.7 g/dl, and group IV was 15.3 g/dl and was found to be statistically significant with p-value of 0.011. The mean corpuscular volume (MCV) among the donors of group I was 88 fl, among group II was 96.9 fl, among group III was 94.2 fl, and among group IV was 94.2 fl. MCV was also found to be statistically significant with p-value of 0.033. The mean corpuscular hemoglobin (MCH) among the donors of group I was 26.9 pg, among group II was 30.4 pg, among group III was 29.2 pg, and among group IV was 30.5 pg. MCH was also found to be statistically significant with p-value of < 0.001. The Mean corpuscular hemoglobin concentration (MCHC) of donors among group I was 30.9 gm/dl, among group II was 31.4 gm/dl, among group III was 31.8 gm/dl, and among group IV was 31.9 gm/dl (Table 4).

Table 4: Various hematological parameters in the donors according to their serum ferritin groups. (RDW SD: red cell distribution width, Hb: Hemoglobin, MCV: Mean corpuscular volume, MCH: Mean corpuscular hemoglobin, MCHC: Mean corpuscular hemoglobin concentration, WBC count: White blood cell count)

Parameters	Group I (<12)		Group II (12-15)		Group III (15-30)		Group IV (>30)		p value
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	
RDW SD (fl)	47.9	5.4	48.2	6.1	46.7	4.7	47.8	5.2	0.795
Hb (g/dl)	14.6	1.0	13.9	0.9	15.7	1.3	15.3	1.5	0.011
MCV (fl)	88.0	8.0	96.9	5.6	92.2	6.4	94.2	8.2	0.033
MCH (pg)	26.9	2.3	30.4	1.9	29.2	1.9	30.5	2.5	<0.001
MCHC (gm/dl)	30.9	1.7	31.4	0.8	31.8	2.2	31.9	1.5	0.237
WBC count (10^3/µl)	5.2	2.2	7.0	2.5	6.0	1.9	6.3	2.6	0.393

Discussion

Although it is highlighted in several studies that an iron depleted and iron deficient state is induced in donors with repeated donation, all the blood collection centre choose only hemoglobin concentration as an prime indicator for selecting the donors [2]. This method blindly opts the donors without a much knowledge on the donors iron status [5]. The process of pre donation screening is directed to determine that the general health condition of the donor is fair enough to tolerate the collection process and is free from transfusion transmitted diseases [1].

Screening hemoglobin does not ensure that the donor has the adequate stores of iron [1]. So, in the present study, we have tested various hematological parameters such as hemoglobin concentration, red cell indices, red cell distribution, and serum ferritin levels. In the present study, the maximum number of donors were in the age group of 21–30 years (60 donors), and they are also the maximum number of young population of any country. This is also similar to various studied by Saini et al. and Devi DG et al. [1, 2].

Presently there is no universal protocol or appropriate policy for monitoring iron pool in whole blood donors. Sweegers et al. conducted a randomised study to analyse the effectiveness of ferritin-guided donation intervals on Hb and ferritin levels. And the standard operating procedure followed in their study is as explained in Figure 1 [4].

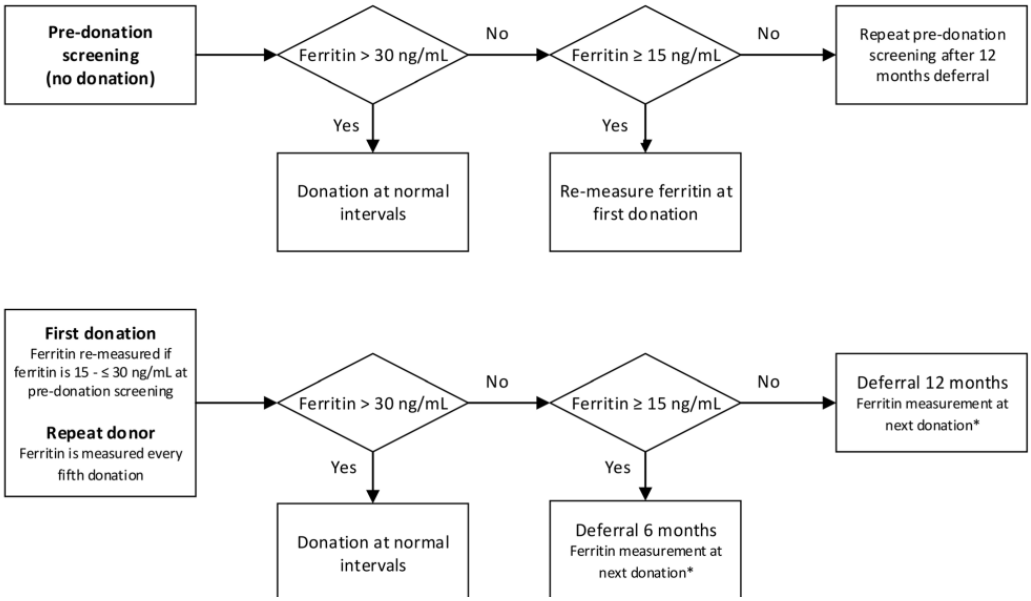

Figure 1: Schematic representation of standard operating procedure adopted for ferritin-guided donation intervals in study by Sweegers M G et al. [4]

In our study, we found that the p value was statistically significant between hemoglobin concentration, MCV, and MCH among the donors of all the groups. This was similar to findings of study by Devi DG et al. [1].

Premenopausal females, teenage groups, and high frequency donors are at high risk of donation-induced iron deficiency [3]. In our study, 9 out of 10 female donors had reduced serum ferritin levels, with 3 donors falling in group I, 4 donors in group II, 2 donors in group III, and one donor with having normal serum ferritin levels. The all of them were first time donors; 90% of the female donors were found to be having decreased iron reserve in the body. Few risk factors include female donors of reproductive age, serum ferritin $<$ 12 ng/ml, first time and reactivated donors, those with $\geq$ 10 donations [7, 8].

In the present study, 50 donors had previous history of blood donations. 2 donors gave history of donating within recent 6 months, out of which 1 had iron reduced state (Group III). 43 donors had history of blood donation in the recent 6 months to 1 year interval. Out of this, 5 were having iron deficient state (Group I), 2 were having iron depleted state (Group II), and 9 were having iron reduced state (Group III). 5 donors had history of blood donation beyond 1 year interval, out of which 1 had iron deficient state (Group I) and 2 were having iron reduced state (Group III). Those donors with previous history of donation yet displaying iron reduced or depleted state has to get due medical attention to replenish iron reserve. Ferritin-based blood donation can address this issue.

Considering the relationship between iron status marker and its effect to frequency of donation, it is essential to pay attention towards certain issues. Post-donation iron supplementation of 100 mg daily for next 20 days should be considered for those with iron deficiency and iron depleted states (group I and group II donors) with serum ferritin levels less than 15 ng/ml [7, 9]. This iron supplementation increases the iron pool in a short period of time, thereby allowing the donors to continue to donate according to their donation interval [4].

However, iron supplementation has its own unintended and unwanted side effects. This may affect the compliance to post-donation iron supplementation and can deteriorate the iron pool [10]. Additionally, by deferring the donors not only based on low hemoglobin concentration but also for low serum ferritin levels, the numbers of donors being deferred also increases. But, over the period of time the increased chances may decrease again as deferral due to low ferritin will lower the deferral due to low hemoglobin concentration [10].

Conclusion

In our study, there was significant correlation between the red cell indices and serum ferritin levels; thus, serum ferritin levels estimation at the intervals between the donations, helps the donors to take appropriate measures. Deferring the donors with serum ferritin levels $\leq$ 30 ng/ml before donation prevents them to end up in iron deficient erythropoiesis. Donor health education regarding the adequate intake of balanced nutritious diet, post-donation iron supplementation, and following ferritin guided donation intervals, will help the blood collection centre to maintain adequate donor pool.

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