Section: Transfusion Medicine

Original Research Article

SEROPREVALENCE OF TRANSFUSION-TRANSMISSIBLE INFECTIONS (TTIs) AMONG BLOOD DONORS AT BLOOD CENTRE OF A TERTIARY CARE HOSPITAL IN NORTH INDIA: A SIX-YEAR RETROSPECTIVE STUDY

Gurpreet Kaur Thiara[1], Amit Gulrez[2], Ashima[3]

[1]Assistant Professor & Head, Department of Transfusion Medicine, Christian Medical College, Ludhiana, Punjab, India.
[2]Associate Professor, Department of Physiology, Christian Medical College, Ludhiana, Punjab, India.
[3]Professor, Department of Pathology, Christian Medical College, Ludhiana, Punjab, India.

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Corresponding Author:
Dr. Ashima,
Professor, Department of Pathology, Christian Medical College, Ludhiana, Punjab, India.
Email: agulrez2008@gmail.com

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ABSTRACT

Background: Blood transfusion continues to be an important source of pathogens in transfused patients. An unsafe blood transfusion is extremely costly, both in terms of human lives and economic impact. Transfusion-transmitted infections (TTIs) pose a significant risk associated with blood transfusions. Accurate risk assessments of TTIs are crucial for ensuring the safety of the blood supply. The objective of this study is to assess the seroprevalence of transfusion-transmitted infections (TTIs) among healthy blood donors in North India population.

Materials and Methods: A retrospective observational study was conducted in the department of Transfusion Medicine of a tertiary care hospital of North India. The study period spanned from January 2018 to December 2023, during which data from all blood donors was reviewed and analyzed for the prevalence of TTIs.

Results: The present study included 44,016 donors for seroprevalence of TTIs. Overall, 1675 donors (3.8%) had a reactive result for one or more TTIs.

Conclusion: Raising public awareness about voluntary blood donation, along with thorough donor screening, counseling, and the use of highly sensitive tests, can help reduce the risk of TTIs.

Keywords: Blood Transfusion, Blood Donors, Donor Screening, Seroprevalence, Transfusion-Transmitted Infections.

INTRODUCTION

Blood transfusion is an essential component of modern medical practice, providing life-saving treatment in a variety of medical conditions, such as severe trauma, major surgical procedures, and hematological disorders.[1,2,3]

Like any other medical intervention, blood transfusion has inherent risks involved, including transfusion-transmissible infections (TTIs). These infections include Human Immunodeficiency Virus (HIV), Hepatitis B Virus (HBV), Hepatitis C Virus (HCV), syphilis and malaria. If not properly screened, it may pose significant risks to recipient.[2,4,5] Safety of blood transfusion services is a critical public health priority worldwide. Globally, the World Health Organization (WHO) mandates that all donated blood should be systematically screened for these infections to ensure a safe and adequate blood supply.[2] Effective screening strategies have greatly reduced the incidence of TTIs in high-income countries.[6] However, in low- and middle-income countries, including India, the prevalence of these infections remains a significant challenge. High burden of infectious diseases, inadequate screening infrastructure, and reliance on replacement donors as opposed to voluntary, non-remunerated donors are some of the contributing factors to this.[7] India faces particular challenges in maintaining blood safety due to its large population and considerable healthcare needs. Seroprevalence

of TTIs among blood donors in India varies significantly across different regions.[8] The present study was performed to establish the seroprevalence of TTIs in a tertiary care hospital of North India.

MATERIALS AND METHODS

Study Design and Setting

This retrospective observational study was conducted in the department of Transfusion Medicine of a tertiary care hospital of North India. The study period spanned from January 2018 to December 2023, during which data from all blood donors was reviewed and analyzed for the prevalence of TTIs.

Study Population

A total of 44,016 blood donors who met the National Blood Transfusion Council (NBTC) eligibility criteria for blood donation were included in the study. Donors were between 18 and 65 years old, had a minimum hemoglobin level of 12.5 g/dL, and were deemed healthy based on a thorough medical history and physical examination. Both male and female donors were included; however, the donor pool was predominantly male.

Blood Collection and Handling

Blood collection from eligible donors was carried out under strict aseptic conditions to ensure donor safety and blood samples' integrity. Each donor was carefully assessed for eligibility based on predefined criteria, including their health status, medical history, and hemoglobin levels. Once deemed eligible, the donors were seated comfortably, and their blood was drawn using a sterile, single-use needle. A single unit of 350 mL/450 mL of whole blood was collected from each donor, depending on their body weight. Blood bags and satellite tubes were labeled before blood collection. Blood was collected and stored under strict asepsis in blood bags containing an anticoagulant solution to prevent clotting. The collected blood was then processed in the blood centre. Whole blood was separated into its main components: Packed Red Blood Cells (PRBCs), plasma, and platelets. The component preparation was achieved through centrifugation, ensuring that each component could be used effectively for different clinical purposes based on the needs of the patients. In addition to the main unit of blood, samples were drawn into test tubes for pre-transfusion testing. These samples were crucial for blood grouping and serological testing to detect TTIs. The blood collected in tubes was transported to the laboratory for immediate analysis. When necessary, care was taken to maintain the chain of custody and the cold chain to preserve the samples' integrity until testing was performed.

Screening for TTIs

To ensure the safety of the blood supply and minimize the risk of TTIs, all blood samples underwent screening process. Each sample was tested for major infections that can be transmitted through blood transfusions, including HIV, HBV, HCV, syphilis, and malaria. Various diagnostic methods were employed to detect these infections. Fourth-generation Chemiluminescence kits were used to detect HIV, HBV, and HCV. Chemiluminescent Immunoassay (CLIA) is an advanced immunoassay technique widely used in Transfusion Medicine (TM) for Transfusion-Transmitted Infections (TTI) screening due to its high sensitivity, specificity, faster turnaround time and automation capability. The Chemiluminescence method can detect various antigens and antibodies specific to HIV, Hepatitis B and Hepatitis C, allowing for the early identification of infections. Each positive result was followed up with confirmatory testing to ensure the accuracy of the diagnosis and to prevent the use of infected blood for transfusion. For syphilis, the venereal disease research laboratory (VDRL) test was utilized. This test is based on detecting antibodies produced in response to the Treponema pallidum bacterium, which causes syphilis. The VDRL test is sensitive and cost-effective, making it a practical choice for screening blood donors. Screening for malaria was conducted using rapid diagnostic tests (RDTs). These tests are designed to detect malaria parasites in the blood by identifying antigens derived from the parasite's presence. Although malaria transmission via blood transfusion is rare, the risk is significant in endemic regions, making it essential to include this screening in the blood safety protocol.

The combined use of these advanced screening technologies ensured that only safe and infection-free blood was available for transfusion. Any blood samples that tested positive for TTIs were discarded following strict safety guidelines, and donors who tested positive were notified, counseled and referred for appropriate medical care. This rigorous screening process was essential in maintaining a safe blood supply and protecting recipients from the potential transmission of serious infections. Internal and external quality controls were performed as per protocol.

Data Collection

The data collection process for this study involved a comprehensive review of donor records maintained in the department of Transfusion Medicine of the tertiary care hospital. Information was systematically gathered from electronic and paper databases, ensuring accuracy and completeness. The key donor data recorded included demographic information, such as age and gender, along with each donor's donation history, which detailed the frequency and timing of their blood donations over the study period.

In addition to demographic data, the TTI screening results were meticulously documented for every donor. Each donor's blood sample was screened for HIV, HBV, HCV, syphilis, and malaria, with results indicating whether the donor tested reactive or non-reactive for any of these infections. These screening

results were essential for calculating the seroprevalence of TTIs among the donor population. The data collection also involved extracting information on the number of donations made each year, allowing for a year-wise analysis of donation trends. This included capturing how external factors, such as the COVID-19 pandemic, influenced donation rates over time. All collected data were recorded in a standardized format to ensure uniformity and easy analysis. Once all the relevant data were gathered, they were organized into tables, with the total number of donations and the incidence of TTIs being calculated for each year of the study. These tabulated data were subsequently used to assess the seroprevalence of each infection over the six-year study period and to identify trends, patterns, and potential areas of concern regarding blood safety. This systematic approach ensured the collected data were reliable, consistent, and suitable for meaningful statistical analysis.

Statistical Analysis

The data were analyzed using IBM SPSS Statistics for Windows, Version 23 (Released 2015; IBM Corp., Armonk, New York) and Microsoft Excel 2019 (Microsoft Corporation, Redmond, Washington). Descriptive statistics were employed to summarize the demographic characteristics of the blood donors and the prevalence of TTIs. The seroprevalence rates for each infection (HIV, HBV, HCV, syphilis, and malaria) were calculated as percentages of the total donor population. Year-wise and gender-wise comparisons were made to examine trends in donation and infection rates over the study period. Additionally, linear regression analysis was conducted to evaluate trends in TTI prevalence over time, identifying any significant increases or decreases in infection rates during the study period.

Ethical Considerations

The study was conducted according to the ethical standards of the institutional review board from Christian Medical College & Hospital, Ludhiana, and all donor data were anonymized to maintain confidentiality. Informed consent was obtained from all donors at the time of donation in compliance with ethical guidelines.

RESULTS

A total of 44,016 blood donors were screened for TTIs between January 2018 and December 2023. The overall prevalence of TTIs during the study period was found to be 3.8%, with varying rates of HIV, HBV, HCV, syphilis, and malaria. Among the donors, 99.7% were males and 0.3% were females. A year-wise breakdown showed that the number of donations were not impacted by the COVID-19 pandemic.

Overall, 1675 donors (3.8%) had a reactive result for one or more TTIs. Of those, 789 donors (47.1%) were HCV reactive, 329 donors (19.6%) were HBV reactive, 324 donors (19.3%) were HIV reactive, 232 donors (13.9%) were syphilis reactive, and 1 donor (0.05%) had malaria.

Some of the donors were reactive for more than one TTI. A total of 43 donors were found to have co-infections during the study period. 28 (65.0%) of these donors were co-reactive for HIV and HCV.

Table 1: Year-wise and Gender-wise distribution of Blood donors (2018-2023)

Year	Total donors	Male	Female
2018	7986	7967 (99.8%)	19 (0.2%)
2019	8787	8762 (99.7%)	25 (0.3%)
2020	7603	7587 (99.8%)	16 (0.2%)
2021	7063	7056 (99.9%)	7 (0.1%)
2022	6407	6394 (99.8%)	13 (0.2%)
2023	6170	6145 (99.6%)	25 (0.4%)
Total	44016	43911 (99.8%)	105 (0.2%)

Table 2: Distribution of voluntary and replacement donors

Year	Total donors	Voluntary donors	Replacement donors
2018	7986	4892 (61.3%)	3094 (38.7%)
2019	8787	5625 (64.0%)	3162 (36.0%)
2020	7603	4612 (61.0%)	2991 (39.0%)
2021	7063	4218 (59.7%)	2845 (40.3%)
2022	6407	4530 (70.7%)	1877 (29.3%)
2023	6170	4843 (78.6%)	1320 (21.4%)
Total	44016	28726 (65.3%)	15290 (34.7%)

Table 3: Year-wise distribution of seroprevalence of TTIs among blood donors (2018–2023)

Year	Total donors	HIV	HCV	HBV	VDRL	MP	Total Reactive Donors
2018	7986	37 (0.5%)	162 (2.0%)	45 (0.6%)	53 (0.7%)	-	297 (3.7%)
2019	8787	63 (0.7%)	164 (1.9%)	97 (1.1%)	39 (0.4%)	1 (0.01%)	364 (4.1%)
2020	7603	60 (0.8%)	158 (2.1%)	46 (0.6%)	39 (0.5%)	-	303 (4.0%)

2021	7063	68 (1.0%)	113 (1.6%)	49 (0.7%)	34 (0.5%)	-	264 (3.7%)
2022	6407	54 (0.8%)	94 (1.5%)	49 (0.8%)	46 (0.7%)	-	243 (3.8%)
2023	6170	42 (0.7%)	98 (1.6%)	43 (0.7%)	21 (0.3%)	-	204 (3.3%)
Total	44016	324 (0.7%)	789 (1.8%)	329 (0.7%)	232 (0.5%)	1 (0.002%)	1675 (3.8%)

Table 4: Prevalence of co-infection among donors

Year	Co- infection
2018	7
2019	6
2020	5
2021	6
2022	9
2023	10
Total	43

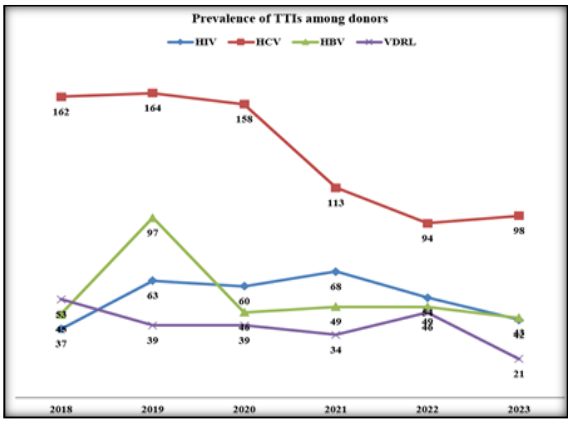

Figure 1: Prevalence of TTIs among donors

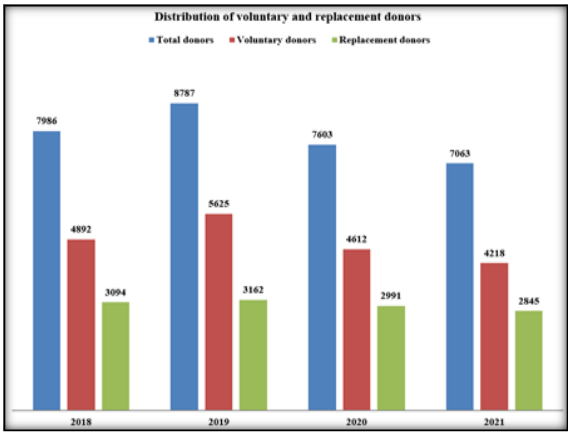

Figure 2: Distribution of voluntary and replacement donors

DISCUSSION

Blood transfusion is a critical life-saving procedure, but it may involve risk, most importantly the transmission of infections. TTIs remain a significant crucial health concern, especially in developing countries like India, where the prevalence of infections such as HIV, HBV, HCV, and syphilis is high and resources are limited. Despite various technologies, challenges like window period, false negatives, asymptomatic carriers, genetic variations in different viral strains and technical errors can lead to TTIs. The occurrence of TTIs among blood donors in a well-organized healthcare system with efficient blood bank services can also serve as a dependable tool for statistically estimating the presence of these infectious agents in the general population.

In this study, the overall prevalence of TTIs among blood donors was found to be 3.8%, with HCV being the most prevalent infection (1.8%), followed by HBV (0.7%), HIV (0.7%), Syphilis (0.5%) and Malaria (0.002%). The prevalence of TTIs observed in this study is consistent with previous studies conducted in India.

In the present study overall prevalence of all TTIs was 3.8% which was similar to studies done by Saini N et al [9] (2.8%), Shrivastava M et al[10] (2.7%), Rawat A et al[8] (4.4%) and Pessoni LL et al[11] (4.0%) as shown in table 5. The variation in prevalence rates across different studies can be attributed to regional differences in donor demographics, screening methodologies, and the effectiveness of public health interventions to reduce the spread of these infections.

In the present study the trend of prevalence of TTIs was Hepatitis C (1.8%) being highest followed by Hepatitis B (0.7%), HIV (0.7%), VDRL (0.5%) and malaria (0.002%) being least common. Results of other studies in comparison to present study is shown in table 6.

The higher prevalence of hepatitis C in apparently healthy blood donors in our study (1.8%) can be explained by the fact that it persists in abundance in our population. Unqualified medical practitioners in India practice unsafe therapeutic practices, such as not sterilizing instruments, reusing needles, blood banks not following guidelines for testing of TTIs, intravenous drug abuse, accidental exposure of healthcare workers, dental procedures, non-use of condoms by sex workers, large numbers of migrant population, tattooing, body piercing, and shaving by village barbers are factors responsible for hepatitis C infection increasing its prevalence. A few other factors, such as multiple blood transfusions in patients with hemoglobinopathies, clotting disorder,

renal failure, cross-contamination from dialysis circuits, and unsafe blood transfusion in trauma, medical, and surgical patients, also lead to HCV infection, causing a rise in its prevalence[12]. Continued vigilance in screening blood donors for HCV is essential for ensuring transfusion safety.

HBV, with a seroprevalence of 0.7%, remains a major public health challenge in India. The relatively high prevalence of HBV underscores the importance of vaccination programs and public awareness campaigns aimed at reducing the transmission of HBV through blood transfusions. Although a safe and effective vaccine for HBV is available, the burden of this infection remains significant, particularly in rural and low-income populations where access to vaccination is limited.

The prevalence of HIV (0.7%) in this study is comparable to findings from other Indian studies. Continued detection of HIV-positive donors highlights the importance of maintaining rigorous screening protocols and educating the public about the risks associated with HIV transmission through blood transfusion.

Syphilis, with a prevalence of 0.5% in this study is a concern. The higher rate of syphilis emphasizes the need for stringent screening and treatment interventions for syphilis to prevent transmission through blood transfusion.

This study's very low prevalence of malaria cases is noteworthy, especially given that malaria is endemic in certain regions of India. The low prevalence of malaria among the donors in this study may reflect the effectiveness of preventive measures, such as the use of insecticide-treated bed nets and antimalarial campaigns.

One notable finding of this study is the higher prevalence of TTIs among male donors (99.7%) compared to females (0.3%). This gender disparity is consistent with other studies conducted in India and globally, where males are the predominant blood donors[13,14] and Table 7.

Social and cultural factors, like the belief that males are healthier to donate blood, may contribute to the lower participation of female donors[15]. Other contributing factors could be anaemia, household pressures, lack of knowledge as well as lack of motivation and fear about procedure in females as compared to males. Encouraging female participation in blood donation programs is essential for improving the blood supply and ensuring better gender representation.

In the current study co-infection was seen among donors which was also comparable to studies done by other authors as shown in table 8. High rate of co-infection with HCV and HIV could be attributed to intravenous drug abuse, unsafe sex practices, multiple blood transfusions.

In the current study, voluntary donors made up 65.2% of all donors, which was seen to be study over the course of the study, as previously reported. However, several other studies showed dominance of replacement donors which may be attributed to a lack of awareness about voluntary blood donation among the general population as shown in table 9.

Table 5: Overall prevalence of all TTIs among donors.

	Total donors	Reactive for TTIs	Overall prevalence
Present study	**44016**	**1675**	**3.8%**
Saini N et al[9]	13035	366	2.8%
Shrivastava M et al[10]	57942	1614	2.7%
Rawat A et al[8]	220482	9622	4.4%
Pessoni LL et al[11]	137209	5553	4.0%

Table 6: Prevalence comparison of various TTIs in present study with other studies.

Study	**Seroprevalence**				
TTIs	**HIV**	**HBV**	**HCV**	**VDRL**	**Malaria**
Present study	**0.7%**	**0.7%**	**1.8%**	**0.5%**	**0.002%**
Saini N et al[9]	0.3%	1.0%	1.5%	-	-
Pessoni LL et al[11]	0.5%	1.6%	0.9%	-	-
Rawat A et al[8]	0.3%	1.6%	0.7%	1.6%	0.06%
Chauhan SC et al[4]	0.5%	0.7%	0.1%	0.8%	-
Shrivastava et al[10]	0.2%	1.8%	0.4%	0.3%	0.008%

Table 7: Comparison of male and female donors distribution in present study with other studies.

	Total donors	Male donors	Female donors
Present study	**44016**	**43911 (99.7%)**	**105 (0.2%)**
Bagde S et al[16]	54831	53764 (98.0%)	1067 (1.9%)
Saini N et al[9]	13035	12736 (97.7%)	299 (2.3%)
Pessoni LL et al[11]	137209	92336 (67.2%)	44873 (32.7%)
Cheema S et al[2]	10797	10332 (95.6%)	465 (4.3%)

Table 8: Comparison of prevalence of co-infection among donors with other studies.

	Total donors	Co-infection
Present study	**44016**	**7 (0.01%)**
Kukar N et al[17]	58953	74 (0.1%)
Cheema S et al[2]	10797	0 (0%)

Table 9: Comparison of voluntary and replacement donors distribution in present study with other studies.

	Total donors	Voluntary donors	Replacement donors
Present study	**44016**	**28726 (65.2%)**	**15290 (34.7%)**
Chauhan S et al[4]	4433	3846 (86.7%)	587 (13.2%)
Rawat A et al [8]	220482	163540 (74.1%)	56942 (25.8%)
Bagde S et al[16]	54831	6818 (12.4%)	48013 (87.6%)
Cheema S et al[2]	10797	2338(21.6%)	8459 (78.3%)

CONCLUSION

The findings of this study underscore the ongoing risk of TTIs in blood donations, with an overall seroprevalence correlating well with prevalence rates of other studies in India. The use of confidential donor screening, increased public awareness, donor vigilance, and strengthening health facilities can all contribute to reducing TTIs. Additionally, implementing a system for regular follow up with donors who test positive for TTIs is crucial as this allows for counseling, treatment, and ensures they do not re-enter the donor pool which is essential for safeguarding the blood supply and the broader population.

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