

Prevalence of Transfusion-Transmitted Infections in Blood Donors in a Tertiary Health Care Centre of North India

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Abstract

Background: Blood is an intrinsic requirement for health care and blood transfusion provides essential support for patients in critical care. However, transfusion-transmitted infections (TTIs) such as HIV, HCV, HBV, syphilis and malaria can be transmitted through contaminated blood or blood products which requires rigorous screening for TTIs. The aim & objective are to assess the prevalence of transfusion-transmitted infections (TTIs) in blood donors. **2.** To evaluate the association between blood groups and TTIs in a tertiary health care centre of North India. **Material and Methods:** This retrospective study was conducted from 1st April 2024 to 31st March 2025 at a tertiary health care centre in the district of Hapur. The results of serologic markers for TTIs (HBsAg, anti-HCV, anti-HIV, syphilis and malaria) of all blood donors were collected from departmental records. Data was entered in Microsoft excel sheet and prevalence was expressed in percentage. For association between TTIs and blood groups, Chi square test was applied by using SPSS software (Version-29), p-value <0.05 was considered as statistically significant. **Results:** A total of 1,412 blood donors were included in the study. Out of these, 104 (7.37%) donors tested positive for TTIs. The prevalence of HCV, HBV, and syphilis was 58 (4.1%), 45 (3.19%), and 1 (0.07%), respectively. No cases of HIV or malaria were detected. A statistically significant association was observed between syphilis infection and the Rh blood group (p = 0.001). The study also confirmed that blood group B was the most common among the ABO blood groups in the donor population. **Conclusion:** Relatively high prevalence of TTIs among blood donors especially, HCV and HBV were found in the present study. However, no significant association was found between ABO blood groups and TTIs. Rh factor was seen significantly associated with syphilis among the blood donors. Awareness programme, strengthening donor screening and testing along with preventive strategies are essential to reduce TTIs.

Keywords: Blood donors, Blood groups, Transfusion-transmitted infections (TTIs).

Received: 15 April 2026

Revised: 02 May 2026

Accepted: 20 May 2026

Published: 01 July 2026

INTRODUCTION

Blood donation represents a vital aspect of modern medical care, serving as a lifesaving intervention for countless patients each year.^[1] The transfusion of blood and its components play a crucial role in modern medicine, often serving as a lifesaving intervention in a variety of clinical settings. Safe transfusion practices significantly improve patient outcomes, while unsafe transfusions can result in serious, and sometimes fatal, complications, particularly through the transmission of transfusion-transmitted infections (TTIs).^[2]

The five common TTIs are: hepatitis B virus (HBV), hepatitis C virus (HCV), human immunodeficiency virus (HIV), syphilis and malaria.^[3] Overall, prevalence of TTIs in India was 1.58%. The prevalence of the respective TTIs was 0.87% for HBV, 0.34% for HCV, 0.14% for HIV, syphilis was 0.17% and malaria was 0.06%.^[4]

Blood groups are significant in blood transfusions. Also, they are associated with various pathogens, related to TTIs.^[1,4] Studies suggest that certain pathogens responsible for TTIs are unable to attach to host cells when specific ABO antigens are present. Conversely, the absence of these antigens may

either increase or decrease susceptibility to such infections, thereby influencing the overall risk of TTIs.^[5-7] Although several studies have reported no significant association between ABO or Rh blood groups and TTIs, other findings suggest that certain blood groups, particularly O Rh(D)-positive, may carry a comparatively higher risk of developing TTIs.^[8-10]

Therefore, it is essential to undertake further research on the prevalence of TTIs among blood donors and their possible association with blood group antigens. The findings of the present study add to this growing body of evidence and highlight the need for continued surveillance. Strengthening such research will not only enhance our understanding of epidemiological

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DOI:
10.21276/acta.2026.v13.i2.792

How to cite this article: Munrit S, Prakash P, Sharma SK, Tomar S, Gautam R, Suman N. Prevalence of Transfusion-Transmitted Infections in Blood Donors in a Tertiary Health Care Centre of North India. *Acta Med Int.* 2026;13(1):905-910.

trends but also enable the healthcare system to adopt more targeted strategies for donor screening, ultimately contributing to the reduction and prevention of these infections.

Aims & objectives:

1. To assess the prevalence of transfusion-transmitted infections (TTIs) in blood donors in a tertiary health care centre of North India.
2. To evaluate the association between blood groups and TTIs.

MATERIALS AND METHODS

Type of study: A retrospective study

Study design: Descriptive, Cross-sectional

Study population: Blood donors fit for blood donation adhering to the inclusion criteria in the tertiary healthcare centre in the district of Hapur.

Study period: 1st April 2024 to 31st March 2025

Sample size: 1412 blood donors i.e. all the selected blood donors who have donated blood during the study period from 1st April 2024 to 31st March 2025 in the tertiary healthcare centre in the district of Hapur.

Selection criteria: Before donating blood, all the blood donors coming in the blood bank, were counselled and evaluated as per standard operating procedure (SOP).

A) Inclusion Criteria: Blood donors aged between 18 and 65 years, with a minimum body weight of 45 kg, haemoglobin levels ≥ 12.5 g/dl, and meeting all other eligibility requirements for blood donation as per the standard operating procedure (SOP).^[11]

B) Exclusion Criteria: Blood donors deemed unfit for donation according to the standard operating procedure (SOP) were excluded from the study.

Data collection procedures: We have collected retrospective data of all the blood donors i.e. 1412 donors from registers in the blood bank of the tertiary healthcare centre during the study period from 1st April 2024 to 31st March 2025.

Plan of analysis/ statistical tools: Data was entered in Microsoft excel sheet and prevalence was expressed in percentage. For association between TTIs and blood groups, Chi square test was applied by using SPSS software (Version-29). p-value <0.05 was considered as statistically significant.

RESULTS

The study comprised 1,412 blood donors. The majority were aged 21–30 years (56.7%), followed by the 31–40 years group (26.9%). Table 1 shows the age-wise distribution. Donors below 20 years made up 6.6%, and those over 50 years were the least represented at 1.6%. This shows that young adults were the primary contributors to blood donation. Table 2 shows gender wise distribution. Out of 1,412 donors, 99.7% were male and only 0.3% were female. Table 3 shows age comparison by gender. Male donors had a mean age of 29.88 ± 7.66 years, while female donors were significantly older, with a mean age of 37.5 ± 7.14 years. This age difference was statistically significant ($p = 0.047$), it

shows that younger males are more likely to donate than females, who tend to donate later.

Transfusion-transmitted infections (TTIs): Prevalence in the Studied Blood Donor Group

Donor blood samples were tested for blood group and TTIs, and the results are presented in [Table 4]. Out of 1412 blood donors, 104 (7.37%) blood donors were positive for TTIs. Blood group B (37.5%) was the most common among donors, followed by O (28.3%), A (23.8%), and AB (10.3%). Most donors were Rh positive (95.9%). HCV was the most common infection (4.1%), followed by HBV (3.19%). HIV and Malaria Parasite (MP) were not detected in any donor. Only 1 case of Syphilis was observed. The overall seropositivity was 7.37%, with HCV being slightly more prevalent than HBV.

[Table 5] shows cross-compared infections (HCV, HBV, HIV, Syphilis, MP) with individual and combined blood groups. HCV was most common in blood group O (34.5%), followed by B (32.8%). HBV also showed a similar trend, more common in B and O groups. A single case of Syphilis occurred in blood group B. No HIV or MP cases were reported across any blood group.

Association between Blood Groups and Transfusion-transmitted infections (TTIs):

[Table 6] shows the statistical significance of differences in infection rates between grouped blood types and Rh status. No significant differences were observed between ABO groups and infections (all $p > 0.05$). However, Rh factor showed a significant association with Syphilis ($p = 0.001$).

HCV:

The comparative percentage frequency of HCV positive was the highest in blood donors having blood group O (34.5%) followed by blood group B (32.8%) and lowest in donors having blood group AB (5.2%) [Table 5]. Among Rh blood groups, HCV reactive was higher in Rh(D) positive donors (94.8%) as compared to Rh(D) negative donors (5.2%). Similar findings were seen in HCV non-reactive donors, Rh(D) positive blood donors (96%) were higher compared to Rh(D) negative donors (3.9%).

HCV positive donors, did not show a statistically significant association when all blood groups (A, B, O, AB) were compared together ($\chi^2 = 3.10$, $p = 0.376$). Similarly, no significant association was observed when donors having blood groups A, B, and AB were compared with blood group O ($\chi^2 = 1.12$, $p = 0.288$). Further analyses comparing A+O versus B+AB ($\chi^2 = 2.39$, $p = 0.122$) and B+O versus A+AB ($\chi^2 = 0.05$, $p = 0.821$) also did not show any statistically significant association with HCV seropositivity. With respect to Rh blood group, the association was not statistically significant ($\chi^2 = 0.20$, $p = 0.654$) [Table 6].

HBV: The comparative percentage frequency of HBV positive donors [Table 5] was higher in donors having blood group B (37.8%) followed by blood group O (31.1%) and blood group A (26.7%). The lowest frequency of HBV positive was observed in blood group AB donors (4.4%). Among Rh blood groups, HBV reactive was higher in Rh(D) positive donors (97.8%) as compared to Rh(D) negative donors (2.2%). When all blood groups (A, B, O, AB) were analysed together, no significant association was observed with HBV infection ($\chi^2 = 1.85$, $p = 0.604$). Comparison between donors with blood groups A, B, and AB versus O also showed no significant association ($\chi^2 = 0.17$, p

= 0.674). Also comparing A+O versus B+AB ($\chi^2 = 0.59, p = 0.44$) and B+O versus A+AB ($\chi^2 = 0.18, p = 0.664$) did not demonstrate any significant association. Similarly, comparison between Rh(D) positive and Rh(D) negative donors showed no statistically significant association with HBV positive ($\chi^2 = 0.39, p = 0.53$) [Table 6].

Syphilis: The comparative percentage frequency of syphilis positive was highest in blood group B (100%). Among Rh blood group syphilis reactive was higher in Rh(D) negative donors (100%) [Table 5]. When all blood groups (A, B, O, AB) were compared together, no significant association was

observed with syphilis infection ($\chi^2 = 1.66, p = 0.645$). Similarly, no significant association was observed when donors with blood groups A, B, and AB were compared with blood group O ($\chi^2 = 0.39, p = 0.529$). Further comparisons of A+O versus B+AB ($\chi^2 = 1.09, p = 0.297$) and B+O versus A+AB ($\chi^2 = 0.51, p = 0.471$) also did not show statistically significant association. However, significant association was observed between Rh blood group and syphilis positive blood donors ($\chi^2 = 23.78, p = 0.001$), indicating association between Rh blood group and susceptibility to syphilis infection [Table 6].

Table 1: Age wise Distribution

Age	Frequency	Percentage
<20years	93	6.6
21 – 30	800	56.7
31 – 40	380	26.8
41 – 50	117	8.3
>50years	22	1.6
Total	1412	100.0

Table 2: Gender wise Distribution

Gender	Frequency	Percentage
Male	1408	99.7
Female	4	0.3
Total	1412	100

Table 3: Age Comparison by Gender

Age	Male	Female	p-value
Age	29.88±7.66	37.5±7.14	0.047

Table 4: Blood Group and Seropositivity

Parameters	A	B	O	AB	Rh(D) +ve	Rh(D)-ve	Total
Donor	336(23.8%)	530(37.5%)	400(28.3%)	146(10.3%)	1355(95.9%)	57(4.1%)	1412(100%)
HCV	16(1.13%)	19(1.34%)	20(1.41%)	3(0.21%)	55(3.89%)	3(0.21%)	58(4.10%)
HBV	12(0.85%)	17(1.21%)	14(0.99%)	2(0.14%)	44(3.12%)	1(0.07%)	45(3.19%)
HIV	0(0%)	0(0%)	0(0%)	0(0%)	0(0%)	0(0%)	0(0%)
Syphilis	0(0%)	1(0.07%)	0(0%)	0(0%)	0(0%)	1(0.07%)	1(0.07%)
MP	0(0%)	0(0%)	0(0%)	0(0%)	0(0%)	0(0%)	0(0%)
Total	28(1.99%)	37(2.62%)	34(2.41%)	5(0.35%)	99(7.02%)	5(0.35%)	104(7.37%)

Table 5: Infection Prevalence by Blood Group

Blood Group	Donor (1412)	HCV		HBV		HIV		Syphilis		MP	
		R (58)	NR (1354)	R (45)	NR (1367)	R (0)	NR (1412)	R (1)	NR (1411)	R (0)	NR (1412)
A	336 (23.8%)	16 (27.6%)	320 (23.6%)	12 (26.7%)	324 (23.7%)	0 (0%)	336 (23.8%)	0 (0%)	336 (23.8%)	0 (0%)	336 (23.8%)
B	530 (37.5%)	19 (32.8%)	511 (36.2%)	17 (37.8%)	513 (37.5%)	0 (0%)	530 (37.5%)	1 (100%)	529 (37.5%)	0 (0%)	530 (37.5%)
O	400 (28.3%)	20 (34.5%)	380 (26.9%)	14 (31.1%)	386 (28.2%)	0 (0%)	400 (28.3%)	0 (0%)	400 (28.3%)	0 (0%)	400 (28.3%)
AB	146 (10.3%)	3 (5.2%)	143 (10.1%)	2 (4.4%)	144 (10.5%)	0 (0%)	146 (10.3%)	0 (0%)	146 (10.3%)	0 (0%)	146 (10.3%)
A+B	866 (61.3%)	35 (60.3%)	831 (61.4%)	29 (64.4%)	837 (61.2%)	0 (0%)	866 (61.3%)	1 (100%)	865 (61.3%)	0 (0%)	866 (61.3%)
A+O	736 (52.1%)	36 (62.1%)	700 (51.7%)	26 (57.8%)	710 (51.9%)	0 (0%)	736 (52.1%)	0 (0%)	736 (52.2%)	0 (0%)	736 (52.1%)
A+AB	482 (34.1%)	19 (32.6%)	463 (34.2%)	14 (31.1%)	468 (34.2%)	0 (0%)	482 (34.1%)	0 (0%)	482 (34%)	0 (0%)	482 (34.1%)
B+O	930 (65.9%)	39 (67.2%)	891 (65.8%)	31 (68.9%)	899 (65.7%)	0 (0%)	930 (65.9%)	1 (100%)	929 (65.6%)	0 (0%)	930 (65.9%)
B+AB	676 (47.9%)	22 (37.9%)	654 (48.3%)	19 (42.2%)	657 (48.1%)	0 (0%)	676 (47.9%)	1 (100%)	675 (47.8%)	0 (0%)	676 (47.9%)
A+B+AB	1012 (71.7%)	38 (65.5%)	974 (71.9%)	31 (68.9%)	981 (71.7%)	0 (0%)	1012 (71.7%)	1 (100%)	1011 (71.6%)	0 (0%)	1012 (71.7%)

Rh(D) +ve	1355 (96%)	55 (94.8%)	1300 (96%)	44 (97.8%)	1311 (95.9%)	0 (0%)	1355 (96%)	0 (0%)	1355 (96%)	0 (0%)	1355 (96%)
Rh(D)-ve	57 (4%)	3 (5.2%)	54 (3.9%)	1 (2.2%)	56 (4.1%)	0 (0%)	57 (4%)	1 (100%)	56 (4%)	0 (0%)	57 (4%)

Table 6: Statistical Association Between Blood Group and Infections

Blood Group	DF	HCV		HBV		Syphilis	
		χ^2	P-value	χ^2	P-value	χ^2	P-value
A,B,O,AB	3	3.10	0.376	1.85	0.604	1.66	0.645
(A+B+AB),O	1	1.12	0.288	0.17	0.674	0.39	0.529
RHP,RHN	1	0.20	0.654	0.39	0.53	23.78	0.001
A+O,B+AB	1	2.39	0.122	0.59	0.44	1.09	0.297
B+O,A+AB	1	0.05	0.821	0.18	0.664	0.51	0.471

DISCUSSION

Transfusion-transmitted infections (TTIs) pose a significant concern regarding patient safety. Since the scientific initiation of blood transfusion practices in the early 1940s, various transfusion-associated complications have emerged as important issues for the medical and scientific communities.^[12]

Post-transfusion infections remain a significant risk for blood recipients. As per World Health Organization (WHO) guidelines, blood should be screened for at least five major TTIs: hepatitis B virus (HBV), hepatitis C virus (HCV), human immunodeficiency virus (HIV), malarial parasite, and syphilis.^[13]

The demographic pattern of blood donors in present study showed 99.7% were male and only 0.3% were female. Different studies conducted in coastal south India, north India and north east India also reported a marked predominance of male blood donors, with males constituting 95.2%, 96.12% and 90.03% respectively.^[12,14,15]

In the present study, the majority of blood donors were aged 21–30 years (56.7%), followed by the 31–40 years group (26.9%). So, young adults were the primary benefactors to blood donation. Similarly, studies conducted by Singh P et al and Alshebri AA et al, majority of blood donors belonged to the 21–30 years age group 46.09% and 40.3% respectively.^[12,16]

In the present study, total of 104 (7.37%) blood donors was positive for TTIs in which HCV infection was seen in 4.10%, HBV in 3.19%, syphilis in 0.07% and no seroreactivity shown in HIV and Malaria. Whereas study done by Varshaben et al showed 37(0.86%) blood donors were positive for TTIs: HBV infection was observed in 0.16% of donors, HCV infection in 0.07%, HIV infection in 0.07%, and Syphilis infection in 0.56%. Seropositivity to malaria was not detected in any donor.^[17] Similarly, study done by Dimple et al in southern Haryana showed seroprevalence of HBV, HCV and syphilis was 1.7%, 1.0% and 0.9% respectively in total donors.^[18] Thakur et al also documented an overall TTIs prevalence of 2.038% with HBV as the leading infection (1.11%) and HCV at 0.43%.^[4] According to Fernandes H et al the overall prevalence of TTIs among donors was 0.6%, with Hepatitis B showing the highest prevalence (0.34%), followed by syphilis (0.11%).^[19] Similarly, Pattanashetti M et al states that the seropositivity rates for HBV (0.58%) and syphilis (0.08%) were comparatively higher, whereas those for HIV, malaria,

and HCV were lower.^[20] The increased prevalence of HCV and HBV among blood donors may be linked to inadequate health practices during common illnesses, limited access to safe sex resources, and widespread intravenous drug use in nearby communities. Promoting good health practices and improving socioeconomic conditions are essential to reduce the burden of these infections.^[13]

In the present study out of total donors, 104 (7.37%) tested positive for TTIs. Among them, blood group B: 37 (2.62%) was more common followed by blood group O: 34 (2.41%) and then blood group A: 28 (1.99%). Rh positive: 99 (7.02%) seropositivity was more than Rh negative: 5 (0.35%). Similarly, study done by Thakur et al stated that out of total donors, 345 (2.04%) were found positive for TTIs. Among them blood group B:145 (0.86%) was more common, followed by blood group O: 97 (0.57%) and then blood group A: 72 (0.43%). Rh positive: 328 (1.94%) seropositivity was more than Rh negative: 15 (0.09%).^[4] Similar findings were also seen in study conducted by Arif et al. Out of total blood donors, 2047 (5.59%) tested positive for TTIs. Seroreactivity was highest in blood group B positive (1.79%), followed by O positive (1.54%) and A positive (1.28%). Among the total seroreactive cases, 93.7% belonged to the Rh-positive blood group, while the remaining 6.3% were Rh-negative.^[21] Whereas, the study done by Alshebri AA et al total of 449 (10.9%) blood donors had a positive TTI in which most common was O positive blood group (50%) followed by A positive (26.8%) and then B positive (9.9%).^[16]

In the present study, 58 (4.10%) blood donors were positive for HCV. Among them, blood group O positive: 20 (1.41%) was more common followed by blood group B positive: 19 (1.34%). Furthermore 45 (3.19%) blood donors tested positive for HBV. Among them, blood group B positive: 17 (1.21%) was more common followed by blood group O positive: 14 (0.99%). Whereas Thakur et al stated that 73 (0.431%) blood donors were HCV-positive, with blood group B positive: 39 (0.23%) being more common followed by with blood group O positive: 13 (0.077%). Their study also showed blood group B positive: 76 (0.449%) being more common followed by blood group O positive: 51 (0.301%), among 188 (1.111%) HBV positive blood donors.^[4] Arif et al stated that 467(1.27%) blood donors were HCV positive. Among them blood group B positive: 279 (2.18%) being the most common followed by blood group O positive: 242 (2.41%).^[21]

In the present study, HCV and HBV show no significant association with ABO blood groups and Rh blood groups. Zahra Naseri et al also reported that HCV shows no significant

association with ABO blood groups; however, individuals with Rh-positive blood groups have a higher risk of hepatitis C infection.^[22] Whereas Sumit Bharadva et al reported a significant association between blood group A negative and HCV infection.^[23] Also, Xu Li et al reported that individuals with non-O blood types have a higher risk of HCV-related hepatocellular carcinoma (HCC) compared to those with blood group O.^[24]

In the present study, only 1(0.07%) blood donor tested positive for syphilis with blood group B negative: 1(0.07%). Whereas Thakur et al stated 49 (0.29%) blood donors tested positive for VDRL. Distribution by blood group showed 10 (0.059%) blood donors with blood group A, 16 (0.095%) with blood group B, 20 (0.118%) with blood group O, and 3 (0.018%) with blood group AB. According to Rh type, 47 donors (0.278%) were Rh positive and 2 donors (0.012%) were Rh negative.^[4]

In the present study, syphilis shows significant association with RH blood groups. However, no significant association were observed between ABO blood groups and syphilis. Shah RJ and Patel D observed an association with both Rh-positive and Rh-negative groups,^[25] whereas Mohammadali F et al. reported no association between ABO or Rh blood groups and syphilis infection.^[9]

In the present study, HIV and malaria Parasite (MP) were not detected in any blood donor. Study done by Elnaim Bushra Ahmad et al in white Nile state, Sudan shows seropositivity for HIV was 2.61%.^[26] Mohammadali F et al reported a significantly higher prevalence of HIV among donors with blood group A.^[9] A study conducted in western part of India also reported no case of malaria.^[23] Prevalence of malaria is seen very low (<1%) in developed countries than high-burden settings such as Equatorial Guinea (18.7%) and Mozambique (37.39%), due to stringent donor selection and advanced nucleic acid testing (NAT) protocols.^[8]

In the present study one blood donor tested positive for both HCV and HBV (0.07%), having blood group O Rh(D) positive. A study done by Bakyt et al. in Kyrgyzstan, co-infection between anti-T. pallidum and HBsAg (6.0%) was found to be the highest, followed by that between anti-HCV and anti-T. pallidum (5.2%), and then between HIV and anti-HCV (4.9%).^[27]

The relationship between TTIs and ABO or Rh(D) blood groups has been explored in multiple studies, but the evidence remains contradictory. While some studies have demonstrated no significant correlation between TTIs and either ABO or Rh blood types.^[23,28,29] Whereas one study noted the greatest risk of TTIs in O positive individuals and the least risk in those with AB negative blood group.^[8] For better understanding the association between TTIs and blood groups, more studies are required.

CONCLUSION

This study shows a relatively high prevalence of TTIs among blood donors especially, HCV and HBV. Although no significant association was found between ABO blood groups and TTIs, Rh factor was seen significantly associated with syphilis among the blood donors. Awareness

programme, strengthening donor screening and testing along with preventive strategies are essential to reduce TTIs.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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