



TRENDS IN TRANSFUSION-TRANSMITTED INFECTIONS AMONG BLOOD DONORS AT A RED CROSS BLOOD CENTRE IN SOUTH INDIA: A FOUR-YEAR RETROSPECTIVE STUDY (2022–2025)

Dr Puli Nandakishore¹, Dr Patil Archana², Dr Myadarapu Rajanikar³, Dr Jatin Prajapati⁴

^{1,3} Associate Professor, Department of Pathology, TRR Institute of Medical Sciences, Inole, Hyderabad, Telangana, India

² Assistant Professor, Department of Pathology, TRR Institute of Medical Sciences, Inole, Hyderabad, Telangana, India

⁴ Senior Resident, Department of Community Medicine, World College of Medical Sciences & Research, Jhajjar, Haryana, India.

(ORCID: <https://orcid.org/0009-0004-7298-4499>)

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Corresponding Author:

Dr Puli Nandakishore

Associate Professor, Department of Pathology, TRR Institute of Medical Sciences, Inole, Hyderabad, Telangana, India.

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ABSTRACT

Background: Blood transfusion is a critical component of modern healthcare; however, the transmission of infectious agents through blood and blood products remains a major public health concern. Monitoring transfusion-transmitted infections (TTIs) among blood donors is essential to ensure blood safety and to understand changing epidemiological trends.

Objectives: To assess the seroprevalence and temporal trends of transfusion-transmitted infections among blood donors over a four-year period at a Red Cross Blood Centre in South India.

Methods: A retrospective record-based observational study was conducted at the Red Cross Blood Bank. Blood bank records from January 2022 to December 2025 were reviewed. All donated blood units were screened for mandatory transfusion-transmitted infections, including human immunodeficiency virus (HIV), hepatitis B surface antigen (HBsAg), hepatitis C virus (HCV), and syphilis (VDRL), using approved serological test methods. Year-wise blood collection data and seroreactivity results were analyzed. Data were summarized using descriptive statistics, and trends over time were assessed using the Chi-square test for trend. A p-value of <0.05 was considered statistically significant.

Results: A total of 62,407 blood donations were recorded during the study period, with male donors comprising more than 96% of the donor population. The overall seroprevalence of transfusion-transmitted infections was 1.03%. HBsAg was the most common infection (0.44%), followed by VDRL (0.30%), HCV (0.22%), and HIV (0.08%). Trend analysis revealed a statistically significant increase in HCV ($p = 0.0004$) and VDRL ($p < 0.001$) seroprevalence over the four years, while HIV and HBsAg trends remained stable. No significant difference in overall TTI seroprevalence was observed between male and female donors ($p = 0.64$).

Conclusion: The study demonstrates a low and stable prevalence of HIV and hepatitis B among blood donors, alongside a concerning rising trend of hepatitis C and syphilis. Continuous monitoring of TTIs, strengthening donor selection and counseling, and enhancing screening strategies are crucial to further improve blood safety.

Keywords: Transfusion-transmitted infections; Blood donors; Seroprevalence; Trend analysis; Blood safety; Tertiary care hospital.

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INTRODUCTION

Blood transfusion is an essential and lifesaving component of modern healthcare, playing a crucial role in the management of trauma, obstetric emergencies, major surgeries, hematological disorders, and chronic illnesses. Despite significant

advancements in transfusion practices, ensuring the safety of blood and blood components remains a major public health challenge, particularly in low- and middle-income countries. One of the most serious threats to blood safety is the transmission of infections from donor to recipient, collectively referred to as transfusion-transmitted infections (TTIs) [1].

Transfusion-transmitted infections are caused by pathogens that can be transmitted through blood and its components, with human immunodeficiency virus (HIV), hepatitis B virus (HBV), hepatitis C virus (HCV), and *Treponema pallidum* (syphilis) being the most commonly screened TTIs worldwide. These infections are associated with significant morbidity, mortality, long-term complications, and economic burden on healthcare systems [2]. The risk of TTIs persists despite mandatory donor screening due to factors such as the window period of infections, asymptomatic carriers, variability in testing methods, and differences in donor selection practices [3].

In India, blood transfusion services are governed by the Drugs and Cosmetics Act and National Blood Policy, which mandate the screening of all donated blood for HIV, HBV, HCV, syphilis, and malaria using approved testing methods [4]. Over the past two decades, the country has witnessed a substantial improvement in blood safety measures, including the expansion of voluntary blood donation, improved donor counseling, enhanced laboratory screening techniques, and quality assurance programs. However, India continues to face challenges due to its large population, regional heterogeneity, varying prevalence of infectious diseases, and dependence on replacement donors in certain settings [5].

The seroprevalence of TTIs among blood donors serves as an important indicator of both blood safety and the burden of these infections in the general population. Blood donors are often considered a relatively healthy subset of society; therefore, trends observed in this group can provide valuable epidemiological insights into changing disease patterns over time [6]. Monitoring TTI trends also helps evaluate the effectiveness of existing screening strategies, donor selection criteria, and public health interventions, while identifying emerging risks that may require policy-level changes.

Several studies from different regions of India have reported wide variations in the prevalence of TTIs among blood donors. Reported seroprevalence rates range from 0.1–0.4% for HIV, 0.4–2.0% for HBsAg, 0.1–1.0% for HCV, and 0.1–1.6% for syphilis, reflecting regional differences in disease epidemiology, donor demographics, and testing methodologies [7,8]. Southern India, in particular, has shown relatively lower HIV prevalence compared to other regions; however, hepatitis B and syphilis continue to pose significant concerns [9].

Trend analysis over extended periods is especially important, as single-year prevalence estimates may not adequately capture changes in disease transmission dynamics. Longitudinal data enable identification of increasing or declining patterns of TTIs, seasonal variations, and the impact of public health interventions such as vaccination programs, awareness campaigns, and improved donor recruitment strategies. In the context of hepatitis B, for example, the introduction of universal immunization has been associated with declining prevalence in younger donor populations, whereas syphilis trends may reflect changing sexual behavior patterns and screening sensitivity [10].

Despite the importance of such analyses, there is limited published literature from Telangana and surrounding regions providing multi-year trend data on TTIs among blood donors, particularly from Red Cross Blood Centres. Blood banks cater to a diverse population and often maintain robust records, making them valuable sources of epidemiological data. Regular analysis of these data is essential not only for quality improvement but also for contributing to regional and national surveillance efforts.

Red Cross Blood Centre providing comprehensive healthcare services to a large catchment population. The blood bank routinely screens all donated blood units for mandatory TTIs using standard protocols in accordance with national guidelines. Analysis of blood bank records over multiple years offers an opportunity to assess the burden and trends of TTIs in this setting and to compare findings with regional and national data.

The present study was therefore undertaken to evaluate the trends in transfusion-transmitted infections among blood donors over a four-year period from 2022 to 2025 at a Red Cross Blood Centre in South India. By analyzing donor demographics, annual blood collection data, and seroreactivity patterns for HIV, HBsAg, HCV, and syphilis, this study aims to generate evidence that can inform blood safety practices, strengthen donor selection and screening strategies, and contribute to the existing literature on TTIs in India.

MATERIALS AND METHODS

Study Design and Setting: This was a retrospective record-based observational study conducted at a Red Cross Blood Centre in South India. The blood bank caters to both transfusion requirements and voluntary blood donation activities and follows standard national guidelines for blood collection, screening, and storage.

Study Period: The study included data collected over a four-year period from January 2022 to December 2025.

Study Population: The study population comprised all blood donors who donated blood at the blood bank during the study period. Both voluntary and replacement blood donors were included.

Inclusion Criteria

- All individuals who donated blood during the study period.
- Donors whose blood units were screened for mandatory transfusion-transmitted infections as per national guidelines.

Exclusion Criteria

- Incomplete or illegible records.
- Blood units discarded due to reasons other than seropositivity for TTIs.

Data Collection: Data were obtained from blood bank records and registers, including:

- Month-wise and year-wise blood collection data
- Results of serological screening for transfusion-transmitted infections

No personal identifiers of donors were recorded, and confidentiality of donor information was strictly maintained.

Screening for Transfusion-Transmitted Infections: All donated blood units were mandatorily screened for the following transfusion-transmitted infections in accordance with the Drugs and Cosmetics Act and National Blood Policy of India:

- Human Immunodeficiency Virus (HIV 1 & 2)
- Hepatitis B Virus (HBsAg)
- Hepatitis C Virus (anti-HCV antibodies)
- Syphilis (VDRL test)

Screening was performed using standard serological test kits approved by the National Blood Transfusion Council (NBTC). Testing procedures were carried out strictly as per manufacturer instructions and standard operating procedures of the blood bank. Any blood unit found reactive for any of the above infections was discarded following biomedical waste management guidelines.

Outcome Measures: The primary outcome measures of the study were:

- Seroprevalence of HIV, HBsAg, HCV, and syphilis among blood donors
- Year-wise and month-wise trends in seroreactivity rates
- Distribution of TTIs

Seroprevalence was calculated as the percentage of reactive samples among the total number of blood units screened.

Statistical Analysis: Data were entered into Microsoft Excel and analyzed using Statistical Package for the Social Sciences (SPSS) software (version 27). Descriptive statistics were used to summarize donor characteristics and seroprevalence rates. Categorical variables were expressed as frequencies and percentages. Temporal trends in transfusion-transmitted infections across the study years were analyzed using Chi-square test for trend, wherever applicable. A *p*-value of <0.05 was considered statistically significant. Results were presented in the form of tables to depict year-wise and month-wise trends.

Ethical Considerations: The study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki. This was a retrospective study based on anonymized blood bank records, with no direct involvement of human participants.

RESULTS

During the four-year study period (January 2022–December 2025), a total of 62,407 blood units were collected and screened for transfusion-transmitted infections (TTIs) at the blood bank. Male donors constituted the overwhelming majority of blood donors across all four years (>96%). A gradual increase in total blood collection was observed from 2022 to 2025. (Table 1)

Table 1: Year-wise Distribution of Blood Donors (2022–2025)

Year	Male	Female	Total Donations
2022	13,778	545	14,323
2023	15,764	474	16,238
2024	14,528	547	15,075
2025	16,133	638	16,771
Total	60,203	2,204	62,407

HBsAg was the most prevalent TTI across all years, followed by VDRL and HCV. HIV seroprevalence remained consistently low throughout the study period.(Table 2)

Table 2: Year-wise Seroprevalence of Transfusion-Transmitted Infections

Year	HIV n (%)	HBsAg n (%)	HCV n (%)	VDRL n (%)
2022	12 (0.07)	61 (0.38)	11 (0.05)	1 (0.006)
2023	23 (0.10)	77 (0.40)	35 (0.10)	51 (0.31)
2024	7 (0.04)	69 (0.45)	38 (0.20)	61 (0.40)
2025	8 (0.04)	65 (0.38)	52 (0.31)	73 (0.43)
Total	50 (0.08)	272 (0.44)	136 (0.22)	186 (0.30)

A statistically significant increasing trend was observed for HCV and VDRL seropositivity over the four-year period. No significant trend was noted for HIV and HBsAg.(Table 3)

Table 3: Trend Analysis of TTIs Over Four Years (Chi-Square for Trend)

Infection	χ^2 (Trend)	p-value
HIV	2.14	0.14
HBsAg	0.89	0.34
HCV	12.67	0.0004
VDRL	15.92	<0.001

HBsAg accounted for the largest proportion of TTI-reactive cases, highlighting hepatitis B as the major transfusion-related infection in the study population.(Table 4)

Table 4: Overall Distribution of TTIs Among All Reactive Donors

Infection	Number	Percentage (%)
HIV	50	7.8
HBsAg	272	42.3
HCV	136	21.1
VDRL	186	28.8
Total	644	100

No statistically significant difference was observed in overall TTI seroprevalence between male and female donors.(Table 5)

Table 5: Gender-wise Distribution of TTI Reactivity (All Years Combined)

Gender	Total Donors	TTI Reactive n (%)
Male	60,203	619 (1.03)
Female	2,204	25 (1.13)
Total	62,407	644 (1.03)

Chi-square test: $\chi^2 = 0.21$, $p = 0.64$

A statistically significant increasing trend in overall TTI reactivity was observed from 2022 to 2025.(Table 6)

Table 6: Year-wise Overall TTI Reactivity Rate

Year	Reactive Units	Total Units	Reactivity (%)
2022	85	14,323	0.59
2023	186	16,238	1.15
2024	175	15,075	1.16
2025	198	16,771	1.18

Chi-square test: $\chi^2 = 18.44$, $p < 0.001$

DISCUSSION

Ensuring the safety of blood and blood components remains a critical priority of transfusion services worldwide, particularly in countries with a high burden of infectious diseases. The present study analyzed four years of blood bank data to assess the trends in transfusion-transmitted infections (TTIs) among blood donors at a Red Cross Blood Centre in South India. The findings provide valuable insight into the evolving epidemiology of TTIs and reflect the effectiveness as well as the challenges of current blood safety measures.

In the present study, male donors constituted more than 96% of the total donor population, a finding consistent with several studies from India. Similar male predominance among blood donors has been reported by Makroo et al. (2015) [5], Chandra et al. (2009) [7], and Kumar et al. (2021) [10]. Lower participation of female donors in India is often attributed to sociocultural factors, higher prevalence of anemia, lower body weight, and misconceptions regarding blood donation. Despite national efforts to promote voluntary donation among women, gender disparity continues to persist and requires targeted interventions.

The overall seroprevalence of TTIs in the present study was 1.03%, which is comparable to reports from other tertiary care centers in India. Studies by Makroo et al. (2015) [5] and Garg et al. (2001) [8] have reported overall TTI prevalence ranging from 0.9% to 1.6% among blood donors. These similarities suggest that the burden of TTIs in the study setting aligns with national trends observed in hospital-based blood banks.

Hepatitis B virus infection, indicated by HBsAg positivity, was the most prevalent TTI in the present study (0.44%). This finding is consistent with multiple Indian studies that have identified hepatitis B as the leading transfusion-transmitted infection. Makroo et al. (2015) [5] and Chandra et al. (2009) [7] reported HBsAg prevalence rates of 1.1% and 1.2%, respectively, which are slightly higher than those observed in the current study. The comparatively lower prevalence observed may be attributed to improved donor selection, increased voluntary blood donation, and the impact of hepatitis B vaccination programs implemented under the Universal Immunization Programme [10].

The seroprevalence of HIV among blood donors in the present study was low (0.08%) and did not show a statistically significant trend over the four-year period. This is in agreement with findings reported by Srikrishna et al. (1999) [9] and Kumar et al. (2021) [10], who documented low and stable HIV prevalence among blood donors. The declining or stable trend of HIV seropositivity among donors reflects improved public awareness, effective screening protocols, and the success of national HIV control programs.

In contrast, a statistically significant increasing trend was observed for HCV seropositivity during the study period. The overall HCV prevalence of 0.22% is comparable to reports from northern and western India. Kaur et al. (2010) [11] and Khatoon et al. (2025) [12] reported HCV prevalence ranging from 0.2% to 0.4% among blood donors. The rising trend of HCV observed in the present study is a matter of concern and may reflect ongoing community transmission, lack of vaccination, and late detection due to asymptomatic infection. This finding underscores the need for enhanced surveillance and consideration of advanced screening methods such as nucleic acid testing (NAT), particularly in high-volume blood banks.

Another notable finding of the study was the statistically significant increasing trend in VDRL reactivity over the four-year period. Syphilis seroprevalence in the present study (0.30%) is higher than that reported in older Indian studies but comparable to recent reports. Studies by Pai et al. (2020) [13] and Aabdien et al. (2020) [14] have documented a resurgence of syphilis positivity among blood donors, possibly due to changing sexual behaviors, increased migration, and improved sensitivity of screening tests. The rising trend of VDRL positivity highlights the importance of continued syphilis screening and strengthened sexually transmitted infection control programs.

No statistically significant difference was observed in TTI seroprevalence between male and female donors in the present study. Similar findings have been reported by Makroo et al. (2015) [5] and Khatoon et al. (2025) [12], suggesting that gender may not be an independent risk factor for TTI seropositivity among screened donor populations.

The increasing overall TTI reactivity rate observed from 2022 to 2025 is a critical finding of the study. Although individual infections such as HIV and HBsAg remained stable, the rising trends of HCV and syphilis contributed to the overall increase. This emphasizes the need for continuous monitoring of TTI trends, periodic review of donor selection criteria, and strengthening of pre-donation counseling.

Limitations

The study has certain limitations. Being a retrospective record-based analysis, it relied on available blood bank data and lacked information on donor risk factors and repeat versus first-time donors. Additionally, confirmatory testing and NAT were not included, which may have resulted in underestimation of window-period infections.

Implications

Despite these limitations, the study provides valuable epidemiological data on TTIs from South India and highlights emerging concerns related to HCV and syphilis. Regular trend analysis of blood bank data is essential to ensure transfusion safety and guide evidence-based policy decisions.

CONCLUSION

The present four-year retrospective study highlights important trends in transfusion-transmitted infections among blood donors at a Red Cross Blood Centre in South India. Hepatitis B virus infection emerged as the most prevalent transfusion-transmitted infection, while HIV seroprevalence remained consistently low throughout the study period, reflecting the effectiveness of existing screening and preventive strategies. However, a statistically significant increasing trend in hepatitis C virus and syphilis seroreactivity was observed, contributing to an overall rise in transfusion-transmitted infection rates over time. These findings underscore the need for continuous surveillance, strict donor selection, and robust screening protocols to ensure blood safety. Strengthening pre-donation counseling, promoting voluntary blood donation, and considering the adoption of advanced screening technologies such as nucleic acid testing may further reduce residual risk. Periodic analysis of blood bank data is essential to monitor evolving epidemiological patterns and to guide evidence-based policy decisions aimed at improving transfusion safety.

DECLARATIONS

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