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The Impact of Donor Recruitment Strategy on Blood Safety: A Comparative Analysis of Non-Remunerated Versus Directed Donors

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Abstract

Background: Blood transfusion safety relies heavily on healthy donor selection. While voluntary non-remunerated donation is the gold standard, patient attendants in regions like Pakistan still frequently choose directed donors for immediate transfusion needs.
Objective: To compare the hematological and serological profiles of non-remunerated and directed donors.
Methodology: This cross-sectional study. Place and Duration of Study: Department of Hematology and Transfusion Medicine, The Children's Hospital and UCHS Lahore, and the Sundas Foundation Lahore, from August 2024 to December 2024. Hematological parameters (hemoglobin and platelets) were analyzed via complete blood count (CBC) on an automated BECKMAN COULTER cell counter. Serological screening for Transfusion-Transmissible Infections (TTIs) was performed via chemiluminescence. Continuous data were analyzed using independent sample t-tests and Pearson's correlation coefficient (r), while categorical variables were evaluated using the Chi-Square test via IBM SPSS 23 software.
Results: A total of 150 donors were recruited (75 non-remunerated, 75 directed) with a mean age of 29.47 ± 6.705 years. Non-remunerated donors exhibited a slightly higher mean hemoglobin level (14.5 ± 1.34 g/dL) than directed donors (14.2 ± 1.38 g/dL), though this difference was not statistically significant (p = 0.086$). However, non-remunerated donors had a significantly higher mean platelet count (287.1 ± 61.8 x 10^9/L) compared to directed donors (245.8 ± 59.01 x 10^9/L; p < 0.001). Pearson correlation showed a weak but statistically significant positive correlation between hemoglobin and platelet counts across the cohort (r = 0.175, p < 0.05). Directed donors demonstrated significantly higher positivity rates for Hepatitis C Virus (HCV: 9.33% vs. 1.33%, p = 0.029) and Malaria (13.33% vs. 2.67%, p = 0.016) compared to voluntary donors. Differences for HBV, HIV, and Syphilis were not statistically significant (p > 0.05).
Conclusion: Non-remunerated blood donors present with superior hematological indices and significantly lower viral/parasitic marker rates. Patient families must be actively counseled regarding the inherent clinical risks associated with directed donations.
Keywords: Blood Donors, Hemoglobin, Platelets, Hepatitis C Virus, Malaria.

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Introduction

Blood transfusion remains a critical and essential component of modern healthcare, acting as a lifeline for patients requiring replacement therapy. In low- and middle-income regions like Pakistan, the high volume of specialized surgical, oncological, and hematological procedures underscores a constant, urgent need for a safe and stable blood supply, estimated at millions of units annually.[1] The provision of safe blood is paramount, and the World Health Organization (WHO) consistently advocates for national procurement systems based entirely on voluntary non-remunerated blood donation (VNRBD).[2] This global programmatic emphasis stems from extensive evidence indicating that donors whose motivation is purely altruistic are associated with the lowest baseline prevalence of blood-borne infections and are statistically more likely to provide an accurate medical history during pre-donation screenings.[3]

Blood banking systems fundamentally rely on distinguishing between two primary donor types: the Non-remunerated Donor, who gives blood willingly without any personal connection to a recipient, and the Directed Donor, who is specifically selected by the patient or their family to donate for their explicit use. In Pakistan's fragmented and decentralized transfusion network, the operational practice of voluntary blood donation remains heavily underrepresented, with VNRBD

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traditionally accounting for less than 15% to 18% of the national blood supply pool.[4] Consequently, modern blood banks are forced to rely heavily on directed or replacement family donors to sustain daily healthcare delivery demands.[5] A central clinical challenge in contemporary transfusion medicine is that directed donation carries an inherently higher risk profile compared to unlinked voluntary donation.[6] Recent localized epidemiological data have demonstrated that individuals recruited under the direct duress or social obligation of a relative's acute medical need may feel coerced to conceal high-risk behaviors or past exposures during the clinical pre-screening interview.[7] This systematic tendency to provide incomplete or misleading information deeply compromises the efficacy of the crucial donor questionnaire, which is structurally designed to protect both the donor and the recipient.[8]

Effective pre-donation screening is, therefore, a multi-faceted process that must encompass both an extensive donor interview and a baseline clinical assessment. Donors must meet a minimum hemoglobin (Hb) threshold to prevent iatrogenic complications such as anemia, dizziness, or fatigue, and to ensure the final blood product has an adequate oxygen-carrying capacity. In local centers, underlying nutritional deficiencies and latent microcytic anemia remain primary causes for donor deferral, representing a major public health challenge across potential donor cohorts.[9] Similarly, baseline platelets (thrombocytes) must fall within normal reference ranges to mitigate the donor's risk of excessive post-donation bleeding while confirming the overall viability and quality of the collected blood component.[10]

Most importantly, the risk of transfusion-transmissible infections (TTIs) remains a severe public health concern. All donated blood units must undergo rigorous serological testing for critical markers including Hepatitis B Virus (HBV), Hepatitis C Virus (HCV), and Human Immunodeficiency Virus (HIV), along with screening for other persistent regional pathogens like malaria and syphilis. Given the differential risk associated with donor recruitment methods, a comparative analysis of the hematological and serological profiles of non-remunerated and directed donors is essential. Such a comparison is necessary to empirically validate the safety differential and inform optimal blood banking practices. The findings will be instrumental in guiding regulatory bodies to refine screening protocols, particularly for directed donations, and strengthening public health campaigns aimed at expanding the safer volunteer donation pool. Therefore, the aim of this study is to compare the detailed blood profile parameters of non-remunerated donors and directed donors to scientifically assess the safety differential between these two critical donor categories.

Methodology

This cross-sectional study was conducted at the Department of Hematology and Transfusion Medicine in Children's Hospital and University of Child Health Sciences (UCHS), and the Sundas Foundation Lahore, from August 2024 to December 2024. A total of 150 donors aged 17–60 years presenting at these institutions who satisfied the American Association of Blood Banks (AABB) donor selection criteria were recruited.

Institutional Review Board (IRB) approval was obtained prior to study initiation (Approval No. 758/SAHS). Blood samples were collected in EDTA (lavender top) vacutainers to determine pre-transfusion hemoglobin (Hb) and platelet counts using an automated cell counter (BECKMAN COULTER, DxH 900). Serological screening was performed on a chemiluminescence instrument (Abbott i2000 SR) for the qualitative detection and differentiation of antibodies to HIV-1, HIV-2, Treponema pallidum (Syphilis), HCV, HBsAg (HBV), and Plasmodium falciparum/Plasmodium vivax antigens (Malaria) in human serum or plasma.All samples were processed and tested within 24 hours of collection. Collected data points included demographics (Name, Age, Gender), hematological parameters (Hemoglobin, Platelet count), and infectious disease screening parameters. A self-designed proforma was utilized for systematic data logging.

Data were tabulated and analyzed using IBM SPSS 23.0 software. Continuous variables (Age, Hb, Platelets) were expressed as Mean ± Standard Deviation (SD), whereas categorical variables were represented as frequencies and percentages. Pearson Correlation (r) was employed to test the linear association between continuous variables. Differences in mean Hb and platelet values between non-remunerated and directed donors were evaluated using an independent sample t-test. Categorical screening parameters and infection rates

were compared using the Chi-square test. A p-value < 0.05 was established as the threshold for statistical significance.

Results

A total of 150 blood donors were successfully evaluated, evenly distributed into 75 non-remunerated (voluntary) donors and 75 directed (replacement) donors. The study population exhibited a stark male bias, with 139 males (93.33%) and 11 females (6.67%), representing a male-to-female ratio of 13:1. The age of the participants ranged from 18 to 52 years, with an overall cohort mean age of 29.47 ± 6.705 years.

The pre-donation hematological parameters of both groups were compared using an independent sample t-test (Table I). Non-remunerated donors demonstrated a slightly higher mean hemoglobin concentration (14.5 ± 1.34 g/dL) than directed donors (14.2 ± 1.38 g/dL); however, this difference did not meet the threshold for statistical significance (p = 0.086). Conversely, mean platelet counts were significantly higher in the non-remunerated cohort (287.1 ± 61.8 x 10^9/L) compared to the directed donor cohort (245.8 ± 59.01 x 10^9/L), a variation that was highly statistically significant (p < 0.001).

A Pearson correlation analysis demonstrated a weak but statistically significant positive linear relationship between hemoglobin concentration and platelet count across the combined donor groups (r = 0.175, p < 0.05), indicating that as hemoglobin profiles rose, platelet counts exhibited a corresponding upward trend.

The evaluation of infectious disease markers revealed critical variations between the recruitment strategies (Table II). Directed donors displayed significantly higher infectious marker rates for both HCV and Malaria compared to voluntary non-remunerated donors.

The prevalence percentages and total frequency breakdowns for these positive infectious markers are structured below in Table III.

The rate of positive testing for HCV was substantially higher in directed donors (9.33%) than in non-remunerated donors (1.33%; p = 0.029). Similarly, a massive disparity was noted in malaria parasite positivity, which stood at 13.33% for directed donors compared to only 2.67% among voluntary individual donations (p = 0.016). Variations in HBV (4.00% vs. 1.33%), HIV (1.33% vs. 0.00%), and Syphilis (2.67% vs. 0.00%) did not achieve statistical significance due to lower absolute case numbers within the cohort.

Discussion

Blood transfusion is a vital, life-saving intervention used across all disciplines of medicine, enabling complex surgeries, managing trauma and massive hemorrhage, and sustaining patients with chronic hematological disorders. The safety of the blood supply remains paramount, and the findings of this study provide critical data supporting the global push toward 100% voluntary

Table I: Comparison of Hematological Parameters Between Donor Types

Parameter	Donor Type	Mean ± SD	p-value	Significance
Hemoglobin (g/dL)	Directed (n=75)	14.2± 1.38	0.086	Non-Significant (NS)
	Non-remunerated (n=75)	14.5±1.34		
Platelets (10^9/L)	Directed (n=75)	245.8±59.01	<0.001	Highly Significant
	Non-remunerated (n=75)	287.1 ± 61.8		

Table II: Screening Outcomes of Infectious Disease Markers Between Groups.

Infectious Agent	Non-remunerated (n=75) Positive / Negative	Directed (n=75) Positive / Negative	p-value	Significance
HBV (HBsAg)	1 / 74	3 / 72	0.311	Non-Significant
HCV (Anti-HCV)	1 / 74	7 / 68	0.029	Significant (p < 0.05)
HIV	0 / 75	1 / 74	0.316	Non-Significant
Syphilis	0 / 75	2 / 73	0.155	Non-Significant
Malaria	2 / 73	10 / 65	0.016	Significant (p < 0.05)

Table III: Absolute Frequency and Percentage Breakdown of TTI Positivity.

Donor Type	Total Screened	HBsAg (+)	Anti-HCV (+)	HIV (+)	Syphilis (+)	Malaria (+)
Non-remunerated	75	1 (1.33%)	1 (1.33%)	0 (0.00%)	0 (0.00%)	2 (2.67%)
Directed	75	3 (4.00%)	7 (9.33%)	1 (1.33%)	2 (2.67%)	10 (13.33%)

non-remunerated blood donation (VNRD). Our primary objective was to compare the infectious disease markers and key hematological parameters between voluntary and directed blood donors presenting at major blood centers in Lahore.

Our results demonstrate a pronounced male bias (13:1 male-to-female ratio), which is highly consistent with published data from blood donation centers across Pakistan and South Asia. For instance, a comparative cross-sectional evaluation conducted at the Armed Forces Institute of Transfusion (AFIT) in Pakistan reported an even starker gender disparity, with males constituting 98.8% of the total donor cohort and females just 1.2%.[11] This severe lack of female donor participation is further substantiated on a macro-epidemiological scale by Shah et al.[12], who evaluated a massive cohort of 94,716 healthy blood donors in Pakistan and found that female participation remained exceptionally minimal, accounting for only 0.03% in replacement and 0.06% in voluntary categories. This extreme regional imbalance highlights that social norms, cultural constraints, and restricted physical mobility often limit women's participation in voluntary blood donation activities. Furthermore, many potential female donors who do step forward are frequently excluded during initial pre-donation screening due to underlying nutritional deficiencies, structural iron depletion, menstruation, and pregnancy.

The most significant finding of our study was the observation that directed donations exhibited a significantly higher marker positive rate for Transfusion-Transmissible Infections (TTIs) compared to voluntary donations. This result is highly consistent with recent evidence from both developed and developing countries. Directed or replacement donors, who are often friends or family donating under social pressure, are more likely to conceal high-risk behaviors or fail to self-defer compared to regular, altruistic voluntary donors. Our finding strongly corroborates numerous studies conducted globally, particularly in regions where replacement or directed donations remain common practice.

When contrasting our TTI seroprevalence directly with regional literature, the risk differential associated with donor selection becomes exceptionally clear. In our directed donor cohort, the positivity rate for HCV reached a high of 9.33% and Malaria stood at 13.33%. Locally, Yousaf et al.[13] confirmed a matching trend in a contemporary Lahore-based tertiary care evaluation, documenting an overall TTI prevalence of 12.18%, driven predominantly by family replacement donor status. In their cohort, HBV (4.73%) and HCV (4.18%) stood out as independent predictors of infection directly tied to donor recruitment methods. While their study identified no active malaria cases, our high malaria positivity (13.33%) within the directed group flags an alarming seasonal or demographic vector surge that is dangerously amplified when selecting replacement pools without stringent unlinked tracking. On a wider geographic canvas across Pakistan, Shah et al.[12] corroborated that replacement collections harbor a disproportionate share of blood-borne threats, showing a significant baseline burden of HCV and syphilis that dynamically rises when voluntary systems are bypassed. This compounding epidemiological danger is compounded by wider regional structural variations; large-scale meta-analyses mapping blood security metrics across the global south have verified that fragmented localized protocols inherently struggle with tracking hidden demographic clusters, which systematically drives up residual risk margins in urban centers.[14]

This uniformity in regional findings underscores the fundamental behavioral and clinical risks associated with non-voluntary donation practices. This systematic trend is driven primarily by the acute psychological stress and hidden social coercion documented by Khan et al.[15], which deeply compromises the reliability of standard oral pre-donation questionnaires, rendering family directed pools highly vulnerable to containment failures and screening bypass.

Regarding hematological parameters, our analysis found that voluntary donors had a slightly higher mean Hemoglobin (Hb) concentration compared to directed donors (14.5 ± 1.34 g/dL vs. 14.2 ± 1.38 g/dL), though this independent variance was not statistically significant ($p = 0.086$). However, a separate Pearson correlation analysis across the entire population demonstrated a weak, statistically significant positive correlation between baseline Hb levels and total platelet counts ($r = 0.175$, $p < 0.05$). Crucially, our data noted a highly significant difference in baseline platelet pools, with voluntary donors exhibiting far healthier margins than their directed counterparts (287.1 ± 61.8 x 10^9/L vs. 245.8 ± 59.01 x

10^9/L; $p < 0.001$). This closely mirrors the foundational clinical principles detailed by Okoroiwu et al.[16], which emphasize that index variations and component stability are vastly superior in altruistic, regular donor populations compared to replacement groups, who may be at a higher risk for underlying nutritional deficiencies or donation-induced iron deficiency anemia.

Conclusion

Collectively, our data strongly support the World Health Organization's recommendation to establish a national blood supply based entirely on regular, voluntary, non-remunerated blood donors. The reduced TTI risk observed in the VNRD group is crucial for improving patient safety in transfusion medicine. While directed donation is often perceived by patient attendants as a safer alternative, our results confirm that this practice offers no safety improvement and, in fact, carries a higher inherent risk profile for serious infections like HCV and Malaria. Blood centers must therefore prioritize rigorous donor selection, thorough pre-donation counseling, and strict TTI screening, while simultaneously scaling up national public health efforts to increase VNRD to ensure a sustainable and safe blood supply.

LIMITATIONS: The primary limitation of this study is that the target population was confined exclusively to blood donors presenting at the Blood Bank of Children's Hospital Lahore and the Sundas Foundation Lahore. Consequently, the localized sample size may not completely capture the wider epidemiological variations of donor demographics present across the entire country.

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