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Influence of blood donation time intervals on ferritin and hemoglobin concentration

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ABSTRACT

Objective: Identify possible significant hemoglobin level variations between blood donations, and observe the effect of periodic donations on iron store.
Methods: Seventy-seven subjects were monitored in the course of 1 year to evaluate if repetitive blood donations had an effect on hemoglobin and ferritin concentrations. Furthermore, we determined if hemoglobin concentration variation, detected by the cyanmethemoglobin method, could be used as an early marker for decreased ferritin concentration, quantified by ELISA.
Results: No association between hemoglobin and ferritin variations was observed, as evidenced from our results. Ferritin variations were greater than 50% between donations; in contrast, hemoglobin remained unchanged within intra-individual biological fluctuations. We observed decreased ferritin values during the first blood donation in 15% of the men and 14% of the women evaluated. During the second blood donation 22% of men and 23% of women had decreased ferritin levels. During the third blood donation 43% of men and 50% of women had decreased ferritin values. Only men donated blood four times during the course of the year with all men having decreased ferritin levels. Decrease in ferritin was conditioned both by the number of blood donations as well as the periodicity between them. Spans greater than 6 months between blood donations reduced the risk of iron store reduction.
Conclusion: We determined hemoglobin is not a sensitive marker for monitoring repetitive blood donor follow-up, since hemoglobin did not vary significantly between donations despite having very low or nil ferritin concentration values.

1. Introduction

Iron is involved in many vital biochemical and physiological processes related to hemoglobin oxygen transport and muscle metabolism. Myoglobin allows oxygen to diffuse from erythrocytes to muscle mitochondria. In addition, ferrous iron in haem is part of the active site of cytochromes, involved in many metabolic pathways related to energy metabolism and enzyme microsomal P-450 system. Synthesis of steroids such as aldosterone, corticosterone, pregnenolone, among others occur in cytochrome P-450 [1]. Furthermore, iron is part of nearly all oxidases, involved in a variety of metabolic and physiological processes.

A 450 ml blood donation results in an iron loss between 200 and 250 mg [2], generating mobilization and

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decreased iron stores [3–5]. Blood donation appears to have beneficial effects related to increase high-density lipoprotein (HDL), a higher oxidative potential of low-density lipoprotein (LDL) and a higher NO_3 concentration [6,7], as well as reducing the risk of atheromanous plaque formation [5,7–10]. Similarly the decrease in iron concentration has been associated with decreased risk of cancer-inducing mutations, attributed to free radical production by high iron concentration causing DNA damage [11–13].

On the other hand, from the clinical point of view iron deficiency occurs in three phases, of which two are subclinical, i.e. without anemia. The first is known as iron deficiency and the second results in iron deficiency from impaired erythropoiesis. The third results in iron deficiency anemia. Since this anemia has the highest worldwide prevalence, it is therefore important to maintain iron homeostasis to sustain its physiological role [14–16]. However, in frequent blood donors with subclinical iron deficiency, diminished ferritin symptoms have been identified. Among them the most relevant is fatigue [17,18] and the restless leg syndrome [19–21].

It is known that biochemical indicators of iron metabolism, serum ferritin levels closely correlate with total body iron stores [22]. Different authors have reported decreased ferritin concentrations in blood donors, donating for the first time, ranging between 2 and 50% of the sample population. This frequency augments considerably in subjects that donate blood repeatedly, between 7 and 100% of donors [5,23–26]. In addition, regulations for every country regarding individual blood donation frequency are among other aspects to be considered. Although it is recommended to have a group of regular blood donors, it is essential to establish time intervals between donations for both men and women. In Colombia men can donate blood every 3 months, whereas a 4 month interval is mandated for women [27].

In Colombia and in many other Latin American countries repetitive blood donor ferritin levels are not followed up upon subsequent donations. This issue is to such an extent that inclusion criteria are the same for donors who donate for the first time. These repetitive blood donors are accepted as long as they have hemoglobin values within ranges established by national legislation depending on each country. In Colombia Resolution 901 of 1996 states that women's hemoglobin should be between 12.5 and 16 g dl^{-1} and for men between 13.5 and 18 g dl^{-1}.

Proposals for monitoring regular donors exist which include highly sensitive tests, but at high cost for many developing countrie's blood banks. These include determination of soluble transferrin receptors [24] or ferritin quantification. The latter, although readily available, significantly increases costs for blood banks [24,26,28].

Therefore, as an alternative to follow-up regular blood donor this work evaluated hemoglobin and ferritin levels depending on the number and frequency of donations. Similarly, to detect variations between donations the behavior of these two analytes was compared by analyzing individual data for hemoglobin and ferritin; considering that both hemoglobin and ferritin have low biological variability in individuals.

2. Materials and methods

2.1. Study type

This was a descriptive, prospective, and longitudinal study.

2.2. Universe

Voluntary subjects with repetitive blood donations were from the "*Unidad de Apoyo al Hospital Universitario San Ignacio Dar Vida*", Bogotá, D.C., Colombia. South America.

2.3. Inclusion criteria

Subjects should meet the requirements to be a blood donor according to Decree 1571 of 1993 [29] and the Handbook of blood bank technical and administrative rules [27], and had never donated blood before this study and agree to become repetitive donor throughout the duration of the study.

2.4. Ethical issues

Blood donor participation was voluntary after signed informed consent. Study protocol was reviewed and approved by the Bacteriology Program Curriculum Committee, School of Sciences at the Pontificia Universidad Javeriana, Bogotá, D.C., Colombia.

2.5. Samples

During the course of 1 year 1747 (100%) volunteers donated blood, where 34% were excluded (594) according to a pre-donation evaluation. The population of the study consisted of 1153 volunteers (66%), with 30% (346/1153) donating blood repetitively. Out of these donors, 38.2% (132 individuals) met the criteria established to donate blood for the first time. All volunteers were contacted by health care professionals (Bacteriologists) in order to explain the study and its implications.

2.6. Methodology

A 1-year longitudinal study was performed. Hemoglobin levels were a pre-requisite to accept the candidate blood donor. During each donation a survey inquiring about the volunteer's lifestyle and eating habits was conducted to verify if these issues did not interfere with analyte results. Blood ferritin values were assayed at the end of each sample collection. Each donor sera was stored at –70 °C until processed.

2.7. Hemoglobin and ferritin quantification

Hemoglobin was quantified by the HemoCue system [30] and ferritin by an ELISA assay [31]. Men ferritin values were considered low if they were below 20 ng ml^{-1} and for women beneath 10 ng ml^{-1}.

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