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A Review on Safeguarding Donors' Health and Well-being: The Need for Personalized Recovery Times

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***Abstract*: Background: The global demand for blood donation and transfusion continues to rise, making recruiting new donors and retaining existing ones essential. However, donor eligibility is linked to the health status of individuals. The increasing prevalence of multi-drug resistant and non-communicable diseases, along with emerging health threats, presents significant challenges to donor health and the stability of transfusion practices, particularly in low-resource health set-tings. Objective: This review examines strategies aimed at safeguarding the health and well-being of blood donors, focusing on existing practices and their effectiveness in different countries or continents. Discussion: While substantial advancements have been made in developed countries such as Europe and America, low-income and resource health settings, especially in Sub-Saharan Africa, face greater challenges. Frequent blood donors often experience low haemoglobin levels, iron depletion, and immune system effects, including lymphopenia and immunoglobulin depletion in frequent plateletpheresis donors, which can result in long-term health risks. Strategies that have been implemented and given positive outcomes, like post-donation testing, personalized inter-donation scheduling, iron supplementation, and continuous health monitoring, need to be considered in low-income or resource health settings. Additionally, donors' health perceptions significantly influence their willingness to donate, underscoring the need for comprehensive education and stronger health protection policies. Personalized recovery times, taking into account individual health status and donation frequency, are essential for preventing long-term health complications. Conclusion: Ensuring the health and well-being of blood donors is vital for maintaining a stable global blood supply. Personalized care and recovery strategies, with a focus on the needs of each donor, are key to protecting donor health. It is a global responsibility to prioritize donor health, especially in vulnerable low-income regions, to meet the increasing demand for blood products worldwide.**

***Keywords*: Blood, Donor, Health and well-being, Personalized recovery.**

1. Introduction

Blood donation is a selfless and lifesaving act in which blood is collected from healthy individuals to help those in need [1]. It is the most effective method of replenishing lost blood or com-ponents to save or stabilize a person's life [2]. This practice has saved the lives of millions of people worldwide [1]. Blood donation is a product of good health, and eligibility to donate de-pends entirely on the donor's sustained health [3]. Donors must maintain good health for their safety and to ensure the well-being of the recipients [1]. The World Health Organization (WHO) emphasises the importance of protecting the health of blood donors and recommends that national policies be developed with continuous monitoring of donor health status through blood transfusion services [3].

Globally, the issue of donor eligibility, or blood donor deferral, remains a concern, as it hinders the adequate supply of blood for transfusion [4]. This challenge affects both low and high-income countries, leading to an unmet demand for blood and unfortunate experiences for both donors and blood banks [5]. The prevalence of blood donor deferrals varies widely across regions, including Africa, Asia, and Europe [6]. Donor deferral may be temporary or permanent, depending on the reason for exclusion. This could be due to infectious diseases, haematological conditions, or other medical factors that either compromise the blood's safety or affect the donor's health [3]. Temporary deferral occurs when a potential donor is temporarily excluded due to a reversible, time-limited factor, such as low haemoglobin or abnormal blood pressure. On the other hand, permanent deferral applies when the exclusion is due to long-term factors [7].

2. Major Observed Donor Health-Related Concern

A. Low Haemoglobin Levels in Repeating Donors

Low haemoglobin levels are a significant cause of temporary deferral among blood donors, particularly among repeating donors [8]. A recent systematic review has shown that deferral due to low haemoglobin is associated with several factors, including donor sex, age, ethnicity, weight, ambient temperature, the length of the inter-donation interval, the haemoglobin level at the last donation, and the donation environment [9]. The study reported that females are at a significantly higher risk of haemoglobin related deferral compared to males. Social and physiological factors, such as pregnancy and menstruation, are thought to be key contributors to low haemoglobin in females. At the same time, higher testosterone levels in males are associated with higher

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haemoglobin levels [9]. Additionally, poor nutrition, including low intake of iron-rich foods, vitamin B12, and folic acid, has been identified as a risk factor for low haemoglobin in donors [6].

B. Iron Depletion

Iron deficiency is common among frequently donating blood donors, with rates ranging from 49% in men to 66% in women [9], [10]. In a recent clinical trial on the effects of donor iron repletion, D'Alessandro and Hod [12] reported several physiological and neurological side effects of iron depletion. These include cognitive dysfunction, fatigue, pregnancy-related complications, reduced exercise endurance, pica, and the less clearly linked restless legs syndrome [13]. Many iron-deficient blood donors develop Non-Anemic Iron Deficiency (NAID), which can negatively affect the donor's quality of life [13].

C. Depletion of Lymphocytes or Immunoglobulins

In recent years, plateletpheresis donations using a leukoreduction system (LRS) chamber have increased due to the growing demand for platelet [PLT] transfusions. Platelet transfusions are commonly used to prevent and treat hemorrhage in thrombocytopenic patients or those with severe platelet dysfunction [14]. As a result, millions of plateletpheresis donations are conduct-ed worldwide each year. However, frequent plateletpheresis donations using an LRS chamber have been linked to a decrease in T-cell lymphocytes (lymphopenia), which increases the risk of infection [15].

In a nationwide study of apheresis donors, Zhao et al. [15] found evidence of an increased infection risk among frequent plateletpheresis donors using an LRS chamber. This risk was shown to increase in a dose-dependent manner. These findings align with earlier research by Rahmani [16], who also observed lymphopenia in frequent plateletpheresis donors. Based on these results, monitoring Tlymphocyte counts in frequent platelet donors is recommended to prevent lymphocyte depletion [15].

3. Strategies to Protect Health and Wellbeing of Blood Donor

Several studies have been conducted to protect the health and well-being of blood donors, resulting in recommended measures to minimize risks. One such risk is the development of anaemia in returning donors.

A. Post-Donation Testing and Personalized Inter-Donation Scheduling

A modelling study by Kim et al. [8], and Spencer et al. [17] explored the effectiveness of various post-donation testing strategies. They calculated the probability of the appropriate time for donor haemoglobin recovery and predicted a personalized inter-donation interval. This approach has already been implemented in several European countries [18]. It helps identify donors at the highest risk of deferral, reduces low haemoglobin deferrals at the time of re-donation, and can either lengthen the inter-donation interval or decrease the number of donations per year to improve donor safety [8].

B. Donor Iron Supplementation

Previous research has shown that iron supplementation can help reverse iron depletion and re-duce haemoglobin deferrals in donors. A notable study by Cable et al., [19] conducted the haemoglobin and Iron Recovery Study, used randomized controlled trials to investigate iron balance and recovery in frequent blood donors. The study found that donors who received iron supplements recovered their iron levels more quickly than those who did not. The trial also demonstrated that extending the inter-donation interval to 12 or 16 weeks is not enough for the average donor to recover their iron stores without supplementation. In fact, 24 weeks after do-nation, two-thirds of donors who did not take supplements had still not fully recovered their lost iron. In a follow-up trial, Cable et al. [19] found that after just 8 weeks of iron supplementation, the effects on total body iron recovery were statistically significant. These findings suggest that daily low-dose oral iron supplementation for 8 weeks could effectively address donation-related iron depletion [13].

C. Donor Vigilance

In 2012, the World Health Organization [WHO] issued guidelines recommending that policy-makers in all nations develop policies to protect the health of blood donors [3]. On a similar note, the European Union launched an extensive donor vigilance program, which addresses not only short-term adverse reactions [such as fainting] but also mid- to long-term effects like iron depletion [20], lymphocyte reduction [15], and protein/immunoglobulin depletion [21] that are often overlooked in many hemovigilance programs [22]. Historically, hemovigilance systems have primarily focused on recipient safety. However, there has been a shift in recent years to-ward prioritizing donor safety and reporting donor complications [23]. Incorporating donor safety into hemovigilance is crucial to completing the full quality cycle of the transfusion process [24]. Many donor vigilance programs, however, still fail to address the long-term effects of lymphocyte or immunoglobulin depletion [15], [21].

Systematic monitoring of adverse events during the donation process enables data aggregation, triggers important research, and ultimately improves donor safety. Blood establishments have long recorded donation-related complications internally, but a uniform and transparent vigilance system, ideally independent of blood establishments, is necessary for data comparison and independent oversight [24]. Over time, likely, standards for blood and plasma collection will increasingly include recommendations for donor management to minimize complications, monitor donation-related issues, and take appropriate action when complications arise. Without dedicated hemovigilance programs, these potential adverse events are difficult to capture [22].

D. Health-Related Donor Perception

Health-related perceptions significantly influence a donor's decision to donate blood. Donors often have a range of positive and negative perceptions about the health impacts of blood donation. Thorpe et al. [25] conducted a broad systematic

review and highlighted that understanding these health-related perceptions is crucial for donor recruitment and retention. Positive beliefs, such as the idea that blood donation improves health by lowering blood pressure or aiding in weight loss [26]. Many donors believe that donating blood helps improve blood quality by re-moving excess or "unclean" blood and stimulating the production of new blood.

On the other hand, negative beliefs are also prevalent. For example, some donors worry that blood donation may negatively affect their physical appearance or reproductive health, with these concerns often being more common in studies from Asian or African countries [25]. A commonly held negative belief is the perceived loss of vitality, likely stemming from concerns about losing iron and blood volume after donation. Surprisingly, one of the most frequently cited concerns is the risk of acquiring infectious diseases, such as transfusion-transmitted infections (TTIs) like HIV [27], [28]. This belief is particularly prevalent in certain regions and among migrant groups, where it serves as a deterrent to donation [25]. Studies worldwide have identified several factors that hinder blood donation, including the perception of not being fit to donate, fear of anemia, concerns about other health risks, and a lack of information about the do-nation process. These perceptions contribute to significant morbidity and mortality in some populations [29].

4. Conclusions

The health and well-being of blood donors are vital to sustaining a reliable blood supply. While considerable efforts have been made to protect donors in developed countries, such measures are often not practised in low-income and resource health settings, where blood demand continues to rise. Personalized recovery times, tailored to individual donor health status, can significantly enhance donor safety and well-being, reducing the risks of long-term health complications. As emerging health threats and rising disease burdens affect new and recurrent donors, it is essential to prioritize donor health protection as a key strategy for maintaining the global blood supply. The global community must acknowledge the collective responsibility to safe-guard the health of blood donors, particularly in developing or under-developed countries. Fostering stronger policies, education, and donor-centered care practices is essential to ensuring a sustainable and safe blood donation system.

5. Recommendations

Health organizations should prioritize developing personalized recovery times for blood donors, considering factors such as donation frequency, donor health status, and specific donation types [e.g., whole blood vs. plateletpheresis]. This will minimize health risks and promote long-term donor retention. Regular post-donation testing and health monitoring should be integrated into standard practices, particularly in high-frequency donation settings. This will enable early identification of potential health issues, such as iron depletion or immune system impacts, and allow timely interventions.

Comprehensive education programs should be implemented to inform donors about the potential risks of frequent donation, recovery needs, and available health protection measures. Raising awareness can also address health-related perceptions and encourage informed decisions about donation. In low-resource health settings, there is need for policies that address the unique challenges of donor health protection. These should include affordable access to health monitoring, iron supplementation, and personalized recovery protocols tailored to local con-texts. Further research is needed to understand the long-term effects of frequent blood donation and to explore innovative methods for improving donor recovery. This will help refine current practices and ensure evidence-based approaches are at the forefront of donor health care.

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