Introduction

Transfusion of blood and/or component is an integral part of management and life-saving measure in the medical field. Not only does donor blood save lives but it also has the potential to endanger life through the risk of transmitting transfusion-transmitted infections (TTIs) in the absence of proper donor screening. TTIs include human immunodeficiency virus (HIV), hepatitis B virus (HBV), and hepatitis C virus (HCV) in healthy donors at a tertiary care hospital-based blood bank. To know the yearly and age-group prevalence of these TTIs as compared with other studies across India.

Context: The ultimate goal of a blood transfusion service is the provision of safe and adequate supply free from transfusion-transmitted infections (TTIs). TTIs not only threaten the recipient’s safety, but they also increase disease burden. Seroprevalence of TTIs in healthy blood donors indirectly reflects the prevalence of these infections in the general healthy population. Aim and Objectives: To study the seroprevalence of human immunodeficiency virus (HIV), hepatitis B virus (HBV), and hepatitis C virus (HCV) in healthy donors at a tertiary care hospital-based blood bank. To know the yearly and age-group prevalence of these TTIs as compared with other studies across India.

Settings and Design: This is a 5 years observational cross-section study conducted in a tertiary hospital-based teaching institute of Central India (Malwa region).

Materials and Methods: The results of serological testing of TTIs and donor variables were analyzed during 2011–2015.

Statistical Analysis Used: Chi-square test and Chi-square for trend analysis on TTIs prevalence.

Results: A total of 58,998 donors were screened for TTIs with dominance of male donation (99.7%). The overall cumulative seroprevalence was 1.14% in our study. The seroprevalence of HIV, HBV, and HCV was 0.09%, 0.98%, and 0.07%, respectively. We found a statistically significant increasing trend for HCV seropositivity during the study.

Conclusion: Our study reflects an increasing trend of HCV seroprevalence over time. Thus, efforts are needed to increase the awareness and to educate the population in reducing risk factors for HCV infection.

Keywords: Hepatitis B virus, hepatitis C virus, human immunodeficiency virus, seroprevalence, transfusion transmitted infections
the formulation of health strategies. The objectives of this study are: (1) to find out the seroprevalence of TTIs among healthy blood donors at a tertiary teaching hospital in central India (Malwa region) and to explore yearly differences in the prevalence of these infections, and (2) to compare other studies undertaken in different parts of India to assess the burden of these infections. We did not divide our donor population in the voluntary and replacement categories as it was known fact that replacement donors have more seroprevalence for TTIs, due to which National blood policy encourages voluntary nonremunerated donation.

MATERIALS AND METHODS

This cross-sectional study was conducted at the blood bank, Sri Aurobindo Medical College and PG Institute, Indore (Madhya Pradesh), India over a period of 5 years from 2011 to 2015. Ethical clearance was taken by the Institutional Ethical Committee. Retrospective data were collected from various registers maintained in the blood bank and for prospective data; all the donors were carefully screened and selected after proper history, clinical examination, and satisfactory answering of detailed donor questionnaires. All the samples collected during the study were screened for TTIs using the following ELISA tests:

• For HIV: P24 antigen and antibodies to HIV 1 and HIV 2 detection by Merilisa fourth generation kit (Meril Diagnostics Pvt. Ltd., Vapi, Gujarat, India)
• For HBV: HBsAg detection by Merilisa (Meril Diagnostics Pvt. Ltd., Vapi, Gujarat, India)
• For HCV: Antibodies to HCV detection by the third generation Erba Lisa ELISA kit (Transasia Bio-Medicals Ltd., Ringanwada, Daman, India).

All the reactive samples were discarded for donation as per the guidelines. The data collected were entered into a Microsoft Office Excel 2007 sheet and percentage and proportions for each variable were calculated. Statistical analysis was done using, Chi-square test and Chi-square test for trend analysis to know prevalence trends by age and by year of donation. P < 0.05 was set as the level of significance.

RESULTS

A total of 58,998 blood bags were collected during the 5-year study from 2011 to 2015. Male blood donation predominates over female donation; the female contribution was only 0.3% [Table 1].

Out of the total donors screened, 674 (1.14%) donors were reactive for HIV, HBV, or HCV during the study. All seropositive donors were male. The highest prevalence among donors was seen for HBV (0.98%) followed by HIV (0.09%) and HCV (0.07%) in decreasing order. Yearly seroprevalence and linear trend of these TTIs are represented in Table 2 and Figure 1, respectively. There was no statistically significant trend for HIV or HBV from 2011 to 2015 ($\chi^2$ for linear trend 0.06 and 1.49, $P$ value 0.80 and 0.22, respectively).

Seroprevalence of HCV shows a statistically significant increasing trend ($\chi^2$ for linear trend was 4.91 and $P$ = 0.027) over the 5 years. We found coinfections of TTIs in a total of five patients (0.008%) in the 5-year study period, with positivity for HIV and HCV or HIV and HBV of both 0.003% and for triple infection of 0.002% ($n$ = 1).

The age range in our study was 18–58 years. The highest prevalence of all infections summed together was found in the age group of 31–40 years [Table 3]. The overall cumulative seroprevalence was lowest in donors of age <20 years (0.15%) and then increased up to 40 years of age, followed by a decline with increasing age. This age-wise trend of cumulative seroprevalence was statistically significant ($\chi^2$ for trend = 24.77, $P$ ≤ 0.0001). In all age groups, HBV seropositivity was highest.

Table 1: Year and Gender Wise Distribution of Blood Donors

| Year | Total donors | Male (%) | Female (%) |
|------|--------------|----------|------------|
| 2011 | 6070         | 6052 (99.7) | 18 (0.3)   |
| 2012 | 11,132       | 11,079 (99.5) | 53 (0.5) |
| 2013 | 14,347       | 14,299 (99.6) | 48 (0.3) |
| 2014 | 13,478       | 13,443 (99.7) | 35 (0.2) |
| 2015 | 13,971       | 13,943 (99.8) | 28 (0.2) |
| Total | 58,998       | 58,816 (99.7) | 182 (0.3) |

Table 2: Year-Wise Seroprevalence of Human Immunodeficiency Virus, Hepatitis B Virus, and Hepatitis C Virus Infections in Donors

| Year | Total | HIV, n (%) | HBV, n (%) | HCV, n (%) | Total, n (%) |
|------|-------|------------|------------|------------|--------------|
| 2011 | 6070  | 10 (0.16)  | 67 (1.1)   | 1 (0.02)   | 78 (1.28)    |
| 2012 | 11,132| 4 (0.04)   | 107 (0.96) | 4 (0.04)   | 115 (1.03)   |
| 2013 | 14,347| 10 (0.07)  | 107 (0.74) | 11 (0.08)  | 128 (0.89)   |
| 2014 | 13,478| 17 (0.13)  | 139 (1.03) | 13 (0.1)   | 169 (1.25)   |
| 2015 | 13,971| 13 (0.09)  | 159 (1.14) | 12 (0.08)  | 184 (1.32)   |
| Total | 58,998| 54 (0.9)   | 579 (0.98) | 41 (0.07)  | 674 (1.14)   |

HIV: Human immunodeficiency virus, HBV: Hepatitis B virus, HCV: Hepatitis C virus

Figure 1: Year-wise trend of seroprevalence of human immunodeficiency virus, hepatitis B virus, and hepatitis C virus

- **HIV**
- **HBV**
- **HCV**

- Linear trend-HIV
- Linear trend-HBV
- Linear trend-HCV
Table 3: Age Distribution of Human Immunodeficiency Virus, Hepatitis B Virus, and Hepatitis C Virus Reactive Blood Donors

| Age in years | Total donors | HIV, n (%) | HBV, n (%) | HCV, n (%) | Total, n (%) |
|--------------|--------------|------------|------------|------------|--------------|
| 18-20        | 4708         | 2 (0.04)   | 5 (0.11)   | 0          | 7 (0.15)     |
| 21-30        | 21,845       | 22 (0.10)  | 168 (0.77) | 14 (0.06)  | 204 (0.93)   |
| 31-40        | 16,126       | 18 (0.11)  | 245 (1.52) | 21 (0.13)  | 284 (1.76)   |
| 41-50        | 11,297       | 12 (0.11)  | 97 (0.86)  | 4 (0.04)   | 113 (1.0)    |
| 51-60        | 5022         | 0          | 64 (1.27)  | 2 (0.04)   | 66 (1.31)    |
| Total        | 58,998       | 54 (0.81)  | 579 (5.90) | 41 (6.8)   | 674 (11.4)   |

HIV: Human immunodeficiency virus, HBV: Hepatitis B virus, HCV: Hepatitis C virus

Discussion

Transfusion of blood and/or blood products are life-saving at one end but may be a route of transmission of TTI’s. To prevent TTIs as a delayed complication of blood transfusion, Government of India mandates the screening of each and every unit of blood as per drugs and cosmetic rules. Despite following all measures such as strict donor selection criteria, voluntary, nonremunerated donation, and more sensitive methods to detect TTIs, some transmission events are still possible because of the window period, false negative results, and other technical errors.[10]

Our study showed the male dominance (99.7%) in donation similar to the other studies.[6,7,10-14] Less female contribution was because of higher incidence of anemia and low weight in childbearing age group females. Another important reason is a lack of awareness and enthusiasm among family members of potential female blood donors. Other factors such as fear of procedure, lack of motivation, and privacy are also of concern which can be improved by increasing awareness among females and by providing privacy in camps. None of the female donors was seropositive for TTIs in our study, similar to the other studies in which female seropositive donors statistically significantly less in number as compared to male donors.[10,14,16] This finding might be due to less number of female donors and difference in risk behavior of females.

In this study, 45% of the total donors belongs to the 18–30 years age group similar to the study of Fernandes et al.[11] (68.5%), Karmarkar et al.[17] (47.6%), and Sinha et al.[13] (44.54%) probably because of the increased awareness and enthusiasm for blood donation and also because of less disease ailments among these young population. The present study found a statistically significant trend with age for cumulative seroprevalence and in line with the study by Karmarkar et al.[17]

Our study, in concordance with the other studies across India, showed the highest seroprevalence for hepatitis B. Comparison of seroprevalence of HIV, HBV, and HCV with other studies is shown in Table 4.

The overall seroprevalence of HIV and HCV was almost the similar or showed a slight difference in studies from South India,[11] Western India (Gujarat),[14,21,22] and central India,[7,9,25] whereas studies from North India[10,18,19] showed a much higher prevalence of HCV. This difference might be due to the difference in the study period, sensitivity of detecting methods, number of donors and different risk behavior in the donor population.

The overall seroprevalence of HIV is much lower in our study (0.09%) as compared with India’s overall HIV prevalence in adults (0.27%) but exact same with the Madhya Pradesh’s prevalence (0.09%) estimated in 2011 by NACO.[26] In our study, maximum seroprevalence of HIV was observed in 31–50-year-old age group (0.11%) whereas, Kaur et al.,[10] Mandal and Mondal,[20] and Makroo et al.[27] reported the highest prevalence in 26–35 years, 18–35 years, and 18–30-year-old age groups, respectively. In accordance with our results, most studies[10,20,27] reported the lowest prevalence on 45–50-year-old age groups. One study from Kolkata[12] found a maximum HIV prevalence on >50 year olds.

HIV seroprevalence across the age group was not statistically significant, whereas Das et al.,[12] reported statistically significant increasing trend. In this study, we observed no significant trend for changing HIV prevalence in the last 5 years in contrast to the national trend for decreasing HIV prevalence from 0.41% to 0.27% during 2001–2011[28] and also found in other studies.[7,9,15,19,20,23,24] One study by Saharwal et al.[29] from Rajasthan and one by Patel et al.[21] from Gujarat showed an increasing trend of HIV from 2007 to 2011 and 2009 to 2011, respectively. These discordances may be due to the difference in the study period and donor population.

The overall seroprevalence of HBV in our study was lower as compared to other studies from central India,[7,9,25] whereas almost similar with studies from Western India.[6,14,21,22] In our study, HBV was more prevalent in the 31–40-year-old age range with statistical significance. The seroprevalence of HBV showed a statistically significant increasing trend with increasing age (χ² for linear trend = 0.016, P = 0.9 for HCV) whereas seropositivity of HBV showed a statistically significant increasing trend with increasing age (χ² for linear trend = 30.46, P ≤ 0.0001). Linear trends of seroprevalence with age are shown in Figure 2.
Table 4: Comparison of Seroprevalence of Human Immunodeficiency Virus, Hepatitis B Virus, and Hepatitis C Virus with Other Studies

| Regions        | Place              | Study period          | HIV   | HBV   | HCV   |
|----------------|--------------------|-----------------------|-------|-------|-------|
| North India    | Makroo et al., Delhi[31] | 2005-2013             | 0.24  | 1.18  | 0.43  |
|                | Arora et al., Haryana[31] | 2002-2006             | 0.3   | 1.7   | 1.0   |
|                | Kaur et al., Ludhiana[31] | 2004-2009             | 0.2   | 1.0   | 1.4   |
|                | Koshy et al., Punjab[31] | 2008-2010             | 0.27  | 1.11  | 1.53  |
| South India    | Reddy et al., Telangana[31] | 2009-2013             | 0.26  | 1.28  | 0.51  |
|                | Fernandes et al., Mangalore[31] | 2007-2009             | 0.06  | 0.34  | 0.06  |
| East India     | Karmarkar et al., Kolkata[31] | 2011                 | 0.60  | 1.41  | 0.59  |
|                | Das et al., Kolkata[31] | May 2009 to April 2010 | 0.32  | 1.55  | 0.35  |
|                | Mandal and Mondal, Darjeeling[30] | 2010-2012             | 0.42  | 1.24  | 0.62  |
|                | Naskar et al., Kolkata[30] | April 2002 to March 2012 | 0.28  | 1.75  | 0.37  |
| West India     | Patel et al., Vadodara[31] | 2009-2011             | 0.30  | 0.85  | 0.21  |
|                | Dhruba et al., Rajkot[14] | 2013                 | 0.07  | 0.68  | 0.07  |
|                | Shah et al., Ahmedabad[22] | 2006-2013             | 0.15  | 0.89  | 0.10  |
|                | Giri et al., Loni[26] | 2009-2010             | 0.07  | 1.09  | 0.74  |
|                | Deshpande et al., Latur[23] | 2007-2011             | 0.38  | 2.82  | 0.22  |
|                | Sastry et al., Pune[24] | 2008-2013             | 0.28  | 1.23  | 0.41  |
| Central India  | Kumar et al., Jagdalpur[8] | November 2009 to May 2011 | 0.53  | 1.76  | 0.20  |
|                | Sharma et al., Gwalior[3] | 2009-2013             | 0.13  | 3.15  | 0.24  |
|                | Bobde et al., Nagpur[25] | January 2010 to June 2014 | 0.30  | 1.18  | 0.16  |
|                | Sawke et al., Bhopal[29] | 2006-2008             | 0.51  | 2.9   | 0.57  |
|                | Present study       | 2011-2015             | 0.09  | 0.98  | 0.07  |

HIV: Human immunodeficiency virus, HBV: Hepatitis B virus, HCV: Hepatitis C virus

Group and lowest on the <20-year-old age group, whereas Giri et al.,[6] Kaur et al.,[10] and Mandal and Mondal,[20] found the highest prevalence in <35 years old and the lowest in >45 year olds. In line with Mandal and Mondal,[20] we observed statistically significant trend of HBV seropositivity with age, whereas Das et al.,[12] and Giri et al.,[6] did not find any insignificant trend.

In the present study, no significant trend for changing HBV seropositivity was observed during the study period whereas Sharma et al.,[7] Sawke et al.,[9] Naskar et al.,[16] Patel et al.,[21] and Sabharwal et al.,[29] found increasing trend and Makroo et al.,[23] Mandal and Mondal,[20] Deshpande et al.,[23] and Koshy et al.[19] found statistically significant declining trend. These conflicting results may also be due to the difference in the study period and the donor population.

Overall HCV seroprevalence in the present study was much lower from the studies of North India.[10,18,19] because of increased risk behavior (intravenous drug users) of their population. Mandal and Mondal,[20] and Makroo et al.,[30] observed statistically significant declining trend of HCV seropositivity with advancing age, whereas Das et al.,[12] found no significant trend across the age groups similar to the present study. Naskar et al.[16] and Sabharwal et al.[29] found statistically significant increasing trend of HCV seropositivity during their study period similar to our study, whereas one large study from North India[30] did not find any significant change. Overall, the conflicting results may be due to differences in the donor base, study period, testing methodology, the degree to which the risk factors are prevalent in the donor population, literacy rate, and self-exclusion of high-risk donors by awareness programs.

Conclusion

The overall prevalence for TTI s in our study from donors of Malwa region was lower as compared to other parts of India. The seroprevalence of HCV showed an increasing trend from 2011 to 2015, whereas we did not observe any statistically significant trend in the HIV and HBV. The increasing trend of HCV infection indicates the need for more awareness programs and education in the general population for the risk factors and complications because evolution to chronic stage then cirrhosis and eventually hepatocellular carcinoma.

Finally, exclusively voluntary, nonremunerated healthy donors blood donation, strict following of screening criteria, usage of more sensitive detection methods, self-exclusion of high-risk donors, avoidance of unnecessary blood transfusion and optimal usage of blood units are the key factors for safe blood transfusion and efficient transfusion services in our area.

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Conflicts of interest

There are no conflicts of interest.
REFERENCES

1. Fernandes H, D’souza PF, D’souza PM. Prevalence of transfusion transmitted infections in voluntary and replacement donors. Indian J Hematol Blood Transfsu 2010;26:89-91.

2. National AIDS Control Organisation Document, Ministry of Health and Family Welfare, Government of India. National Blood Policy; 2007. Available from: http://naco.gov.in/sites/default/files/National%20Blood%20Policy_0.pdf [Last accessed on 2016 Dec 09].

3. Singh N. NAT: Safe Blood, Safe India; 2011. Available from: http://archivehealthcare.expertbd.com/200810/knowledge02.shtml [Last accessed on 2016 Dec 09].

4. Shrivastava Akash, Kumar Sanjay. Lead story-hepatitis in India: Burden, strategies and plans. NCDC NewsI 2014;3:1-3. Available from: http://www.ncdc.gov.in/writereaddata/linkimages/Newsltr0103_20146480274026.pdf [Last accessed on 2016 Dec 09].

5. Mane A, Kalaskar V. Demographic determinants and trends in seroprevalence of hepatitis C virus in healthy blood donors. UJMDS 2013;1:41-5.

6. 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.

7. Sharma DC, Rai S, Bharat S, Iyenger S, Gupta S, Jain B. A 10 years comparative study to assess trends in seroprevalence of transfusion transmitted infections among blood donors at Gwalior, India. Open J Blood Dis 2014;4:24-32.

8. Kumar A, Sharma SM, Ingole NS, Gangane S. Seroprevalence of transfusion transmissible infections (TTIs) among blood donors in a tertiary care hospital, central India: A prospective study. Muller J Med Sci Res 2014;5:11-6.

9. Sawke N, Sawke GK, Chawla S. Seroprevalence of common transfusion-transmitted infections among blood donors. Peoples J Sci Res 2010;3:5-7.

10. Kaur R, Singh A, Singh GP. Increasing prevalence of hepatitis among transfusion transmitted infections: A tertiary care centre experience. J Evol Med Dent Sci 2012;1:87-81.

11. Reddy SR, Chowdary RD, Bilolikar AK. Seroprevalence of transfusion transmissible infections among healthy blood donors at KIMS blood bank. J Med Sci Res 2014;2:137-9.

12. Das BK, Gayen BK, Aditya S, Chakraborty SK, Datta PK, Joseph A. Seroprevalence of hepatitis B, hepatitis C, and human immunodeficiency virus among healthy voluntary first-time blood donors in Kolkata. Ann Trop Med Pub Health 2011;8:49-60.

13. Sinha SK, Roychoudhury S, Biswas K, Biswas P, Bandopadhayay R. Prevalence of HIV, hepatitis B, hepatitis C and syphilis in donor’s blood: A study from eastern part of India. Open J Hematol 2012;3:1-6.

14. Dhruba GA, Agrawat AH, Dalsania JD, Katara AA, Dave RG. Transfusion transmitted diseases/infections among blood donors in a tertiary care hospital at Rajkot, Gujarat, India. Int Res J Med Sci 2014;2:16-9.

15. Makroo RN, Hegde V, Chowdhry M, Bhatia A, Rossamna NL. Seroprevalence of infectious markers and their trends in blood donors in a hospital based blood bank in North India. Indian J Med Res 2015;142:317-22.

16. Naskar S, Nandy S, Basu K, Basu R. Study of seroprevalence of HIV, hepatitis B and C and syphilis among blood donors in a tertiary care hospital, Kolkata. IOSR J Dent Med Sci 2013;11:63-6.

17. Karmarkar PR, Shrivastava P, Ray TG. Seroprevalence of transfusion transmissible infections among blood donors at the blood bank of a Medical College of Kolkata. Indian J Public Health 2014;58:61-4.

18. 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.

19. Koshy JM, Manoharan A, John M, Kaur R, Kaur P. Epidemiological profile of seropositive blood donors at a tertiary care hospital in North India. CHRISMED J Health Res 2014;1:91-4.

20. Mandal R, Mondal K. Transfusion transmitted infections among blood donors from a sub-Himalayan rural tertiary care centre in Darjeeling, India. J Tradit Complement Med 2015;6:224-9.

21. Patel SV, Popat CN, Mazumdar VS, Shah MB, Shringarpure K, Mehta KG, et al. Seroprevalence of HIV, HBV, HCV and Syphilis in blood donors at a tertiary hospital (Blood Bank) in Vadodara. Int J Med Sci Public Health 2013;2:747-50.

22. Shah N, Shah JM, Jhaveri P, Patel K, Shah CK, Shah NR. Seroprevalence of HBV, HCV, HIV and syphilis among blood donors at a tertiary care teaching hospital in Western India. Gujrmat Med J 2013;68:35-9.

23. Deshpande RH, Bhosale S, Gadgil PA, Sonawane M. Blood donor’s status of HIV, HBV, HCV and syphilis in this region of Marathwada, India. JKIMSU 2012;1:111-6.

24. Sastry JM, Agawane SU, Harke VA. Retrospective study of the five-year prevalence and trends of transfusion transmitted infections (TTIs) among blood donors at a charitable hospital blood bank in Pune, India. Int J Healthc Biomed Res 2014;2:193-200.

25. Bobde V, Parate S, Kumbhalkar D. Seroprevalence of viral transfusion transmitted infections among blood donors at a government hospital blood bank in central India. Health Agenda 2015;3:15-9.

26. NACO. India’s Voice against AIDS. State Fact Sheets 2013–14. Department of AIDS Control. Ministry of Health and Family Welfare, Government of India; 2014. Available from: http://naco.gov.in/sites/default/files/State_Fact_Sheet_2013_14.pdf [Last accessed on 2016 Dec 09].

27. Makroo RN, Chowdhry M, Bhatia A, Arora B, Rosamna NL. Seroprevalence of HIV among blood donors in a tertiary care centre of North India. Indian J Med Res 2011;134:950-3.

28. Annual Report NACO 2014-15. National AIDS Control Organization. Department of Health and Family Welfare. Available from: http://naco.gov.in/sites/default/files/annual_report%20_NACO_2014-15_0.pdf [Last accessed on 2016 Dec 09].

29. Sabharwal ER, Biswas NK, Vishnu Purohit V. Prevalence and patterns of transfusion transmissible infections among blood donors in Sri Ganganagar, Rajasthan, India: A retrospective study. J Pharm Biomed Res 2012;15:1-4.

30. Makroo RN, Walia RS, Chowdhry M, Bhatia A, Hegde V, Rosamna NL. Seroprevalence of anti-HCV antibodies among blood donors of North India. Indian J Med Res 2013;138:125-8.