Plasma iron values in National Blood Transfusion Service donors

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SYNOPSIS Haemoglobin, haematocrit, and plasma iron values were estimated on blood samples collected from 100 male and 113 female National Blood Transfusion Service blood donors, and from 83 male and 66 female age-matched control subjects. No significant differences in any of these values were found to exist between the donors and controls, and it is considered that the serum or plasma iron level is unsuitable for use as a screening test of early iron deficiency in donors.

It is a matter of concern to a transfusion service that its donors should experience no ill effects, and especially so where recruitment of donors is on a voluntary basis. On the other hand, increasing demands both for blood and blood products dictate that the available supply of donors be used to the best possible advantage, and that individual donors be bled at the shortest intervals that will allow full replenishment of the losses incurred.

The most probable effect of repeated blood donations is iron deficiency, accentuated by the low iron content of many diets and the relatively inefficient absorptive mechanisms concerned. Such a deficiency may coexist with a normal level of circulating haemoglobin (Stafford and Kemp, 1964; Fielding, O'Shaughnessy, and Brunström, 1965) and therefore the routine haemoglobin screening test applied to donors does not exclude all those who may be failing to make good their iron losses.

Donors in the National Blood Transfusion Service (NBTS) are called up at intervals of not less than six months and give 430 ml of blood, including samples. In the region covered by the South London Blood Transfusion Centre, donors are bled if their haemoglobin level exceeds 12.4 g/100 ml (85%) by a copper sulphate specific gravity method; it is not the practice to give them supplementary iron.

Laurell (1947) was able to demonstrate low serum iron values in donors, but his subjects had given some 2,500 ml over the previous 12 months. Remy, Goldeck, and Krüger (1952) also demonstrated a tendency towards low values in donors giving 1,200 to 1,500 ml in a year, but Hagberg, Wallenius, and Wranne (1958) found no change in serum iron and

total iron-binding capacity (TIBC) in donors who had been bled on up to four occasions in the previous 12 months. Kaldor (1953) found both three-monthly donors and controls to have similar mean serum iron values, although in his female groups differences of doubtful significance were recorded.

Iron absorption tests have been used in similar studies: Heistø and Foss (1958) found that the rise in serum iron following an oral dose increased in subjects who had given blood, as compared with normal controls, that this increase became more marked after further blood donations, and that it could be reversed by iron replacement therapy. Berde, Holländer, Undritz, and Zehnder (1955) reported that a similar test gave normal results provided that donations did not exceed 1,000 ml per 12 months. However, iron absorption tests are not feasible for the screening of blood donors since they involve fasting overnight and the collection of samples for several hours after the oral dose of iron.

The present investigation records plasma iron values, haemoglobin and haematocrit levels, in a series of NBTS donors and in control subjects, with the object of seeing whether regular blood donation produces any significant change. Comparison of serum or plasma iron levels can only usefully be made between mean values for different groups, since individual values are subject to quite wide variations dependent upon a number of factors (Zilva and Patston, 1966).

MATERIALS AND METHODS

The subjects were all donors attending NBTS sessions who had donated three or more times, the last previous

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donation being within 12 months. Age-matched controls were either potential donors attending for the first time, or healthy workers attending the Medical Department, British Railways Southern Region, London Bridge. Controls in the latter group were questioned and selected in the same way as are prospective blood donors. Donors and controls were excluded from this study if they had received any recent iron therapy. The age range of both groups was 18 to 65.

SAMPLING Blood was taken into lithium heparin for plasma iron estimation (equivalent to the serum level by the method used), and into EDTA for haemoglobin and haematocrit determination. From donors, the samples were taken via the collecting set at the end of the donation, while with controls who were not donors, simple venepuncture with minimal venous stasis was used. From a small series of donors bled at St. George's Hospital blood was taken by both methods and the relevant values compared in the pre- and post-donation samples.

METHODS Haemoglobin levels were measured by a routine cyanmethaemoglobin method using an EEL Spectra colorimeter and haematocrits were determined by a microcentrifugation method. Plasma iron estimations were carried out on the AutoAnalyzer using the method of Young and Hicks (1965).

RESULTS

1 COMPARISON OF PRE- AND POST-DONATION VALUES The 'pre-donation' sampling is equivalent to the method used in 53 of the male controls, that is, those

not bled at NBTS donor sessions. All other figures were obtained from post-donation samples, the blood being taken after a period of about five minutes with a cuff inflated to 40 to 60 mm Hg on the arm used. All values were higher in the pre-donation samples, the mean differences being: haemoglobin concentration 0.5 g/100 ml; haematocrit 1.8%; plasma iron 6.8 μ g/100 ml. Individual shifts of plasma iron ranged from 2 to 10 μ g/100 ml in the 10 donors studied in this way.

2 PLASMA IRON VALUES IN DONORS AND CONTROLS These are set out for males and females respectively in Tables I and II. In the total values for the groups, neither sex shows any significant difference in mean plasma iron between donors and controls. No correction has been made in the tables for the 52 male controls bled by simple venepuncture; if the effect shown in (1) above applies to the larger group then the mean plasma iron value for male controls should be lowered by about 4.3 μ g/100 ml to make it more strictly comparable with that of male donors. In each donor group, about half had donated three to eight times previously, and a further quarter up to 14 times, the remainder ranging up to 64 donations. There was no apparent relationship between these figures and plasma iron levels.

3 HAEMOGLOBIN AND HAEMATOCRIT VALUES Here again, no significant differences were found between donors and controls of either sex. Mean haemo-

TABLE I
RESULTS IN MALES

Male Donors				Male Controls		
Age Range (yr)	No. in Group	Mean Plasma Iron (μ g/100 ml)	SD	No. in Group	Mean Plasma Iron (μ g/100 ml)	SD
18-29	19	120.3	34.4	20	106.6	31.0
30-39	26	103.9	34.4	12	107.2	22.5
40-49	30	103.2	42.9	20	87.4	30.6
50-59	22	87.6	29.7	19	103.6	24.1
60-65	3	124.7	32.4	12	110.8	35.6
Total	100	103.9	39.46	83	102.0	30.1

TABLE II
RESULTS IN FEMALES

Female Donors				Female Controls		
Age Range (yr)	No. in Group	Mean Plasma Iron (μ g/100 ml)	SD	No. in Group	Mean Plasma Iron (μ g/100 ml)	SD
18-29	25	91.9	38.5	40	94.7	44.4
30-39	27	92.3	33.2	14	81.2	39.1
40-49	25	71.4	25.5	6	83.7	14.3
50-59	28	92.6	33.0	6	95.7	30.3
60-65	8	92.5	14.8	nil	—	—
Total	113	87.7	33.1	66	91.0	40.7

globin values for donors and controls were 14.8 g/100 ml and 15.2 g/100 ml (males), and 13.1 g/100 ml and 13.2 g/100 ml (females). The corresponding haematocrit values were 44%, 45%, 39%, and 40% respectively.

A number of low haemoglobin values were found in all groups and some of these, in donors and donor controls, were too far below the 12.4 g/100 ml NBTS rejection level for the difference to be due to the sampling effect noted above. Of 11 donors with haemoglobin values below 11.9 g/100 ml, the mean plasma iron level was 62 µg/100 ml (range < 10-104).

DISCUSSION

Previous work, cited above, has shown evidence of some degree of storage iron depletion following repeated blood losses of the magnitude experienced by blood donors. Laurell (1947) found lowered serum iron levels in his donors, who were, however, being bled more frequently than is usually the case now. Other workers have reported changes in the iron absorption test following donations, and however these be interpreted, the finding that the test reverted to normal following iron treatment suggests that some degree of depletion had occurred (Remy *et al*, 1952; Berde *et al*, 1955; Heistø and Foss, 1958). More recently, the chelation of body iron by an administered dose of desferrioxamine has been used as a measure of body iron stores; in a series of 45 women with normal haemoglobin levels 15 (33%) showed evidence of iron depletion (Fielding *et al*, 1965), while of 24 male blood donors who were incurring a mean annual loss of 900 ml, 10 (41%) showed similarly abnormal results (Fielding, Karabus, and Brunström, 1968). The similar figures in these two groups possibly reflect a comparable rate of blood loss, 900 ml annually, being roughly equivalent to a loss per menstrual cycle of 70 ml.

In the present study, plasma iron levels in male and female donors did not deviate from the normal controls; nor was there any difference when the females in the premenopausal age groups were judged separately. As a screening test for individual donors, the serum iron level has already been invalidated because of wide fluctuations related to

the time of day, the menstrual phase, and the presence of minor infections, in addition to day-to-day fluctuations which also occur (Zilva and Patston, 1966). The work of Fielding and his colleagues suggests that occult iron deficiency occurs both in healthy menstruating females and in male blood donors. The failure in the present study to demonstrate any fall in mean plasma iron amongst menstruating females who are also blood donors suggests that the serum/plasma iron level is an insufficiently sensitive index of iron depletion to be of value even for group studies. The only group in whom a lowered plasma iron level could be shown was that of 11 subjects, both donors and controls, in whom there was evidence of early anaemia.

Anyone donating blood at intervals of three months should receive supplementary oral iron; of those being bled six-monthly about a third of the males and presumably a higher proportion of the females would also benefit by being given iron. At present a screening test for occult iron deficiency is lacking, at least one sufficiently cheap and simple to be applicable on a large scale to NBTS blood donors.

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