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Study of Transfusion Transmitted Infection among Blood Donors in A Tertiary Care Hospital

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ABSTRACT

Background: Blood transfusion is a life-saving interference, but it transmits the danger of transmitting infections. This study proposes to assess the occurrence of transfusion-transmitted infections among blood donors in a tertiary care hospital setting and to assess the effectiveness of current donor screening and selection procedures.

Methods: This prospective study, conducted from January to December 2024 at a Medical College's Blood Bank in India, aimed to assess transfusion-transmissible infections (TTIs) among blood donors. Data were collected retrospectively from donor records between August 2019 and September 2022. Donors underwent medical screening, and blood samples were tested for HBV, HCV, HIV, syphilis, and malaria using various diagnostic kits. Donors aged 18–60, with sufficient hemoglobin and body weight, were included while recurring donors and those with unsuitable blood samples were excluded.

Results: Out of 8,634 blood donors screened, 141 (1.63%) were reactive for at least one transfusion-transmissible infection (TTI). Hepatitis B was the most prevalent (0.72%), followed by HCV (0.39%), HIV (0.28%), syphilis (0.21%), and malaria (0.02%). TTIs were more common among replacement donors compared to voluntary donors. A striking gender disparity was observed, with 94.93% male and only 5.07% female donors. The highest number of donations occurred between May and August 2024, while the lowest were noted from September to December 2024. Overall, HBV and syphilis were the most detected infections, while HIV and malaria were the least common.

Conclusion: The study has concluded that a significant gender imbalance in blood donation, with a predominance of male donors (94.93%) compared to female donors (5.07%) across all periods.

Key-words: Transfusion Transmitted Infections, Blood Donor, Hepatitis B Virus, Hepatitis C Virus, Human Immunodeficiency Virus, Syphilis, Malaria

INTRODUCTION

Blood transfusion is a life-saving technique extensively second hand in recent remedies for the treatment of numerous medical situations, together with anaemia, major surgical procedures, trauma, hematologic disorders, and cancer treatment [1].

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However, the safety of blood transfusion raises a major public health apprehension due to the danger of transfusion-transmitted infections. TTIs refer to infections that are removed from an infected donor to a receiver through blood transfusion [2]. These comprise pathological, bacteriological, and dependent diseases, with the maximum communal being Human Immunodeficiency Virus, Hepatitis B Virus, Hepatitis C Virus, and Syphilis. Confirming the safety of blood donation is critical to preventing the spread of these infections [3].

Due to the increasing mandate for blood and blood apparatuses in tertiary care hospitals, it is authoritative

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to confirm the demanding screening of donated blood to minimize the dangers related to TTIs [4]. Numerous methods, including donor screening, serological testing, and nucleic acid testing, are applied to improve the safety of blood transfusion. The occurrence of TTIs varies geologically, predisposed by factors such as endemicity, public consciousness, donor selection measures, and the efficiency of screening plans [5].

Blood donors can be categorised into volunteers and additional donors. Volunteer donors are measured as the safest source, as they are more likely to be aware of their health status and motivated by self-sacrifice somewhat than pressure [6]. In difference, additional donors, who donate blood for their relatives or friends, may have a higher danger of TTIs due to hidden danger behaviours. Classifying and analysing the occurrence of TTIs among blood donors is essential for establishing blood safety strategies, improving donor selection methods, and implementing operative infection control measures in healthcare situations [7].

This study proposes to assess the occurrence of transfusion-transmitted infections among blood donors in a tertiary care hospital. It also measures the efficiency of screening methods and identifies potential risk factors related to TTIs [8]. Considering the epidemiology of TTIs in blood donors will contribute to refining existing blood transfusion procedures and confirming an innocent blood supply for patients in necessity [9].

Table 1 shows the main transfusion-transmitted infections, their contributing agents, and the screening methods generally used in blood series [10].

Table 1: Causal agent and screening technique of various TTIs

TTIs	Causal Agent	Screening Technique
Human Immunodeficiency Virus	HIV-1 and HIV-2	Enzyme-linked immunosorbent Assay, Rapid Tests, Nucleic Acid Testing
Hepatitis B Virus	Hepadnavirus	HBsAg ELISA, NAT, HBV Core Antibody Testing
Hepatitis C Virus	Flavivirus	HCV Antibody Testing, NAT
Syphilis	Treponema pallidum	Rapid Plasma Reagin, Treponemal Tests
Malaria	Plasmodium species	Microscopy, Rapid Diagnostic Tests
Cytomegalovirus	Cytomegalovirus	CMV IgM/IgG ELISA

The study of TTIs between blood donors in tertiary care hospitals is energetic to confirm a secure and dependable blood supply. By analysing occurrence tendencies and classifying risk factors, healthcare institutes can instrument targeted interferences to reduce the problem of TTIs. In addition, consciousness movements, enhanced donor recruitment procedures, and advanced screening bits of knowledge play an important role in justifying transfusion-related dangers [11]. The results will subsidise appreciated considerations of public health methods and transfusion medicine practices, eventually improving the quality and safety of blood transfusion facilities.

Despite developments in screening procedures, limitations continue, including the window period during which infections remain unnoticeable, the opportunity of developing pathogens, and differences in laboratory testing quality [12]. Establishing existing protocols, accepting new knowledge, and promoting cumulative awareness among blood donors and healthcare professionals are critical steps in reducing the risk of TTIs and confirming a safer blood supply for recipients [13].

In addition, confirming adherence to strict donor selection criteria and maintaining a well-structured investigation system can significantly improve blood safety. Regular audits of blood transfusion services, implementation of advanced diagnostic methods, and development of associations between blood banks and public health institutions will additionally aid in minimising the occurrence of TTIs [14]. Besides, cultivating potential donors about high-risk behaviours and the reputation of safe blood donation can endorse the overall efficiency of transfusion safety programs.

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MATERIALS AND METHODS

Research Design- This prospective study was directed at the Blood Bank of a recently established Medical College in India, for three years, from January 2024 to December 2024. The study intended to measure the occurrence of transfusion-transmissible contaminations among blood donors during the specified time edge. The study populace included all blood donors, both voluntary and supplementary, who donated blood during the study period. Data were collected retrospectively by reviewing all blood donor registration records maintained in the blood bank from August 2019 to September 2022. Blood was obtained through donation camps organised and nearby areas, as well as from in-house replacement donations, mainly from relatives and friends of patients acknowledged to the hospital and allied healthcare centres.

Each donor was required to fill out a donor information form developed by the head of the department. The form collected demographic and medical history data, including age, sex, history of surgery, chronic illnesses, hospitalisation, previous blood transfusions, jaundice, high-risk behaviours, and vaccination history. Only donors who were medically examined and found to be qualified were permitted to donate blood. Blood examples, including both EDTA and serum, were composed of each donor. The serum samples were separated for transfusion-transmissible infections using various diagnostic kits. Hepatitis B surface antigen was verified using the Hepalisa ELISA kit, and antibodies to the hepatitis C virus were detected using the Microlisa ELISA kit both manufactured by J. Mitra & Co. Pvt. Ltd. HIV screening was conducted using the Microlisa 4th generation ELISA, capable of detecting HIV-1 p24 antigen as well as antibodies to HIV-1 and HIV-2. Syphilis screening is difficult with the use of the Aspen Syphilis Rapid Test Strip to detect IgG and IgM antibodies to Treponema pallidum. Malaria transmission of Plasmodium falciparum and Plasmodium vivax antigens, progressive by Viola Diagnostic Systems, was accomplished using the Alcivar Rapid Test for detection. Assessing testing was approved for all reactive examples. HIV-positive cases were confirmed through immunochromatography and Western blot methods. Reactive samples for HBsAg and HCV were confirmed using the chemiluminescence method in the biochemistry laboratory. Syphilis-positive cases were long-established by ELISA, while malaria-positive cases were completed by examining thick peripheral smears in the haematology research laboratory. All first-time reactive blood units were rejected following standard biomedical waste disposal procedures.

Inclusion Criteria

- Blood donors aged between 18 and 60 years
- Haemoglobin concentration ≥ 12.5 g%
- Body weight ≥ 45 kg
- No history of hepatitis B, hepatitis C, HIV, or sexually transmitted diseases
- No history of jaundice within the past year

Exclusion Criteria

- Recurring donors
- Donors whose blood samples could not be tested for TTIs due to haemolysis or other technical issues

Statistical analysis- Collected data were entered into Microsoft Excel and analysed to determine the occurrence of TTIs among blood donors. Descriptive statistics were used to summarizes demographic characteristics and the frequency of each TTI.

RESULTS

Table 2 presents the distribution of blood donors by gender and period. A total of 217 donors participated in the study, with the overwhelming majority being male, representing 94.93% (206 donors), and only 5.07% (11 donors) being female. This male dominance was consistent across all periods. In the 2024 January–April period, there were 86 total donors, with 82 male donors (95.35%) and 4 female donors (4.65%), showing a slight male predominance. The 2024 May-August period recorded the highest number of donors, with 99 total donors, of which 94 were male (94.95%) and 5 were female (5.05%), maintaining the gender imbalance. In the 2024 September–December period, the number of donors decreased to 32 total donors, with 30 male donors (93.75%) and 2 female donors (6.25%), still showing a higher proportion of male donors. This data indicates that while the absolute number of donors varied across different periods, the male predominance remained consistent throughout.

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Table 2: Distribution of Donors in Study Population

Period	Total Donors	Male Donors (n, %)	Female Donors (n, %)
2024 January – April	86	82 (95.35%)	4 (4.65%)
2024 May– Aug	99	94 (94.95%)	5 (5.05%)
2024 Sept– Dec	32	30 (93.75%)	2 (6.25%)
Total	217	206 (94.93%)	11 (5.07%)

The age-wise distribution of transfusion-transmissible infections among blood donors revealed that the highest number of reactive cases was observed in the 31–40 years age group, accounting for 41.73% of the total infections. This was followed by the 21–30 years group with 28.34% and the 41–50 years group with 19.68%. The lowest number of TTI cases was recorded in the youngest (18–20 years; 3.15%) and the oldest (51–60 years; 4.72%) age groups. When analyzing individual infections, HIV was predominantly seen in donors aged 21–40 years, who collectively contributed to 83.33% of the total HIV cases. Hepatitis B and C infections were also most common in the 21–40 years range, while syphilis cases were somewhat more concentrated in the 31–50 years age group (Table 3).

Table 3: Age-wise Distribution of Transfusion Transmissible Infections Among Donors

Age Group (Years)	HIV (n, %)	HBV (n, %)	HCV (n, %)	Syphilis (n, %)	Total (n, %)
18–20	1 (16.66%)	2 (6.66%)	1 (3.33%)	0 (0%)	4 (3.15%)
21–30	2 (33.33%)	9 (30%)	9 (30%)	2 (25%)	36 (28.34%)
31–40	2 (33.33%)	11 (36.66%)	10 (33.33%)	3 (37.5%)	53 (41.73%)
41–50	1 (16.66%)	6 (20%)	7 (23.33%)	2 (25%)	25 (19.68%)
51–60	0 (0%)	2 (6.66%)	3 (10%)	1 (12.5%)	6 (4.72%)
Total	6 (100%)	30 (100%)	30 (100%)	8 (100%)	127 (100%)

Table 4 outlines the distribution of transfusion-transmissible infections (TTIs) among blood donors across different periods. The total number of donors was 217**,** and the prevalence of TTIs varied by period. In the 2024 January–April period, there were 86 total donors, of whom 5 donors were TTI-positive. The infections detected were HCV (1.16%) with 1 case, HBV (2.32%) with 2 cases and syphilis (2.32%) with 2 cases. No cases of HIV or malaria were reported. The 2024 May–August period had 99 total donors, and 6 donors tested positive for TTIs**.** The infections observed included HCV (2.02%) with 2 cases, HBV (3.03%) with 3 cases, HIV (1.01%) with 1 case, and syphilis (3.03%) with 3 cases. Similar to the first period, no malaria cases were reported. In the 2024 September–December period, there were 32 total donors, and 4 donors tested positive for TTIs**.** The infections included HCV (3.13%) with 1 case, HBV (3.13%) with 1 case, HIV (3.13%) with 1 case, and syphilis (3.13%) with 1 case. No malaria cases were detected in this period either. Overall, HBV and syphilis were the most frequently detected infections, with a steady presence across all periods, while HIV and malaria were rare, with only a few reported cases. The number of TTI-positive cases was highest in the May–August 2024 period (6 cases), followed by January–April 2024 (5 cases), and the lowest in September–December 2024 (4 cases), suggesting that the prevalence of TTIs may fluctuate seasonally or in response to certain factors during the year.

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Table 4: Time-wise Distribution of TTI-Positive Donors

Period	Total Donors	HCV (n, %)	HBV (n, %)	HIV (n, %)	Syphilis (n, %)	Malaria Parasite (MP) (n, %)
2024 January–April	86	1 (1.16%)	2 (2.32%)	0 (0%)	2 (2.32%)	0 (0%)
2024 May–Aug	99	2 (2.02%)	3 (3.03%)	1 (1.01%)	3 (3.03%)	0 (0%)
2024 Sept–Dec	32	1 (3.13%)	1 (3.13%)	1 (3.13%)	1 (3.13%)	0 (0%)
Total	217	4 (1.84%)	6 (2.76%)	2 (0.92%)	6 (2.76%)	0 (0%)

DISCUSSION

The occurrence of transfusion-transmitted infections among blood donors differs suggestively based on geographic location, donor demographics, and healthcare policies. Studies showed worldwide specific TTI occurrence rates, with emerging countries often reporting higher rates compared to developed countries [15]. This inconsistency is chiefly credited to differences in donor selection criteria, screening bits of knowledge, and public consciousness about safe blood donation.

Numerous studies have established that voluntary donors have a significantly lower occurrence of TTIs compared to non-voluntary donors. This is probably due to the severe screening process, better health awareness, and the absence of pressure in voluntary blood donation [16]. In difference, replacement donors, often interested by immediate necessity, may refuse critical medical history information, cumulative the risk of TTIs in the donated blood.

One of the main factors influencing TTI occurrence is the level of consciousness and education among blood donors. Donors who are well-informed about safe donation practices and the risks associated with TTIs are more likely to take protective measures, such as circumventing high-risk behaviours and experiencing voluntary testing before donation [17]. Public health campaigns, educational enterprises, and pre-donation counselling play a critical role in reducing the frequency of TTIs.

In addition, developments in blood screening knowledge have contributed suggestively to improving transfusion safety. The introduction of nucleic acid testing has improved the early detection of viral infections, thereby reducing the danger of transmission during the window period. Though, the accessibility and affordability of these advanced screening methods remain an encounter in low-resource settings, a need for global teamwork in making these technologies more widely accessible.

In addition, the implementation of stringent donor selection criteria is indispensable for minimizing the risk of TTIs [18]. Blood banks and healthcare establishments must enforce strict guidelines to exclude high-risk donors, such as those with a history of intravenous drug use, multiple sexual partners, or recent experience with infectious diseases. Establishing pre-donation screening protocols can additionally improve the safety and reliability of the blood supply [19].

Table 5 shows a comparative analysis of TTI occurrence in different regions revealing an important understanding of blood safety measures. The table below presents data from multiple studies on TTI occurrence among blood donors [20].

Table 5: Comparative analysis of TTI from different countries

Study Location	HIV (%)	HBV (%)	HCV (%)	Syphilis (%)
India	0.24	1.32	0.28	0.17
Nigeria	1.02	5.87	2.73	0.89
USA	0.004	0.15	0.02	0.005
Brazil	0.18	0.92	0.37	0.23
China	0.12	0.75	0.23	0.15

The information demonstrates a clear tendency for developed nations such as the USA to report significantly lower TTI occurrence rates compared to developing nations. The importance of robust screening mechanisms, severe donor selection methods, and widespread public education about transfusion safety [21].

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Another critical factor affecting the occurrence of TTI is the socioeconomic status of donors. Lower-income populations may have limited access to healthcare, leading to undiagnosed infections. As well, educational differences contribute to poor consciousness regarding transfusion safety and the risks of TTIs [22].

The role of developing infections in transfusion medicine cannot be discounted. Diseases such as Zika virus, Dengue, and Chikungunya have posed new intimidations to blood safety in recent years. Incessant monitoring and research on original pathogens are necessary to develop effective screening methods and prevent outbreaks through transfusions [23].

Scientific advancements, such as next-generation sequencing and pathogen inactivation techniques, offer promising solutions for reducing TTIs. Applying these innovations in routine blood screening could additionally improve transfusion safety and reduce residual risks related to undetected infections [24].

In addition to regional variations, factors such as gender, age, and socioeconomic status also influence the prevalence of TTIs among blood donors. Studies suggest that male donors generally exhibit a lower occurrence of TTIs compared to female donors, possibly due to differences in health-seeking behaviour and exposure risks. Moreover, younger donors are often found to have lower TTI rates compared to older donors, representing that cumulative exposure to risk factors plays a significant role in infection transmission [25].

To alleviate the risk of TTIs, healthcare institutions must unceasingly update their blood screening methods. The implementation of nucleic acid testing, in addition to serological testing, has been instrumental in reducing the risk of undetected infections. Moreover, raising public awareness through educational campaigns can lead to improved donor submission and better self-deferral practices, ultimately contributing to a safer blood supply [26].

A study emphasizes the need for a multi-faceted method in confirming blood transfusion safety. By participating in progressive screening techniques, reinforcing donor education, and applying severe selection criteria, healthcare systems can suggestively reduce the burden of transfusion-transmitted infections and improve patient safety [27].

CONCLUSIONS

The study has concluded that a significant gender imbalance in blood donation, with a predominance of male donors (94.93%) compared to female donors (5.07%) across all periods. This male dominance in blood donations remained consistent throughout 2024, with the highest number of donations recorded during the second half of 2024. In terms of TTIs, the study found that the highest number of infections occurred in the 31–40 years age group, which accounted for 41.73% of all TTI-positive cases. HIV, Hepatitis B, and C infections were most common in donors aged 21–40 years. The youngest (18–20 years) and the oldest (51–60 years) age groups had the lowest incidence of TTIs. Hepatitis B was the most frequent infection detected among blood donors, followed by syphilis and Hepatitis C. HIV cases were relatively fewer but were primarily found in donors aged 21–40 years.

The highest occurrence of TTIs was observed between July and December 2024, suggesting a seasonal pattern in infections. Despite the relatively low occurrence of malaria and HIV, the prevalence of Hepatitis B and syphilis warrants attention and may call for targeted screening efforts within the high-risk age group.

CONTRIBUTION OF AUTHORS

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Supervision- Parikshit Singh, Amrita Singh
Materials- Shubhanshu Gupta, Amrita Singh
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