



MAPPING THE BURDEN OF TRANSFUSION-TRANSMITTED INFECTIONS TO ENHANCE TRANSFUSION SAFETY: A ONE-YEAR RETROSPECTIVE STUDY IN EAST CENTRAL RAJASTHAN

Transfusion Medicine

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ABSTRACT

Background: Transfusion-transmissible infections (TTIs) continue to pose a significant threat to the safety of blood transfusions, particularly in low-resource regions. Infections such as human immunodeficiency virus (HIV), hepatitis B virus (HBV), hepatitis C virus (HCV), syphilis, and malaria are of particular concern. This study aimed to determine the prevalence and distribution of TTIs among voluntary blood donors at a tertiary care hospital in North Rajasthan. **Materials And Methods:** A retrospective cross-sectional analysis was conducted at the blood Centre of a tertiary care institution over a 12-month period, from August 2023 to July 2024. A total of 34,208 voluntary blood donors were screened for HIV, HBV, HCV, syphilis, and malaria using chemiluminescence immunoassay (CLIA) using Vitros 5800 automated system and rapid diagnostic tests. The donor population included 21,930 in-house donors and 12,278 individuals from organized voluntary blood donation (VBD) camps. Data were statistically evaluated to assess the prevalence and co-infection patterns of TTIs. **Results:** The overall prevalence of TTIs among the 34,208 donors was 1,369 (4%) with male donors accounting for about 1343 (98.1%). The highest seroprevalence was observed for HBV, with 517 cases (1.51%), followed by syphilis with 414 (1.21%), HCV with 253 (0.74%), and HIV with 185 (0.54%). No cases of malaria were detected. The prevalence of TTIs was significantly higher among in-house donors 1168 (3.41%) compared to those from voluntary blood donation camps 201(0.59%). A total of 15 donors (0.04%) had co-infections involving two or more TTIs. **Conclusion:** This study underscores the ongoing risk of TTIs among voluntary blood donors, with HBV being the most prevalent infection. The comparatively lower infection rate among VBD camp donors supports the promotion of structured and community-based donor recruitment strategies. Enhanced donor selection criteria, advanced screening technologies, and targeted awareness programs are essential to mitigate TTI transmission risks and maintain a safe and reliable blood supply. **Categories:** Internal Medicine, Medical Education, Medical Simulation

KEYWORDS

seroprevalence, syphilis, hepatitis B, HIV, blood donors, transfusion-transmissible infections

INTRODUCTION

Blood transfusion plays a pivotal role in contemporary healthcare, offering essential support in numerous clinical situations such as major surgeries, trauma care, obstetric hemorrhage, and hematological diseases. Despite its life-saving benefits, transfusion carries the risk of transmitting infections known as transfusion-transmissible infections (TTIs). These include pathogens such as human immunodeficiency virus (HIV), hepatitis B virus (HBV), hepatitis C virus (HCV), syphilis, and malaria, which can lead to severe or chronic illnesses in recipients if proper screening is not implemented during the donation process.

The World Health Organization (WHO) advocates universal screening of donated blood for major TTIs as a standard of transfusion safety. While significant progress has been made in reducing TTI transmission in developed countries through robust screening technologies and quality assurance programs, many low- and middle-income countries, including India, continue to face challenges in this domain. Factors such as a high burden of endemic infectious diseases, variable access to advanced testing technologies, and a continued dependence on replacement donors hinder optimal blood safety practices.

India, with its vast and diverse population, presents a complex landscape in terms of blood transfusion services. The prevalence of TTIs among blood donors exhibits marked regional variations, reflecting differences in local healthcare infrastructure, awareness, and socioeconomic conditions. Studies conducted in various regions have reported varying seroprevalence rates. For example, a study by Pallavi et al. identified HBV as the most frequently detected TTI, with an overall prevalence of 1.35% among voluntary donors in a university hospital setting. Similar findings have been observed in other regions, where HBV continues to be the dominant infection due to its efficient transmission through blood and blood products.

Though HIV prevalence among donors has shown a declining trend in recent years owing to enhanced testing protocols and public health initiatives, it remains a significant concern due to its lifelong implications. Hepatitis C virus also poses a considerable threat due to its potential to cause chronic liver damage and hepatocellular

carcinoma. Studies from regions such as coastal Karnataka and the Andaman and Nicobar Islands have highlighted the continued detection of HIV, HBV, and HCV in donor populations, further emphasizing the importance of ongoing surveillance.

Syphilis, while less prevalent, is still relevant due to its ability to survive in stored blood products if not properly screened. Malaria, though rarely transmitted through transfusion, remains a potential threat in endemic areas, particularly where donor selection does not adequately consider exposure risks.

Given these challenges, systematic monitoring of TTI prevalence among blood donors is essential. Donor populations serve not only as a source of safe blood but also as a proxy for evaluating infection trends in the general population. Regular analysis of TTI data aids in understanding the local epidemiology of these infections and informs strategies for improving transfusion safety. In this context, the present study investigates the seroprevalence of TTIs among voluntary donors at a tertiary care center in East Central Rajasthan over a one-year period. The findings aim to provide insights into the current status of transfusion safety and support policy development for optimizing blood donation practices and minimizing the risk of transfusion-related infections.

MATERIALS AND METHODS

Study Design And Setting

This was a retrospective observational study conducted at the blood bank of a tertiary care center in East Central Rajasthan. The study period spanned one year, from August 2023 to July 2024, during which the records of all blood donors were reviewed and analyzed to determine the prevalence of transfusion-transmissible infections (TTIs).

Study Population

A total of 34,208 blood donors were included in the study. Of these, 21,930 donations (64.1%) were collected through in-house blood donation and 12,278 (35.9%) through Voluntary blood Donation (VBD) camps. Donors were selected based on WHO criteria, which included age between 18 to 60 years, a minimum haemoglobin level of 12.5 g/dL, and absence of any significant medical illness. All donors

underwent pre-donation counselling, medical history screening, and a brief physical examination to ensure fitness for donation. While both males and females were eligible, the majority of donors were male.

Blood Collection And Handling

Blood was collected under strict aseptic precautions by trained personnel using sterile, single-use blood collection bags containing anticoagulant (CPDA-1). Approximately 450 mL of whole blood was collected from each eligible donor. Each unit was labelled immediately after collection and transported to the processing area for component separation, where whole blood was centrifuged to yield red blood cells (RBCs), plasma, and platelet concentrates as per standard protocols.

In addition, pilot samples were collected in vacutainers at the time of donation for serological screening. The samples were tested for HIV, HBV, HCV, syphilis, and malaria. All tests were performed by Chemiluminescence Immunoassay (CLIA) and rapid diagnostic tests (RDTs) approved for blood donor screening. Appropriate biosafety and cold chain measures were observed during sample collection, transportation, and storage to maintain the integrity and reliability of test results.

Data Analysis

Data were compiled from the donor records, and TTI screening results were tabulated and analysed. The prevalence of each infection was calculated for the overall population, as well as separately for in-house and VBD camp donors. Co-infections involving two or more TTIs were also identified and recorded.

Screening for Transfusion-Transmissible Infections (TTIs)

To ensure transfusion safety and minimize the risk of infectious disease transmission, all blood donations collected during the study period underwent systematic screening for transfusion-transmissible infections (TTIs). The infections screened included HIV, HBV, HCV, syphilis, and malaria.

Chemiluminescence Immunoassay were used for the detection of HIV-I and II antibodies, HBsAg (hepatitis B surface antigen), and HCV antibodies, as per national guidelines for blood donor screening. These assays offer high sensitivity and specificity and are routinely employed in Indian blood centres to identify seropositive cases early and reliably.

For syphilis, screening was performed using the Venereal Disease Research Laboratory (VDRL) test, which detects antibodies produced in response to *Treponema pallidum*. Positive or equivocal results were confirmed using additional specific tests wherever required.

Malaria screening was conducted using rapid diagnostic tests (RDTs), which detect antigens associated with malaria parasites in donor blood. While malaria is a rare transfusion-transmitted infection, its screening remains essential in endemic regions like parts of India.

All donations that tested positive for any TTI were excluded from transfusion use, and the respective units were discarded in accordance with regulatory protocols. Donors who tested reactive were counselled confidentially and referred for further medical evaluation and care.

Data Collection

Data for this study were retrospectively collected from the donor database and records maintained at the blood bank of the tertiary care centre. The study included 34,208 voluntary blood donors who donated between August 2023 and July 2024.

The donor pool included 21,930 in-house voluntary donations and 12,278 donations collected via voluntary blood donation (VBD) camps. TTI screening results were compiled and tabulated to determine overall and subgroup-specific prevalence rates.

Additionally, cases of co-infections (i.e., donors testing positive for more than one TTI) were identified and documented. The data were entered in a standardized format to ensure consistency, and duplicates or incomplete records were excluded during the validation phase.

Statistical Analysis

Data analysis was performed using IBM SPSS Statistics for Windows, Version 23.0 and Microsoft Excel 2019. Descriptive statistics were used to summarize donor characteristics and infection prevalence. The seroprevalence of each TTI (HIV, HBV, HCV, syphilis, and malaria)

was calculated as a proportion of the total number of donors and further stratified by donation type (in-house vs. VBD camp).

The Chi-square test was applied to assess differences in TTI prevalence between donor subgroups (e.g., in-house vs. camp, male vs. female), with a p-value < 0.05 considered statistically significant. Co-infection rates were also reported. While the study was limited to a one-year duration, comparisons were made across donor categories to observe distribution trends and infection burden.

Ethical Considerations

The study protocol was reviewed and approved by the Institutional Ethics Committee of S.M.S. Medical College and Hospital, Jaipur. Donor confidentiality was strictly maintained throughout the data collection and analysis process. Informed consent was obtained from all donors at the time of donation in accordance with national guidelines. No personally identifiable information was used in the final analysis, ensuring complete anonymity and ethical compliance.

RESULTS

A total of 34,208 blood donors were included in the study, comprising 21,930 (64.1%) in-house donors and 12,278 (35.9%) outdoor camp donors. The majority of donors were in the 18–30 years age group, accounting for 51.4% (n=17,590) of the total donations. The 31–40 years group contributed 34.2% (n=11,714), while donors aged 41–50 years and 51–65 years constituted 12.1% (n=4,123) and 2.3% (n=781), respectively. The proportion of young donors (18–30 years) was higher in outdoor camps (62%) compared to in-house donations (45.5%).

The donor population was overwhelmingly male, comprising 32,659 (95.5%), while only 1,549 (4.5%) donors were female. In-house donations demonstrated a lower female participation (3.2%) compared to outdoor camps (6.9%).

The overall prevalence of transfusion-transmissible infections (TTIs) among donors was 4% (n=1,369). Among these, in-house donors contributed 3.42% (n=1,168), while outdoor camp donors accounted for 0.58% (n=201). The most frequently detected infection was hepatitis B virus (HBV) at 1.51% (n=517), followed by syphilis at 1.21% (n=414), hepatitis C virus (HCV) at 0.74% (n=253), and HIV at 0.54% (n=185). No cases of malaria were detected.

Seropositivity was significantly higher among male donors (3.91%, n=1,343) compared to female donors (0.09%, n=26). The prevalence of HBV (1.49%), HCV (0.73%), HIV (0.53%), and syphilis (1.16%) was concentrated predominantly in the male donor group. Among female donors, seropositivity remained low across all infections, with HBV and syphilis constituting the majority of positive cases.

Table 1: Age Group Of Donors

AGE GROUP (YEARS)	IN HOUSE DONORS (%)	OUTDOOR CAMP DONORS (%)	TOTAL
18-30	9978 (45.5%)	7612 (62%)	17590
>30-40	7785 (35.5%)	3929 (32%)	11714
>40-50	3509 (16%)	614 (5%)	4123
>50-65	658 (3%)	123 (1%)	781
TOTAL	21930	12278	34208

Table 2: Disease Wise Distribution Of TTI Reactive Donors

DISEASES	IN HOUSE (%)	OUTDOOR CAMP (%)	TOTAL
HIV	163 (0.48%)	22 (0.06%)	185 (0.54%)
HCV	221 (0.65%)	32 (0.09%)	253 (0.74%)
HBV	438 (1.28%)	79 (0.23%)	517 (1.51%)
SYPHILIS	346 (1.01%)	68 (0.2%)	414 (1.21%)
MALARIA	0	0	0
TOTAL	1168 (3.42%)	201 (0.58%)	1369 (4%)

Table 3: Gender Distribution Of Donors

	MALE (%)	FEAMALE (%)	TOTAL
IN HOUSE	21228 (96.8%)	702 (3.2%)	21930
OUTDOOR CAMP	11431 (93.1%)	847 (6.9%)	12278
TOTAL	32659 (98.47%)	1549 (4.53%)	34208

Table 4: Gender Distribution Of TTI Reactive Donors

DISEASES	MALE SEROPOSITIVITY (%)	FEMALE SEROPOSITIVITY (%)	TOTAL (%)

HIV	183 (0.53%)	2 (0.01%)	185 (0.54%)
HCV	251 (0.73%)	2 (0.01%)	253 (0.74%)
HBV	511 (1.49%)	6 (0.02%)	517 (1.51%)
SYPHILIS	398 (1.16%)	16 (0.05%)	414 (1.21%)
MALARIA	0	0	0
TOTAL	1343 (3.91%)	26 (0.09%)	1369 (4%)

DISCUSSION

Blood transfusion remains an essential component of modern medical care; however, it carries inherent risks, particularly the transmission of transfusion-transmissible infections (TTIs). Despite advances in screening technologies and increasing awareness, TTIs continue to pose a challenge to transfusion safety, especially in resource-constrained settings like India. This study, conducted over a one-year period at a tertiary care center in North-East India, evaluated the seroprevalence of TTIs among voluntary blood donors. Of the 34,208 donors screened, 1,369 tested reactive for at least one TTI, yielding an overall prevalence of 4%.

The most frequently detected infection in this study was hepatitis B virus (HBV), with a seroprevalence of 1.51%, consistent with trends reported in similar Indian studies where HBV remains the most common TTI. Studies by Pallavi et al. and Karkee et al. have also identified HBV as the predominant infection among donors, though with slightly varying prevalence rates, reflecting regional differences in HBV burden, vaccination uptake, and public health infrastructure. The continued high prevalence of HBV underscores the need to expand vaccination coverage, especially in rural and underserved populations, and to reinforce pre-donation counseling.

Syphilis was the second most prevalent TTI in this cohort, with a rate of 1.21%, which is higher than reported in many other regions of India. This may be attributed to regional variations in sexual health awareness, access to healthcare, or social determinants. Interestingly, the prevalence of syphilis was higher among female donors compared to males, although the overall number of female donors was low. This finding warrants further investigation and highlights the importance of targeted STI screening and health education for female populations.

Hepatitis C virus (HCV) and human immunodeficiency virus (HIV) were found in 0.74% and 0.54% of donors, respectively. These values align with national data showing declining trends in HCV and HIV due to improved public health programs, better donor selection, and enhanced screening technologies such as third-generation ELISA. However, the presence of these infections, even at low rates, justifies continued vigilance in screening, especially considering the long-term health consequences associated with these infections.

A significant observation in this study was the higher prevalence of TTIs among in-house donors (5.14%) compared to those from voluntary blood donation (VBD) camps (1.63%). This supports the long-standing evidence that voluntary, non-remunerated donors from organized camps tend to have lower TTI risks compared to walk-in or replacement donors. Therefore, strengthening community-based voluntary donation campaigns remains a cornerstone strategy for improving transfusion safety.

The male predominance among donors (as seen in over 90% of the donor pool) is consistent with national trends in India, where cultural, physiological, and logistical barriers continue to limit female participation in blood donation. Efforts to encourage and facilitate female donors—through workplace awareness, mobile camps in women-centric institutions, and addressing myths around donation—are critical to building a more inclusive and sustainable donor base.

Although co-infections were relatively rare (15 donors, 0.04%), their presence is clinically important. The observed combinations of HIV + HCV, HIV + syphilis, and HBV + HCV, among others, suggest overlapping modes of transmission and reinforce the need for comprehensive donor histories and laboratory diagnostics.

Notably, no cases of malaria were detected among the 34,208 donors. This may reflect low endemicity in the study region, as well as the impact of preventive measures such as vector control programs, public health campaigns, and effective donor screening practices.

Overall, the findings of this study align with regional and national

trends, emphasizing the persistent risk of TTIs despite advances in testing and awareness. These results reinforce the need for continued investment in donor education, expanded use of highly sensitive testing methods, and a robust national surveillance system to monitor infection trends in the donor population.

CONCLUSIONS

This study highlights a notable burden of transfusion-transmissible infections (TTIs) among voluntary blood donors, with an overall seroprevalence of 4.12% during the one-year study period. Hepatitis B virus (HBV) was the most frequently detected infection, underscoring the urgent need for strengthened vaccination coverage, public awareness campaigns, and robust donor selection and screening protocols. The prevalence of syphilis, HCV, and HIV, though comparatively lower, remains a public health concern due to their potential long-term impact on transfusion recipients.

The findings also reveal a marked predominance of male donors, reflecting a gender imbalance that calls for targeted strategies to encourage and empower female participation in blood donation initiatives. The absence of malaria cases in the donor pool likely reflects regional epidemiological patterns or effective vector control measures.

Importantly, the higher TTI prevalence among in-house donors compared to those from voluntary blood donation (VBD) camps reinforces the need to promote organized, community-based blood drives, which are associated with safer donor profiles. The detection of co-infections further emphasizes the necessity for comprehensive screening and donor counseling.

Overall, this study reinforces the importance of continuous surveillance, rigorous screening methodologies, and public health interventions aimed at reducing the transmission of TTIs through blood transfusion. Ensuring a safe and sufficient blood supply requires ongoing commitment to voluntary, non-remunerated donor mobilization, technology-driven testing, and policy-level reinforcement.

REFERENCES:

1. Lottermann S, Sharma S: Blood transfusion. StatPearls [Internet]. StatPearls Publishing, Treasure Island (FL); 2023.
2. Screening donated blood for transfusion-transmissible infections: recommendations . (2023). Accessed: September 18, 2024: <https://www.who.int/publications/i/item/9789241547888>.
3. Raykar NP, Makin J, Khajanchi M, et al.: Assessing the global burden of hemorrhage: the global blood supply, deficits, and potential solutions. SAGE Open Med. 2021, 9:10.1177/20503121211054995
4. Pallavi P, Ganesh CK, Jayashree K, Manjunath GV: Seroprevalence and trends in transfusion transmitted infections among blood donors in a university hospital blood bank: a 5 year study. Indian J Hematol Blood Transfus. 2011, 27:1-6. 10.1007/s12288-010-0047-x
5. Rawat A, Diwaker P, Gogoi P, Singh B: Seroprevalence & changing trends of transfusion-transmitted infections amongst blood donors in a Regional Blood Transfusion Centre in north India. Indian J Med Res. 2017, 146:642-5.
6. Arora D, Arora B, Khetarpal A: Seroprevalence of HIV, HBV, HCV and syphilis in blood donors in Southern Haryana. Indian J Pathol Microbiol. 2010, 53:308-9. 10.4103/0377-4929.64295
7. Singh K, Bhat S, Shastri S: Trend in seroprevalence of hepatitis B virus infection among blood donors of coastal Karnataka, India. J Infect Dev Ctries. 2009, 3:376-9. 10.3855/jidc.246
8. Sehgal S, Shaiji PS, Brar RK: Seroprevalence and trends of transfusion transmissible infections in blood donors in Andaman and Nicobar islands- an institutional retrospective study. J Clin Diagn Res. 2017, 11:EC21-4. 10.7860/JCDIR/2017/25137.9649
9. Mohammed KA, Hameed MM, Mousa AH, Saleh AT: Prevalence and trends of transfusion transmissible infections among blood donors in Basra, Iraq. BMJ Open Gastroenterol. 2023, 10:10.1136/bmjgast-2022-000968
10. Omidkhoda A, Razi B, Arabkhaeali A, Amini Kafi-Abad S: Trends and epidemiological analysis of hepatitis B virus, hepatitis C virus, human immunodeficiency virus, and human T-cell lymphotropic virus among Iranian blood donors: strategies for improving blood safety. BMC Infect Dis. 2020, 20:736. 10.1186/s12879-020-05405-9
11. Alhajj M, Zubair M, Farhana A: Enzyme linked immunosorbent assay. StatPearls [Internet]. StatPearls Publishing, Treasure Island (FL); 2024.
12. Nayak S, Acharya B: VDRL test and its interpretation. Indian J Dermatol. 2012, 57:3-8. 10.4103/0019-5154.92666
13. Rapid diagnostic tests for infectious diseases | CDC Yellow Book . (2024). Accessed: September 18, 2024: <https://wwwnc.cdc.gov/travel/yellowbook/2024/posttravel-evaluation/rapid-diagnostic-tests-for-infectious-diseases>.
14. Giri PA, Deshpande JD, Phalke DB, Karle LB: Seroprevalence of transfusion transmissible infections among voluntary blood donors at a tertiary care teaching hospital in rural area of India. J Family Med Prim Care. 2012, 1:48-51. 10.4103/2249-4863.94452
15. Anjali H, Issac A, Anjali MR, Anish TS: Transfusion-transmissible infections among voluntary blood donors at Government Medical College Thiruvananthapuram, Kerala, India. Asian J Transfus Sci. 2012, 6:55-6. 10.4103/0973-6247.95060
16. Mandal R, Mondal K: Transfusion transmissible infections among blood donors from a sub-Himalayan rural tertiary care centre in Darjeeling, India. J Tradit Complement Med. 2016, 6:224-9. 10.1016/j.jtcme.2015.02.003
17. Chatteraj A, Behl R, Kataria VK: Infectious disease markers in blood donors . Med J

- Armed Forces India. 2008, 64:33-5. 10.1016/S0377-1237(08)80142-6
18. Panchanadeswaran S, Johnson SC, Mayer KH, et al.: Gender differences in the prevalence of sexually transmitted infections and genital symptoms in an urban setting in southern India. *Sex Transm Infect.* 2006, 82:491-5. 10.1136/sti.2006.020768
 19. Gupta N, Kumar V, Kaur A: Seroprevalence of HIV, HBV, HCV and syphilis in voluntary blood donors . *Indian J Med Sci.* 2004, 58:255-7.
 20. Chandekar SA, Deshpande SA, Muley PS: A clinico-pathological study of 120 cases of ovarian tumors in a tertiary care hospital. *IJCMR.* 2018, 5:3389. 10.21276/ijcmr.2018.5.5.35