

Frequency of Blood Donation and Iron Stores of Blood Donors in Calabar, Cross River, Nigeria

Okpokam, D.C, Emeribe, A.O, Akpotuzor, J.O

Department of Medical Laboratory Science, University of Calabar, Calabar, Cross River State, Nigeria.

The purpose of this study was to assess the influence of frequency of blood donation on iron stores in 163 male blood donors. Forty one were 1st time (control group), Thirty-eight were 2nd time, thirty-eight were 3rd time, thirty one were 4th time and fifteen were 5th time male blood donors in UCTH, Calabar. Packed cell volume (PCV) and haemoglobin (Hb) concentration were determined using particle counter model PCE-210, while serum iron (SI) and total iron binding capacity (TIBC) were determined using kits purchased from Human Diagnostics (D-65205) Wiesbaden - Germany. Transferrin saturation (TS) was determined by computation of serum iron concentration and total iron binding capacity values while serum ferritin (SF) was determined using enzyme linked immunoassay method kit purchased from Boehringer Mannheim Immunodiagnosics (Cat No. BC -1025 and BC - 1120) from Germany. The PCV, Hb, SI, TIBC, TS and SF of 2nd, 3rd, 4th and 5th time blood donors were significantly reduced ($p>0.001$) progressively as frequency of donation increased when compared with the 1st time blood donors. However, their mean cell haemoglobin concentration (MCHC) revealed no significant change ($p>0.001$) as frequency of donation increased. A strong and significant positive correlation existed between SF and PCV, SF and Hb ($p<0.05$). 10.5%, 41.9% and 60% of 3rd, 4th, and 5th time blood donors within the year respectively had deficient iron stores with transferrin saturation of $<16\%$. It is the conclusion of this study that increased frequency of blood donation reduced the iron stores of donors. Therefore, donors should be advised on eating balanced diet as well as the use of iron supplements.

Key words: Blood donors, iron stores, serum iron, transferrin saturation, serum ferritin

Introduction

Voluntary unpaid blood donation is a humanitarian act towards the sick by the healthy. The well being and health of the blood donors are of prime importance in effective health care delivery (1). Accident victims, people undergoing surgery and patients receiving treatment for leukaemia, cancer or other diseases, such as sickle cell disease and thalassaemia, all utilized blood. In America, more than 23 million units of blood components were transfused every year. In most countries,

strict regulations have been established for the selection of blood donors that incorporate criteria that serve to protect both the donors and recipients (2). A donor generally donates approximately 450ml of blood at the time of donation. If 450ml of blood is taken in a donation, approximately 225mg of iron will be lost. Hence adequate iron stores are very important in maintenance of the donor's health (3).

Acceptable frequency of donation reported by the American Association of Blood Banks is normally three times a year. Haemoglobin of 13.5g/dl for men and 12.5g/dl for women donors have been reported (2) as the minimum standard for donation in American. Iron is one

Received: October 21, 2010 Revised: April 1, 2011 Accepted: December 26, 2011

Corresponding author : Okpokam D.C, Department of Medical Laboratory Science, University of Calabar, Calabar, Cross River State, Nigeria. E mail: chiomatallest@yahoo.co.uk Phone: 08068896860

of the elements required by the body for its metabolism particularly in the production of haemoglobin. The regulation of systemic iron is through the proteins as transferrin (Iron mobilization) and ferritin (iron sequestration) (4). The physiologic importance of the storage iron is that it provides a rapid supply in the event of blood loss. SF concentration is an indicator of mobilizable body iron store (5) and in apparently healthy population it varies significantly from one country to another (6). Age, sex, race, pregnancy, lactation and attitude have been reported to influence individual iron status (7). This work is aimed at assessing the influence of frequency of blood donation (1st, 2nd, 3rd, 4th and 5th time) on iron stores by assessing; PCV, Hb, SI, TIBC, TS and SF of male subjects presenting themselves as blood donors at University of Calabar Teaching Hospital, Calabar, Nigeria.

Materials and Methods

A total of one hundred and sixty-three male subjects were recruited into this study by random sampling. Forty one of whom were 1st time blood donors and they served as control, thirty eight were 2nd time blood donors, thirty eight 3rd time blood donors, thirty-one 4th time blood donors and fifteen 5th time blood donors who attended the University of Calabar Teaching Hospital blood donor bay. The inclusion criteria are that they must pass the copper sulphate test for the assessment of haemoglobin, they must be seronegative for Human Immunodeficiency Virus (HIV 1&2), hepatitis B & C and Syphilis. They must fill the questionnaire and give their consent. The 163 participants were commercial donors (those who receive money to donate), and their ages ranged between 18-60years. Seven milliliters of venous blood sample was collected by a clean venepuncture from donors between 9:00am-12noon into 2 sample containers. 2mls of blood was delivered into potassium Ethylene Diamine Tetra Acetic Acid (K₂EDTA) bottle containing 4mg of the anticoagulant for the analysis of PCV and Hb using particle counter model PCE-210 while the remaining 5mls was delivered into sterile iron-free screw-cap bottle, allowed to clot within one to two hours at room temperature and centrifuged to obtain the serum used for analysis of SI and TIBC using kits purchased from Human Diagnostics (D-65205) Wiesbaden – Germany. SF using enzyme linked immunoassay method kit purchased from Boehringer Mannheim Immunodiagnosics (Cat No. BC – 1025 and BC - 1120) from Germany. All the kits purchased were used based on manufacturer instruction. TS was determined by computation of SI concentration

and TIBC values. The results obtained were subjected to statistical analysis using the ANOVA, chi-squared test and Pearson correlation. Unless otherwise stated the data were expressed as mean \pm standard deviation. $P < 0.05$ was considered significant in all statistical comparisons.

Result

The Pack cell volume (0.398 \pm 0.020L/L), haemoglobin (132 \pm 19.3g/L), MCHC (33.3 \pm 1.07g/L), SI (14.6 \pm 7.10 μ mol/l), TIBC (60.20 \pm 4.02 μ mol/l), TS (30.20 \pm 3.00%) and SF (44.7 \pm 3.82ng/ml) levels of 163 male prospective donors is shown in Table 1. The values, however, were observed to fall within the reference range. Table 2 shows the iron related parameters of 2nd, 3rd, 4th and 5th time donors in comparison with 1st time donors. It was observed that the iron related parameters of 2nd, 3rd, 4th and 5th time donors were progressively reduced ($p < 0.001$) as frequency of donation increased when compared with the 1st time donors. However, their mean cell haemoglobin concentration (MCHC) revealed no significant change ($p > 0.01$). A strong and significant correlation between SF and PCV, SF and Hb was observed (figs: 1a and 1b) ($p < 0.05$). The Figure showed that as the SF levels increase the PCV and Hb levels also increased. Blood donors who were iron deficient with transferrin saturation $< 16\%$ is shown in Table 3. 10.5%, 41.9% and 60% of 3rd, 4th and 5th time blood donors respectively had their iron stores depleted with transferrin saturation of $< 16\%$.

Discussion:

Haemoglobin level assessed by copper sulphate qualitative method is one of the criteria used for selection of donors in University of Calabar Teaching Hospital blood donor bay. The parameter indicated whether a donor is fit in terms of haemoglobin assessment. Those that passed copper sulphate screening test for the assessment of haemoglobin, seronegative for Human Immunodeficiency Virus (HIV 1&2), hepatitis B & C and Syphilis were used in this study. The exclusion criteria include those on iron supplement, those with a major trauma/surgery and multiple sex partners. The PCV, Hb, MCHC, SI, TIBC, TS and SF were observed to be similar to that reported from other parts of Nigeria for the general population and blood donors (6, 8, 9 and 10). It was observed that while there was a significant reduction in PCV, Hb, SI, TS and SF as the number of donation

Table 1 PCV, Hb, SI, TIBC, TS and SF levels of 163 male blood donors in UCTH

Parameters	Mean ± SD
PCV (L/L)	0.398 ± 0.020
Hb (g/L)	132 ± 19.3
MCHC (g/L)	33.3 ± 1.07
SI (µmol/L)	14.6 ± 7.10
TIBC (µmol/L)	60.20 ± 4.02
TS (%)	30.20 ± 3.00
SF (ng/mL)	44.7 ± 3.82

Table 2 Mean ± SD of PCV, Hb, SI, TIBC, TS and SF values of blood donors based on number of times of donation

No of donation	1 st Time Donors (n = 41)	2 nd Time Donors (n = 38)	3 rd Time Donors (n = 38)	4 th Time Donors (n = 31)	5 th Time Donors (n = 15)	P Value
PCV (L/L)	0.439 ± 0.31	0.417 ± 0.30	0.383 ± 0.30	0.291 ± 0.38	0.271 ± 0.38	P < 0.001
Hb (g/L)	146 ± 10	139 ± 12	128 ± 10	113 ± 12	96 ± 15	P < 0.001
MCHC (g/L)	33.3 ± 0.07	33.3 ± 0.06	33.3 ± 0.06	33.2 ± 0.07	32.7 ± 1.99	P > 0.001
SI (µmol/L)	16.8 ± 3.6	14.8 ± 3.7	14.0 ± 2.8	13.4 ± 10.8	5.5 ± 4.3	P < 0.001
TIBC (µmol/L)	60.8 ± 13.5	62.6 ± 12.9	70.9 ± 13.3	73.7 ± 12.6	79.1 ± 5.9	P < 0.001
TS (%)	27.60 ± 4.30	23.60 ± 3.20	19.75 ± 5.4	18.18 ± 8.4	10.95 ± 9.90	P < 0.001
SF (ng/mL)	88.3 ± 60.6	51.6 ± 41.9	35.4 ± 31.2	11.4 ± 9.1	3.8 ± 4.5	P < 0.001

Table 3 Number of male blood donors who were iron deficient with Transferrin Saturation < 16%

Number of Donations	Number of Subject	TS > 16%	TS < 16%
1	41	41 (100%)	0 (0%)
2	38	38 (100%)	0 (0%)
3	38	34 (89.5%)	4 (10.5%)
4	31	18 (58.1%)	13 (41.9%)
5	15	6 (40%)	9 (60%)
Total Number	163	137	26

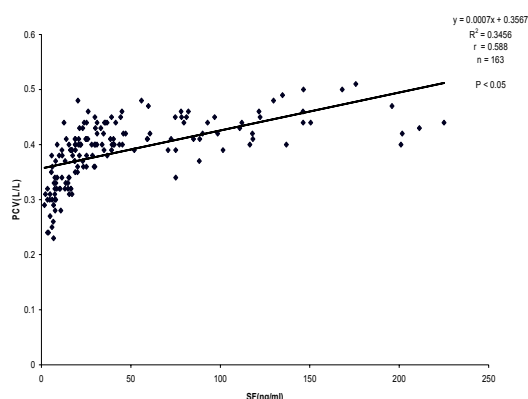


Fig.1a. Correlation graph between SF and PCV of 163 male blood donors

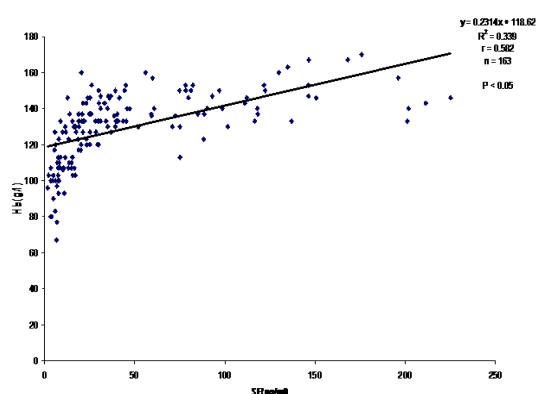


Fig.1b. Correlation graph between SF and Hb of 163 male blood donors

increased, the TIBC was observed to be significantly elevated as frequency of donation increased ($p < 0.05$).

This work has shown that PCV, Hb, MCHC, SI, TIBC, TS and SF of one-time (41) and two time (38) donors in this locality did not differ significantly from that of the general population (6, 8 and 9) suggesting

appropriate frequency of donation in this locality to be 2 times as 2nd time donor parameters were similar to that of the general population. This finding disagree with earlier reports of 3 time frequency (2). The reason we may attribute to poor economic status of these donors as they donate for monetary gains, poor nutrition status as

well as no iron supplement after each donation.

The iron related parameters of 3rd, 4th, and 5th time male donors were significantly reduced ($p < 0.001$) when compared with first and second time donors. This also is similar to that reported by Ahmed et al., (2006) who observed reduction in serum ferritin with increasing frequency of blood donation that became very significant in donors donating 4 or more times in the last two years in Karachi Pakistan (11). The implication of this finding is that at 3rd time donation, the donors starts developing anaemia due to depletion of iron stores. This is made obvious by the iron stores of 3rd time donors being reduced by 10.5% as seen in their transferrin saturation level (Table 3), thus indicating that after 2 times donation, donors are no longer quite fit to donate blood. We suggest a placement on iron supplements on donors at this point if they have intentions of donating for the 3rd time in the year. The PCV, Hb, SI, TS and SF of 4th and 5th time donors were markedly reduced particularly in the 5th time donors where their SF and TS is far too low when compared to 1st – 4th time donors respectively (Table 2). This means that at 4th and 5th time donations, the iron stores of these donors are completely depleted leaving such donors in a state of anaemia. This is shown in their PCV ($0.291 \pm 0.380\text{L/L}$, $0.271 \pm 0.380\text{L/L}$) and Hb ($113 \pm 12\text{g/L}$, $96 \pm 15\text{g/L}$) levels respectively (Table 2). Considering this observation, we may suggest that 4th and 5th time donations should be discouraged as the quality of such blood may not be satisfactory for use. Again, this will also help to prevent the donors from developing anaemia due to blood donation.

Furthermore, it was observed that 15 donors participated in the 5th time donation which is half the number of the 1st-4th time donors. The low number we attribute to them been screened out during donor test fitness. However, these group of donors were observed to be youths between the ages of 20-30 years who are not gainfully employed and so they come occasionally when they have needs to raise money for their upkeep. A significant positive correlation between SF and PCV and SF and Hb was observed, as the frequency of donation increased among the donors (Figs 1a and b). This finding was similar to that reported in Thailand (12). The implication of this is that the levels of PCV and Hb are directly dependent on the amount of stored iron in the body.

The present work has shown difference in the frequency of blood donation and iron parameters of blood donors in Nigeria. The findings of this work have demonstrated reduced iron stores in male blood donors who donate more than twice in a year in this locality. This

then calls for a public education of all, particularly the donors on the health hazards of donating more than 3 times in a year especially in the third world countries like ours where we depend mostly on commercial donors for blood donation. Again we suggest as a rule in blood donor bays, any donor who have donated twice should be placed on iron supplement to prevent iron stores depletion. Moreover, the importance of eating balanced diet by the donors should always be emphasized as they visit for donation. From the present work we conclude that the appropriate frequency of donation in this locality should be 2 times a year but at the most 3 times while the donor is on iron supplement.

References

1. Ali AM, McAvoy AT, Ali MA, Goldsmith CH, Blajchman MA. An approach to determine objectively minimum haemoglobin standards for blood donors. *Transfusion* 2001; 25 (3) : 286 – 288.
2. Huestis DW, Busch S. Selection of blood donors in practical blood transfusion, 2nd ed. Boston: Little Brown and Company, 1991; P 7- 48.
3. Hewitt space PE, Wagstaff W. ABC of Transfusion. *Bri Med J*. 1999; 299: 1391 – 1394.
4. Roskams AJ, Connors JR. Iron transferrin and ferritin in the rat brain during development and aging. *J of Neurochem* 1994; 63 (2): 709 – 716.
5. Milman N. Serum ferritin in Danes: studies of iron status from infancy to old age, during blood donation and pregnancy. *Int J Hematol* 1996; 63 (2) : 103-135.
6. Usanga EA. Iron stores of Nigerian blood donors as assessed by serum ferritin concentration. *Cent Af J Med* 1990; 36: 170-173.
7. Molla A, Khurshid M, Molla AM. Prevalence of iron deficiency anaemia in children of the urban slums of Karachi. *J Pak Med Asso* 1992; 42(5): 118-121.
8. Dacie JV, Lewis SM. Practical Haematology 9th ed. Chur Livingstone P. 2001; 412 – 414.
9. Ukaejiofor EO, Isaac-Sodege WA, Adigun ES, Ipadola A. Normal hematological values in adult Nigerians. *Nig Med J* 1979; 9:117-119.
10. Akpotuzor JO, Isong C. Okpokam DC, Etukudo MH. Levels of serum iron, total iron binding capacity, transferrin saturation fraction and packed cell volume of blood donors in Calabar. *Pak J Nutri* 2008; 7 (3) 500 – 502.
11. Ahmed B, Ayesha A, Muhammed A, Ahmad KA. Effect of frequent blood donations on iron stores of non anaemic male blood donors. *J Pak Med Asso* 2006; 31-34
12. Linpisarn S, Thanangkul O, Suwanraj C, Kaewwichit R, Krieka LJ, Whitehead P. Iron deficiency in Northern Thai Population: the effect of iron supplement studied by means of plasma ferritin estimations. *Ann Clin Biochem* 1987; 21 (Pt 4 : 268 – 274.