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Original Research

Exploring the Prevalence of Transfusion-Transmitted Infections Among Blood Donors: A Tertiary Care Center Investigation

[1]Seema Nagpal, [2]Pooja Garg

[1]Associate Professor, [2]Assistant Professor, Department of Pathology, Sakshi Medical College & Research Centre, Guna, Madhya Pradesh, India

ABSTRACT:

Background: A transfusion-transmitted infection (TTI) arises from a virus, parasite, or another pathogen and can be conveyed to a recipient through the transfusion of contaminated donated blood. TTIs primarily encompass Human Immunodeficiency Virus, Hepatitis B Virus, Hepatitis C Virus, Syphilis, and Malaria. Blood transfusion plays a pivotal role in treating numerous diseases. A significant worry is the asymptomatic phase during which the infection may be transmitted to the recipient. To mitigate this risk, criteria for deferring donors have been established and put into practice. The aim of this study was to determine the seroprevalence of transfusion-transmitted infections (TTIs) in a tertiary care hospital. **Methods**: This hospital-based cross-sectional study took place in the Blood Bank, Department of Pathology, spanning one year. **Results**: Throughout this duration, a total of 1443 blood units underwent screening. The seroprevalence rates for HIV, HBV, HCV, and Syphilis were found to be 0.12%, 1.69%, 2.12%, and 0.71%, respectively. No donors tested positive for Malaria, resulting in a seroprevalence of nil for this infection. The majority of donors were males, with a male-to-female ratio of 62.6:1, and most fell within the 2nd and 3rd decades of life. While the seroprevalence of transfusion-transmitted infections (TTI) was higher in replacement donors compared to voluntary donors, this difference was not statistically significant. **Conclusion**: It is crucial to screen blood products to reduce the risk of transfusion-transmitted infections (TTI). Additionally, promoting voluntary blood donation and discouraging professional blood donation can be beneficial in further minimizing these risks.

Keywords: Blood transfusion,Seroprevalence,Syphilis.

Corresponding Author: Pooja Garg, Assistant Professor, Department of Pathology, Sakshi Medical College & Research Centre, Guna, Madhya Pradesh, India

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INTRODUCTION

Blood, an invaluable and life-preserving resource, is carefully reserved for critical situations; nevertheless, its transfusion is not devoid of risks, posing potential threats to both morbidity and mortality. This, in turn, imposes a considerable economic burden on the nation's healthcare system.[1] One of the foremost perils associated with blood transfusion is the likelihood of acquiring transfusion-transmitted infections (TTI) if stringent screening measures are not diligently enforced. Safeguarding the process of blood transfusion is of paramount importance, thereby presenting a substantial challenge within the realm of transfusion medicine. To mitigate these risks, several crucial steps must be taken to ensure the secure and safe administration of blood. Meticulous donor selection stands as a fundamental measure, emphasizing the careful screening and evaluation of potential blood donors to exclude individuals with potential risks of transmitting infections.[2] This involves assessing not only medical history but also lifestyle factors that might contribute to a higher likelihood of harboring infectious agents. In addition to donor selection, the implementation of diverse screening tests plays a pivotal role, encompassing rigorous examinations for Human Immunodeficiency Virus (HIV), Hepatitis B Virus (HBV), Hepatitis C Virus (HCV), Syphilis, and Malaria. These screening protocols serve as a comprehensive safety net, minimizing the chances of TTI during blood transfusion. Regular updates and enhancements to these tests are crucial to staying ahead of emerging infectious threats and ensuring the continued effectiveness of the screening process.

Furthermore, the application of pathogen inactivation procedures adds an additional layer of security to the blood supply chain. These advanced techniques are designed to deactivate or eliminate pathogens present

in donated blood, further enhancing the safety of transfusions. Continued research and development in this area are essential to improving the efficiency and applicability of these methods, ensuring their widespread adoption in healthcare systems globally. Voluntary blood donation emerges as a beacon of safety and benevolence in this landscape.[3] In India, adherence to the Drugs and Cosmetics Act (1st Amendment) Rules 1992 and the guidelines established by the National AIDS Control Organisation (NACO) mandates the rigorous screening of blood and blood components for various infectious agents. This underscores the critical importance of comprehensive safety measures in blood transfusion practices, promoting not only the health and well-being of the recipients but also fortifying the integrity of the entire healthcare system. Encouraging voluntary blood donation not only ensures a steady and safe blood supply but also fosters a sense of community responsibility, emphasizing the collective effort required to maintain a reliable and secure transfusion system.

Before administering a blood transfusion, a series of meticulous precautions are set in motion to uphold the quality of blood products, evaluate compatibility, and guarantee the safety of the recipient. These precautionary measures are integral to maintaining the integrity of the transfusion process and minimizing potential risks associated with the procedure. A significant milestone in global healthcare standards was achieved by 2012, with 70% of countries having implemented a national blood policy. This policy serves as a comprehensive framework outlining guidelines and regulations to govern the collection, processing, testing, storage, and distribution of blood and blood products. Such policies are instrumental in establishing standardized procedures that contribute to the overall safety and efficiency of blood transfusion practices. Moreover, a substantial 69% of countries had enacted specific legislation addressing safety and quality standards related to blood transfusions. These legal frameworks set forth stringent requirements and protocols, ensuring that blood transfusion services adhere to the highest standards of safety, quality, and ethical conduct. The existence of legislation underscores the commitment of these countries to safeguarding the health and well-being of individuals receiving blood transfusions, while also establishing accountability within the healthcare system.

Blood for transfusion can be sourced either from the potential recipient through autologous transfusion or from another individual through allogeneic or homologous transfusion, with the latter being more prevalent. In the case of allogeneic transfusion, the process typically initiates with blood donation, a crucial step that forms the backbone of the blood supply chain. Blood is commonly donated as whole blood, collected intravenously, and mixed with an anticoagulant to prevent clotting during the collection process.[4,5] In developed countries, blood donations are often conducted anonymously, meaning the donor's identity is not disclosed to the recipient. However, despite this anonymity, each blood product in a blood bank undergoes meticulous traceability throughout its entire lifecycle. This traceability extends from the collection and testing phases to the separation into components, storage, and eventual administration to the recipient. Such comprehensive tracking systems enable the management and investigation of any suspected cases of transfusion-related disease transmission or transfusion reactions, ensuring a high level of accountability and safety in the transfusion process. In contrast, in less developed countries, donors are sometimes specifically recruited for or by the recipient, particularly when the donor is a family member.[6] In these instances, the donation often takes place immediately before the planned transfusion, highlighting the practical challenges and differences in blood procurement methods across varying healthcare systems. This underscores the need for flexibility in blood procurement strategies to adapt to the specific circumstances and resources available in different regions.A notable aspect of blood donation and transfusion safety is the ongoing research into contamination reduction techniques. One such area of investigation involves evaluating the effectiveness of using an alcohol swab alone versus an alcohol swab followed by an antiseptic. The clarity on which method is more effective in reducing contamination in the donor's blood is yet to be conclusively established, underlining the importance of ongoing research and advancements in transfusion medicine to enhance the safety and efficacy of blood transfusions globally. As technology and scientific understanding evolve, continuous improvements in blood procurement, processing, and transfusion practices are crucial to ensuring the highest standards of safety for both donors and recipients.[7] These global efforts to establish national policies and legislation highlight a collective commitment to enhancing the safety and quality of blood transfusions on an international scale. By fostering a regulatory environment that prioritizes these critical aspects, countries contribute to the overall reliability of blood transfusion services, instilling confidence in both healthcare professionals and the general population. This concerted approach reflects a dedication to public health and underscores the ongoing evolution of transfusion medicine to meet the highest standards of safety and efficacy. The recognition that an individual can be a healthy carrier of an infection underscores the critical importance of rigorous screening of blood products before transfusion. If the blood or its components from such carriers are transfused to another person, there is a risk of contributing to the overall prevalence of the infection within the population. This scenario not only poses a direct threat to individual health but can also have indirect consequences, potentially imposing an economic burden on the country's healthcare system as a result of increased disease prevalence and

associated medical costs. Therefore, meticulous screening of blood products becomes an imperative step in preventing the inadvertent spread of infections through blood transfusions. The focus of the current study is to assess the seroprevalence of transfusion-transmitted infections among blood donors in a specific region. This research aims to provide a comprehensive understanding of the prevalence of infections in the donor population, forming the basis for informed decisions and interventions. By evaluating the prevalence of infections, the study seeks to contribute valuable insights that can guide the strict implementation of national guidelines for safe blood transfusion in the identified area.[8]The ultimate goal of such an investigation is to enhance the safety of blood transfusions, ensuring that the blood supply is free from potentially harmful infections. Strict adherence to national guidelines not only protects the health of individual recipients but also plays a crucial role in safeguarding public health at large. The findings from this study can serve as a foundation for targeted interventions, improved screening protocols, and enhanced blood safety measures in the region. This proactive approach aligns with the broader objectives of public health initiatives, promoting a healthier population and mitigating the economic repercussions associated with transfusion-transmitted infections. Moreover, the study's emphasis on seroprevalence underscores the importance of understanding the prevalence of antibodies to infectious agents in the donor pool. This information can be instrumental in identifying trends and patterns that may influence the design of targeted screening tests.[9] Additionally, the research contributes to the ongoing discourse on the development and refinement of screening protocols, encouraging a continuous improvement cycle in blood safety practices. Ultimately, such initiatives not only protect individual recipients but also contribute to the collective well-being of the community, fostering a healthcare system that prioritizes prevention and safety.

MATERIALS AND METHODS

The present study was conducted at the Blood Bank of the Department of Pathology over a span of one year, with ethical approval granted by the Institutional Ethics Committee of the current institution /This hospital-based cross-sectional study aimed to comprehensively investigate and analyze the blood donation patterns within the institution. The study enrolled a total of 1443 donors, encompassing both voluntary and replacement donors. The selection of donors for phlebotomy adhered to the established working strategy of the blood bank. Rigorous procedures were in place, involving thorough history-taking and physical examinations for all potential donors. The inclusion criteria followed a standard protocol, ensuring that only voluntary and replacement donors deemed healthy were included in the study. Donors who were found to be ineligible based on predetermined criteria were excluded from participation. This stringent approach to donor selection aimed to maintain the integrity of the study's data by focusing on individuals whose health status met the necessary standards.

Written informed consent was obtained from each donor, emphasizing the ethical considerations and respect for donor autonomy. This step was crucial in ensuring that participants were fully aware of the study's objectives, procedures, and potential risks, and they willingly agreed to contribute to the research. The actual sample collection procedures were carried out meticulously, adhering strictly to the study protocol. This phase involved the collection of blood samples from each participant, following standardized and aseptic techniques. The systematic approach to sample collection aimed to obtain reliable and accurate data for subsequent analysis. Overall, the study's design, ethical approval, donor selection criteria, and sample collection procedures collectively reflect a methodologically sound and ethically responsible approach to investigating blood donation patterns at the specified institution. The data collected from this study are likely to contribute valuable insights into the donor demographics, health status, and adherence to safety protocols, ultimately informing future strategies for optimizing blood donation practices.

SAMPLE COLLECTION

A labeled pilot tube was used to collect 3.0 ml of blood from the tubing of a donor bag. Subsequently, the collected blood was centrifuged for 5 minutes at 2500 rpm to obtain clear, non-hemolyzed serum. This serum underwent testing for HIV, HBV, HCV, Syphilis, and Malaria in accordance with standard protocols. For the testing of HIV, HBV, and HCV, ELISA kits, along with a semi-automated ELISA washer and reader, were employed. ELISA is a qualitative assay based on the principle of Sandwich ELISA. The testing for Syphilis utilized Rapid test strips, a qualitative membrane-based immunoassay designed to detect Treponema pallidum antibodies (IgG and IgM) in whole blood, serum, or plasma. Additionally, the Rapid Malaria Ag card was utilized for malaria testing. This test is based on chromatographic immunoassay for the qualitative determination of malarial parasites in a blood sample. The collected data was entered into Microsoft Excel and analyzed using the Statistical Package for the Social Sciences (SPSS) software.

RESULTS

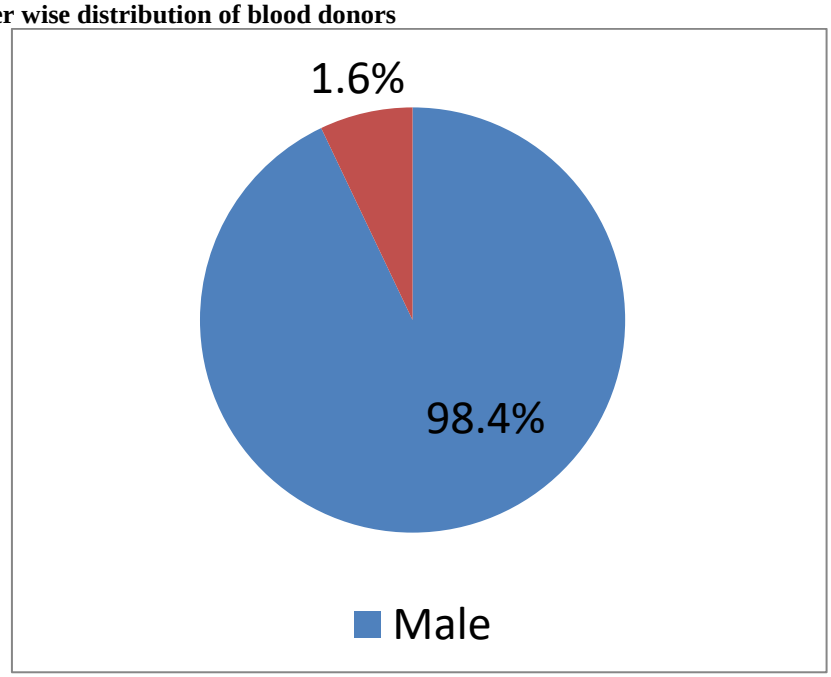
In the study, a total of 1443 donor blood units underwent screening for HIV, HBV, HCV, Syphilis, and Malaria. The donors' ages ranged from 18 to 60 years, with the majority (1297 donors or 89.9%) falling within the 2nd and 3rd decades of life, constituting 61.4% and 28.5%, respectively. Among the 1443 donors, 1419 (98.4%) were males, while

only 24 (1.6%) were females, resulting in a male-to- female ratio of 61.7:1. (Table 1)

Table 1: Gender wise distribution of blood donors

Gender	Blood units screened (n)	Percentage (%)
Male	1419	**98.4%**
Female	24	**1.6%**
Total	**1443**	**100%**

Figure 1: Gender wise distribution of blood donors

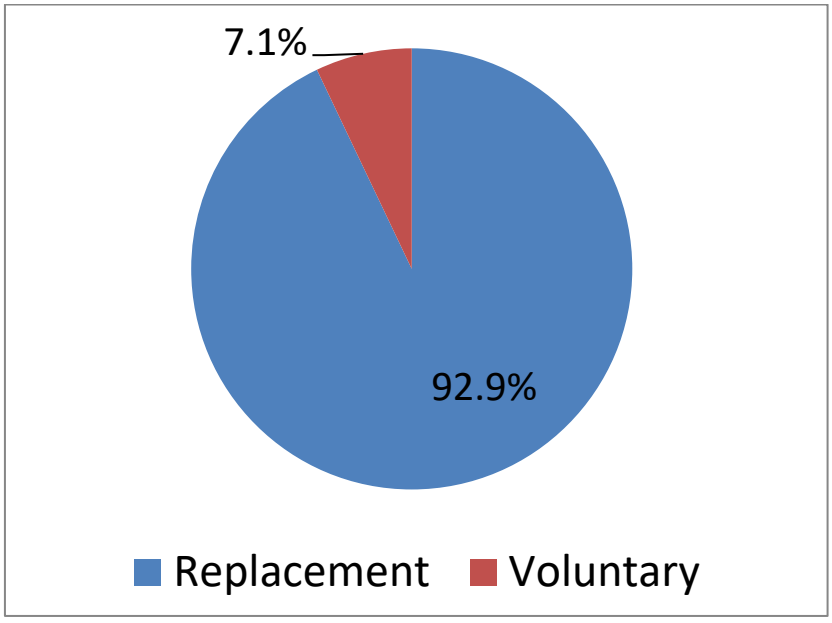


Among the 1443 blood donors, 1341 individuals (92.9%) were categorized as replacement donors, while the remaining 102 individuals (7.1%) were classified as voluntary donors (refer to Table 2).

Table 2: Categorization of blood donors

Donor	Blood units screened (n)	Percentage (%)
Replacement	1341	**92.9%**
Voluntary	102	**7.1%**
Total	**1443**	**100%**

Figure 2: Categorization of blood donors



The prevalence rate of transfusion-transmitted infections (TTI) was 4.71%, with 67 units testing seropositive out of the 1443 screened blood units. Among the 67 seropositive units, 61 units (4.73%) were from replacement donors, while 6 units (4.4%) belonged to voluntary donors .

Table 3: Seroprevalence of TTI in voluntary and replacement donors

Type of donors	No. of donors		No. of seropositivity	
	(n)	(%)	(n)	(%)
Voluntary	102	7.1	06	4.4
Replacement	1340	92.9	61	4.73
Total	1443	100	67	4.71

The seroprevalence rates for HIV, HBV, HCV, and Syphilis were observed to be 0.12%, 1.69%, 2.12%, and 0.71%, respectively (refer to Table 4). Notably, there were no instances of Malaria seropositivity among the screened blood donors. Additionally, out of the 1443 blood units screened, no cases of co-infection were identified.

Table 4: Seroprevalence of HIV, HBV, HCV and Syphilis in voluntary and replacement donors

Donor	No.	HIV		HbsAg		HCV		Syphilis	
		(n)	(%)	(n)	(%)	(n)	(%)	(n)	(%)
Voluntary	06	00	(0%)	02	(1.95%)	02	(1.95%)	01	(0.48%)
Replacement	61	02	(0.15%)	23	(1.71%)	29	(2.16%)	09	(0.70%)
Total	67	02	(0.13%)	25	(1.73%)	31	(2.14%)	10	(0.69%)

DISCUSSION

In developed nations, the prevalence of transfusion-transmitted infections (TTI) has markedly decreased in recent decades, thanks to effective preventive measures.[10] However, the situation contrasts in developing countries, such as India, where the delayed initiation of the National Policy for Blood Transfusion Services has been identified as a contributing factor. This study sheds light on the blood donation landscape in the region, revealing that a significant 92.9% of donors were replacement donors, while only 7.1% were voluntary donors. The predominance of replacement donors may be attributed to misconceptions and fears associated with blood donation, indicating a critical need for health education and awareness programs in the area. Efforts to dispel myths and alleviate fears could potentially encourage more voluntary donations, contributing to a safer and more sustainable blood supply. The study also assessed the seroprevalence of various infections, revealing rates of 0.12% for HIV, 1.69% for HBV, 2.12% for HCV, and 0.71% for Syphilis.[11] Remarkably, no cases of Malaria were reported among the donors. HIV posed a significant challenge, with a seroprevalence of 0.13% (2 cases), both identified in replacement donors. Interestingly, none of the voluntary donors tested positive for HIV, though the difference in seroprevalence between replacement and voluntary donors was not statistically significant. This discrepancy underscores the potential benefits of promoting 100% voluntary donations, as evidenced by the absence of seropositive cases among voluntary blood units.The study also highlights the screening strategy employed in India, following WHO strategy 1 for HIV screening. A negative test result is considered indicative of an HIV-free blood unit, while reactive results prompt the discarding of the blood unit. Additionally, donors are directed to Voluntary Counselling and Testing Centers (VCTC) for counseling, emphasizing a holistic approach to donor care beyond the mere identification of infections. In conclusion, the findings from this study underscore the importance of addressing the prevailing misconceptions surrounding blood donation in the region, promoting voluntary donations, and refining screening strategies to enhance the safety of the blood supply. Implementing robust health education initiatives and advocating for increased voluntary donations could contribute significantly to reducing the prevalence of transfusion-transmitted infections in developing countries like India. By fostering a culture of voluntary donation and ensuring effective screening processes, there is potential for substantial improvements in blood safety and public health outcomes.[12]The study rigorously adhered to the guidelines recommended by the World Health Organization (WHO), ensuring a standardized and internationally recognized approach to the research. The findings regarding Hepatitis B Virus (HBV) seroprevalence revealed that 25 blood units (1.73%) tested positive for HBV, with 23 cases (1.59%) originating from replacement donors and 2 cases (0.13%) from voluntary donors. This resulted in HBV seroprevalence rates of 1.86% and 1.70%, respectively. The provision of post-test counseling to Hepatitis B surface antigen (HbsAg)-positive donors reflects a responsible and comprehensive approach, guiding them toward immunization and recommending the screening of family members for preventive measures. Furthermore, the study indicated a 2.14% seroprevalence of Hepatitis C Virus (HCV), with 31 out of 1443 blood units testing positive for HCV. The seroprevalence rates among replacement and voluntary donors were 2.16% and 1.96%, respectively, with no statistically significant difference observed between the two groups. The study reported HCV seroprevalence rates of 1.0% and 1.02% among replacement and voluntary donors,

respectively.[13] Given the relatively high seroprevalence of HCV among blood donors, the study emphasizes the need for community-based health education initiatives. These initiatives could play a crucial role in raising awareness about Hepatitis C, its transmission, and preventive measures, ultimately contributing to a reduction in the prevalence of HCV among blood donors and the broader community. In summary, the study's adherence to WHO guidelines, detailed reporting of seroprevalence rates for HBV and HCV, and the implementation of post-test counseling for positive cases collectively contribute to the robustness of the research. The identified seroprevalence rates underscore the importance of ongoing health education efforts to mitigate the transmission of Hepatitis B and C in the community and enhance the overall safety of blood transfusions. By combining accurate data collection with targeted interventions, there is potential for significant strides in preventing and managing these infections within the context of blood donation practices. The study brings attention to a notable and consistent reduction in the prevalence rate of Syphilis in India over the years. This decline is particularly striking, with the Syphilis prevalence decreasing from 10.4% in the period of 1977-1985 to 2.5% in 1995-1996.[14] The current work continues to reflect this positive trend, reporting a further reduction in Syphilis seroprevalence to 0.69%. Such a decline is indicative of successful public health interventions, increased awareness, and improved screening practices, contributing to a safer blood supply in the region.[15]The study also highlights the low prevalence of Malaria among blood donors, with no cases detected in the screened donors. This is a significant finding, especially considering the potential risks of post-transfusion Malaria, particularly in endemic areas. In regions where Malaria is prevalent, screening for the parasite is crucial to prevent transfusion-related cases, which can be particularly problematic for vulnerable populations such as pregnant women and immunodeficient patients. The absence of Malaria cases among the screened blood donors in this study underscores the effectiveness of screening measures in place, contributing to the overall safety of the blood supply. Moreover, the findings emphasize the importance of implementing guidelines for chemoprophylaxis in recipients, particularly in areas where Malaria is endemic.[16] Chemoprophylaxis can serve as an additional layer of protection against the transmission of Malaria through blood transfusions, further safeguarding the health of recipients, especially those who may be more susceptible to the adverse effects of the disease. In conclusion, the study's observations regarding the declining prevalence of Syphilis and the absence of Malaria cases among blood donors demonstrate positive trends in the safety of the blood supply in India. These findings also highlight the need for continued vigilance, adherence to screening protocols, and the implementation of preventive measures to ensure the ongoing improvement of blood transfusion safety in the region. The success achieved so far underscores the potential for sustained efforts to yield positive outcomes in maintaining a secure and reliable blood supply for medical interventions.

CONCLUSION

A consistent decline in the incidence of transfusion-transmitted infections (TTI) has been observed with the introduction of mandatory testing of blood units. Despite this improvement, the risk may not be entirely eliminated, as donors may be in the window period, potentially transmitting infections. To further minimize TTI, there is a crucial need to rigorously implement donor selection guidelines and apply sensitive screening tests. Simultaneously, encouraging the younger population to actively participate in voluntary blood donation can contribute significantly to enhancing the safety and availability of blood. This dual approach, combining stringent donor selection protocols with increased voluntary blood donation, plays a vital role in reducing the risk of transfusion-transmitted infections.

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