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PREVALENCE AND TRENDS OF TRANSFUSION-TRANSMITTED INFECTIONS IN VOLUNTEER BLOOD DONORS OF ISLAMABAD AND RAWALPINDI: A RETROSPECTIVE STUDY

Original Research

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ABSTRACT

Background: Blood transfusion remains a cornerstone of modern medicine, yet it carries an inherent risk of transmitting infectious diseases. Regular surveillance of transfusion-transmitted infections (TTIs) among blood donors is essential to ensure transfusion safety and to inform public health strategies. In Pakistan, despite advancements in donor screening, TTIs continue to pose a challenge, reflecting underlying epidemiological and healthcare gaps that warrant continuous monitoring and policy reinforcement.

Objective: This study aimed to assess the prevalence and distribution trends of major transfusion-transmissible infections—hepatitis B virus (HBV), hepatitis C virus (HCV), human immunodeficiency virus (HIV), and *Treponema pallidum* (syphilis)—among voluntary, non-remunerated blood donors in Islamabad and Rawalpindi.

Methods: A retrospective cross-sectional study was conducted at the Pakistan Red Crescent Society from October 2024 to May 2025. Data from 9,213 voluntary donors aged 18–60 years were analyzed. Donor demographic details, including age and gender, were obtained from institutional records. Screening for HBV, HCV, HIV, and syphilis was performed using electrochemiluminescence immunoassay (ECLIA) technology on the Roche Cobas e411 analyzer, following standard manufacturer and quality control protocols. All data were reviewed for completeness, and infection prevalence was calculated as proportions of total donations.

Results: Out of 9,213 donors, 9,121 (99.0%) were male and 92 (1.0%) were female. A total of 362 donors (3.93%) were reactive for at least one TTI. HCV was the most prevalent infection (1.58%, n=146), followed by HBV (1.38%, n=127), syphilis (1.03%, n=95), and HIV (0.14%, n=13). No co-infections were detected, and all positive cases were male. The highest infection rates were observed among donors aged 18–34 years.

Conclusion: The persistence of TTIs among voluntary donors highlights an ongoing public health concern in Pakistan. Strengthening donor selection, enhancing screening sensitivity, promoting immunization coverage, and improving community awareness are imperative for maintaining a safe blood supply and reducing transfusion-related risks.

Keywords: Blood donors, HBV, HCV, HIV, Pakistan, Syphilis, Transfusion-transmitted infections, Voluntary donation.

INTRODUCTION

Blood transfusion is a vital medical procedure involving the intravenous administration of whole blood or specific components—such as red blood cells, platelets, plasma, or cryoprecipitate—from a donor to a recipient (1). It remains indispensable in managing a wide range of medical conditions, including major trauma, complex surgeries, and hematologic disorders. Despite its life-saving potential, transfusion carries inherent risks, most notably the transmission of infectious agents collectively termed transfusion-transmitted infections (TTIs). Globally, pathogens such as *Treponema pallidum* (syphilis), hepatitis B virus (HBV), hepatitis C virus (HCV), and human immunodeficiency virus (HIV) continue to threaten blood safety (2,3). The occurrence of TTIs is multifactorial, influenced by donor-related factors, procedural safeguards, and systemic blood safety measures. Among these, the type of donor and the quality of screening protocols are of particular concern. Evidence consistently shows that Voluntary Non-Remunerated Blood Donors (VNRDs) present a lower infection risk compared with family or replacement donors, who may conceal risk factors under social pressure (4,5). Furthermore, in many resource-limited countries, the lack of highly sensitive diagnostic tools such as Nucleic Acid Amplification Testing (NAT) prolongs the "window period" between infection and detection, thereby heightening the possibility of infected donations entering the supply (6). While high-income countries have significantly reduced the residual risk of TTIs through routine NAT and stringent serological screening, low- and middle-income countries (LMICs) continue to face disproportionate challenges due to limited infrastructure, inconsistent donor screening, and inadequate surveillance systems (7). In Pakistan, this disparity remains evident. A multicenter retrospective study analyzing data from 2016 to 2020 reported an overall TTI seroprevalence of 3.6%, with HCV being the most prevalent pathogen (8).

Similarly, northern regional analyses have echoed these findings, identifying HCV as the dominant infection among donors (9). More recent data from Malakand Division (2021–2024) revealed a 2.42% overall TTI prevalence among 94,000 donors, with a worrying uptick in HIV and syphilis cases, indicating an evolving epidemiological landscape (10). A systematic review in 2022 further confirmed that Pakistan's pooled HCV prevalence among blood donors remains higher than that of most Asian countries, underscoring the persistence of this public health concern (11). Collectively, these findings highlight that TTIs among blood donors in Pakistan remain a pressing challenge, with trends suggesting dynamic changes in infection patterns—particularly the rising incidence of HIV and syphilis. This calls for sustained surveillance, stronger donor recruitment systems prioritizing voluntary donors, and the expansion of advanced screening technologies. Moreover, as voluntary donors represent a relatively healthy and traceable segment of the population, their infection patterns can serve as an early indicator of broader community-level disease dynamics. This study aims to determine the prevalence and temporal trends of major TTIs—HBV, HCV, HIV, and syphilis—among voluntary blood donors in the Islamabad–Rawalpindi region. It further seeks to analyze annual variations, donor demographics, and emerging epidemiological markers to inform public health interventions, refine donor recruitment strategies, and strengthen national blood safety policies in Pakistan.

METHODS

This study was designed as a retrospective cross-sectional analysis conducted at the Pakistan Red Crescent Society, utilizing blood donation records from voluntary donors in Islamabad and Rawalpindi. The study period spanned from October 2024 to May 2025. Ethical approval was obtained from the Institutional Review Board (IRB) of Riphah International University and all procedures were performed in accordance with the ethical principles of the Declaration of Helsinki. Confidentiality of donor data was strictly maintained, and informed consent had been obtained from all participants at the time of donation as part of the institutional donor protocol. Eligible participants included voluntary, non-remunerated blood donors aged 18–60 years who met the World Health Organization (WHO) criteria for blood donation and had successfully completed the standard pre-donation screening process during the study period. Donors were excluded if they had incomplete demographic or screening data, were identified as replacement or paid donors, or disclosed any chronic medical condition, recent transfusion history, or high-risk behavior inconsistent with WHO donor selection guidelines. Data were extracted from the centralized blood bank database, encompassing a total of 9,213 voluntary donors. Demographic characteristics such as age, sex, and donation frequency were recorded. Laboratory screening data for major transfusion-transmissible infections—hepatitis B virus (HBV), hepatitis C virus (HCV), human immunodeficiency virus (HIV), and *Treponema pallidum* (syphilis)—were obtained and analyzed. All samples were processed and tested using the Enzyme-Linked Immunosorbent Assay (ELISA) technique on

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a Roche Cobas e411 automated analyzer. The testing protocol followed the manufacturer's specifications, with rigorous internal quality control (QC) procedures applied prior to and during testing to ensure accuracy and reproducibility of results. Each donor sample was first centrifuged for 10 minutes at 5000 rpm to separate serum from the gel vial. After verifying QC performance, the serum was loaded into racks containing Hitachi sample cups for automated processing on the Cobas e411 platform, which operates based on the principle of electrochemiluminescence immunoassay (ECLIA). Upon completion of the reaction cycle, results were electronically documented and cross-verified by senior laboratory technologists for validity. The data were subsequently compiled for statistical evaluation, where seroprevalence rates of each TTI were calculated as proportions of total donations. Descriptive statistics were performed to summarize donor demographics and infection rates, and comparative analysis was intended to assess yearly and categorical variations.

RESULTS

A total of 9,213 voluntary blood donors were analyzed in this study. The overwhelming majority were male (99.0%, n = 9,121), while female donors accounted for only 1.0% (n = 92), reflecting a significant gender imbalance in voluntary blood donation patterns. The participants ranged in age from 18 to 60 years, with a prominent representation of younger adults. The most frequent donors were aged 18–24 years (31.4%, n = 2,865), followed by those aged 25–34 years (27.2%, n = 2,510). Participants aged above 55 years comprised only 9.1% (n = 838), demonstrating a declining participation rate with increasing age Out of 9,213 blood donations screened, 362 donors (3.93%) were found positive for at least one transfusion-transmitted infection (TTI). Among these, *Hepatitis C virus* (HCV) was the most prevalent (1.58%, n = 146), followed by *Hepatitis B virus* (HBV) (1.38%, n = 127), *Treponema pallidum* (syphilis) (1.03%, n = 95), and *Human immunodeficiency virus* (HIV) (0.14%, n = 13). No donor was found positive for more than one infectious marker. Notably, all cases of infection occurred among male donors; none of the female donors tested positive for any TTI. When analyzed by age group, the 25–34-year category exhibited the highest incidence of infections across all TTIs. In this group, 57 cases of HBV, 69 of HCV, and 45 of syphilis were reported, followed by the 18–24-year category, which recorded 31 cases of HBV, 22 of HCV, and 27 of syphilis. The lowest infection rates were observed among donors older than 55 years, who demonstrated minimal or no positivity for the tested infections. These findings suggest a greater susceptibility or exposure risk among younger adults compared to older donors.

Table 1: Prevalence of Transfusion-Transmitted Infections among Voluntary Blood Donors (N = 9,213)

Infection	Positive cases (n)	Prevalence (%)
HCV	146	1.58%
HBV	127	1.38%
Syphilis	95	1.03%
HIV	13	0.14%
Total TTIs	362	3.93%

Table 2: Age-Wise Distribution of Transfusion-Transmitted Infections in the Voluntary Blood Donors

Age Group	HIV	HBV	HCV	Syphilis
18-24	6	31	22	27
25-34	2	57	69	45
35-44	4	23	48	17
45-54	1	10	7	6
>55	0	6	0	0

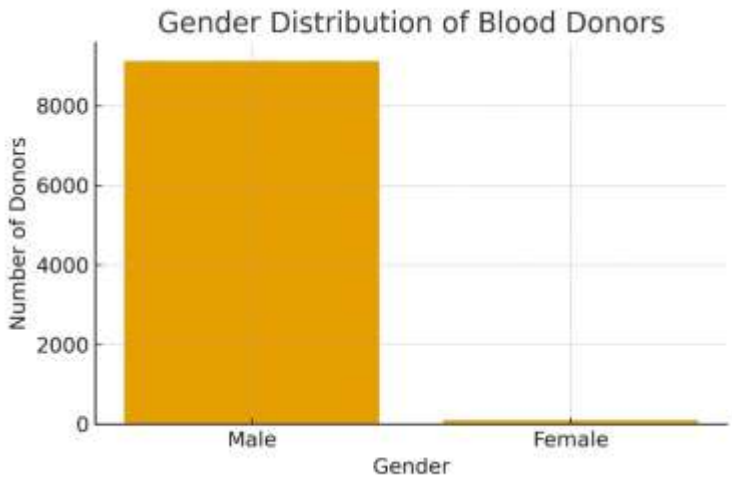

Figure 1 Gender Distribution of Blood Donors

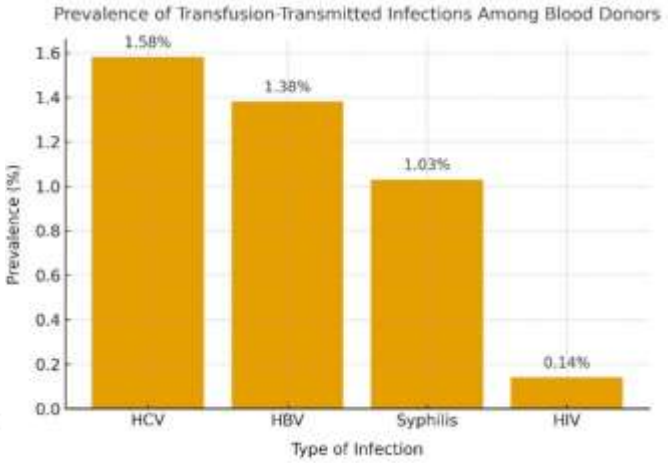

Figure 2 Prevalence of Transfusion-Transmitted Infections Among Blood Donors

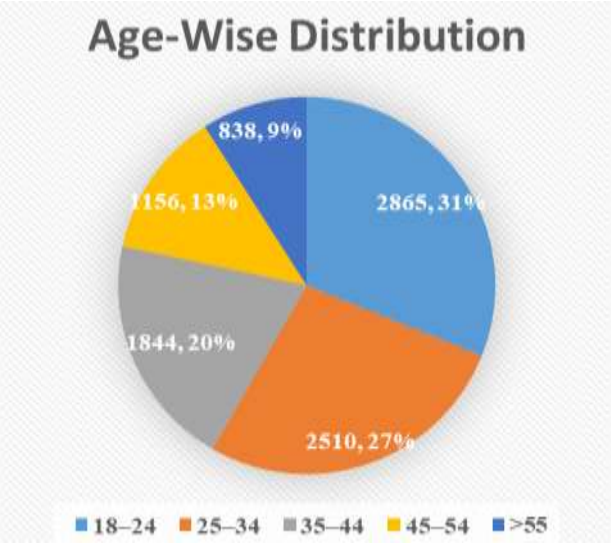

Figure 1 Age-Wise Distribution

DISCUSSION

This study assessed the frequency and distribution of transfusion-transmitted infections (TTIs) among voluntary, non-remunerated blood donors in Islamabad and Rawalpindi using retrospective serological data from 9,213 donations. The findings underscore critical patterns in donor demographics and infection prevalence that have important implications for transfusion safety and public health surveillance in Pakistan. A striking observation was the overwhelming predominance of male donors, who accounted for 99% of all donations, while only 1% were contributed by females. This gender disparity mirrors the sociocultural and systemic barriers that restrict women's participation in blood donation, including health misconceptions, familial discouragement, and logistical challenges. Similar gender distributions have been reported in other regional studies conducted in Pakistan, where over 95% of blood donors were male (12,13). The resulting reliance on male donors may reduce donor diversity and limit the sustainability of the national blood supply. Increasing female participation through culturally sensitive awareness campaigns and safe donation environments could therefore serve as a valuable intervention for strengthening donor base stability. The age distribution of donors demonstrated that younger adults, particularly those aged 18–34 years, formed the backbone of the voluntary donor population. Approximately 58.6% of donations originated from this age group, indicating an encouraging trend toward youth participation. This pattern has also been reflected in studies from other regions, such as South America, where young adults dominate donor pools (14,15). However, the gradual decline in donations with

advancing age suggests that retention strategies for older donors are needed to maintain long-term supply continuity. The prominence of young donors also highlights the importance of targeted education about safe health practices and infection prevention within this age group, given their higher likelihood of exposure to community-based risk factors. The overall TTI prevalence in the present study was 3.93%, with HCV emerging as the most prevalent infection (1.58%), followed by HBV (1.38%), syphilis (1.03%), and HIV (0.14%). These results correspond closely with previous national data indicating HCV as the leading transfusion-transmissible pathogen among Pakistani donors (16,17). The comparatively lower rates of HIV and syphilis are encouraging but should not be misconstrued as negligible threats, as both infections demonstrated increasing trends in other recent local studies. In contrast, some neighboring countries report comparatively lower TTI prevalence, such as 1.46% in voluntary donors in India, where HBV predominates (18). These interregional differences likely reflect disparities in community infection burden, donor selection criteria, and diagnostic capacity.

The high prevalence of HBV and HCV observed in this study aligns with long-recognized endemicity of viral hepatitis in Pakistan, largely attributed to unsafe medical practices such as reuse of syringes, poor sterilization of medical instruments, and transfusions from inadequately screened donors (19). Although national immunization programs have reduced HBV prevalence among children, adult donor populations remain vulnerable. The persistence of HCV transmission, in particular, underscores the absence of a vaccine and the need for continued community-level interventions. The detection of syphilis in over 1% of donors is equally concerning, as it indicates ongoing community transmission of this sexually transmitted infection, which carries both reproductive and transfusion-related implications. Age-specific analysis revealed that the 25–34-year age group exhibited the highest frequency of all TTIs, particularly HCV and syphilis. This concentration of infections among younger and middle-aged men may be linked to increased social mobility, higher occupational exposure, and engagement in healthcare or community settings where unsafe practices persist. In contrast, the near absence of infections in donors over 55 years may reflect reduced exposure to such risks or generational differences in medical practices. Comparable age-related trends have been reported in prior epidemiological research, further validating this association (20,21). The combined TTI rate in this study (3.93%) was markedly higher than that reported in high-income countries, where residual risk has been minimized to below 0.01% through advanced screening methods such as Nucleic Acid Amplification Testing (NAT) and strict donor selection protocols (16,22). However, similar rates have been observed in other low- and middle-income countries, including Brazil (4.04%) and Ethiopia (11.5%), highlighting that Pakistan faces a shared challenge in achieving a safe and sustainable blood supply (17,23). The findings thus emphasize the urgent need for upgrading blood screening technologies, enforcing standardized national donor registries, and expanding NAT coverage in all major blood centers to shorten the diagnostic window period and reduce transmission risk.

A notable strength of this study is the use of a large dataset encompassing thousands of voluntary donations across two major urban centers, which enhances representativeness and statistical reliability. The findings provide updated regional insight into TTI trends and identify key demographic patterns relevant to public health policy. However, certain limitations must be acknowledged. The retrospective nature of data collection may have introduced information bias due to incomplete or inaccurate record entries. The study relied solely on serological testing without confirmatory molecular assays, which could underestimate the true infection prevalence within the early seroconversion window. Additionally, the data were restricted to voluntary donors from specific centers, limiting generalizability to the national donor population and precluding inclusion of replacement or paid donors. Future studies should adopt multicenter, prospective designs incorporating molecular diagnostic techniques such as NAT to provide more accurate prevalence estimates. Including both voluntary and replacement donors would allow comparative analysis and yield insights into differential risk profiles. Expanding the demographic base to include more female donors and older adults could also enhance donor diversity and reduce dependency on limited male donor pools. Public health authorities should further integrate donor education, pre-donation counseling, and targeted awareness programs to reduce community-level transmission of TTIs and improve blood safety nationwide (24). In summary, this study revealed a 3.93% overall prevalence of transfusion-transmitted infections among voluntary donors, with HCV and HBV remaining the dominant pathogens. These findings reaffirm the persistent burden of TTIs in Pakistan and underline the importance of sustained surveillance, modernization of screening practices, and inclusive donor recruitment strategies to secure a safer national blood supply.

CONCLUSION

This study highlights that transfusion-transmitted infections remain a persistent concern among voluntary blood donors in Islamabad and Rawalpindi, with hepatitis viruses continuing to pose the greatest risk to blood safety. The predominance of infections among younger male donors underscores the need for more inclusive and targeted donor recruitment strategies, particularly involving women

and older adults. Although improved screening practices have reduced certain risks, the continued presence of infections such as syphilis indicates gaps in preventive and educational measures. Ensuring a safe and sustainable blood supply therefore requires not only advanced laboratory testing but also comprehensive public health interventions focused on donor education, vaccination, and community awareness to strengthen the overall integrity of the transfusion system in Pakistan.

AUTHOR CONTRIBUTION

Author	Contribution
Manzoor Ullah	Substantial Contribution to study design, acquisition and interpretation of Data Critical Review and Manuscript Writing Has given Final Approval of the version to be published
Mafia Arshad	Substantial Contribution to acquisition and interpretation of Data Has given Final Approval of the version to be published
Mehreen Azeem	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Hashmatullah Stanikzai	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Muhammad Atif	Substantial Contribution to study design and Data Analysis Has given Final Approval of the version to be published
Sheraz Ali	Contributed to study concept and Data collection Has given Final Approval of the version to be published
Ahtisham Mehmood Hadi	Writing - Review & Editing, Assistance with Data Curation
Ali Husnain*	Writing - Review & Editing, Assistance with Data Curation

REFERENCES

1. S. Jamal, N. Mansoor, A. Ali, A. Nadeem, J. Aijaz, and F. Meraj, “Degree of blood safety of voluntary non-remunerated versus replacement blood donations: A multi-centre study of the large cohort of blood donors from two provinces of Pakistan,” Vox Sang., vol. 118, no. 12, pp. 1078–1085, Dec. 2023.

2. J. P. Da Silva-Sampaio et al., “PREVALENCE OF TRANSFUSION-TRANSMISSIBLE INFECTIONS IN BLOOD DONORS FROM PIAUI STATE, NORTHEASTERN BRAZIL,” J. Infect. Public Health, p. 102988, Oct. 2025.

3. M. A. Rathore, A. J. Abbasi, I. A. Khuskh, T. Ghafoor, N. Sabir, and M. A. Rathore, “Trends of Transfusion Transmissible Infections among Predominantly Male Blood Donors in Rawalpindi: A Five-Year Retrospective Study,” Ann. King Edw. Med. Univ., vol. 30, no. 3, Sept. 2024.

4. “Prevalence and Association of Transfusion-Transmissible Infections with Age of Blood Donors: A Regional Transfusion Centre Study in Northern Pakistan,” J. Coll. Physicians Surg. Pak., vol. 33, no. 09, pp. 978–982, Sept. 2023.

5. "Trends in Voluntary and Replacement Blood Donors: Seroprevalence of Transfusion-Transmitted Infections in Malakand Division, 2021–2024," J. Coll. Physicians Surg. Pak., vol. 35, no. 10, pp. 1340–1344, Oct. 2025.

6. Y. Akbar Jamali, A. G. Noonari, A. B. Khuhro, Sanaullah Kalhoro, H. Shah, and A. G. Gad, "Prevalence of Hepatitis B and C in Pakistan from 2001 to 2022: A Systematic Review," J. Health Rehabil. Res., vol. 3, no. 2, pp. 316–325, Dec. 2023.

7. N. Saba et al., "Seroprevalence of Transfusion-Transmitted Infections among Voluntary and Replacement Blood Donors at the Peshawar Regional Blood Centre, Khyber Pakhtunkhwa, Pakistan," J. Lab. Physicians, vol. 13, no. 02, pp. 162–168, June 2021.

8. U. Aslam, A. Gohar, F. Ahmad, M. Hasan, and M. Nausherwan, "Transfusion Transmitted Infections in Blood Donors of Pakistan Red Crescent Lahore: A Mixed Method Study," Ann. King Edw. Med. Univ., vol. 23, no. 4, Dec. 2023.

9. S. Deshmukh, Y. Rathod, S. Thakore, and S. Jadhav, "Prevalence of Transfusion-Transmissible Infections among Voluntary Blood Donors in a Tertiary Care Hospital," Cureus, Sept. 2024.

10. M. M. Bhatti, A. Junaid, and F. Sadiq, "The Prevalence of Transfusion Transmitted Infections among Blood Donors in Pakistan: A Retrospective Study," Oman Med. J., vol. 37, no. 3, pp. e386–e386, May 2022.

11. Mwakasungula S, Rougeron V, Arnathau C, Boundenga L, Miguel E, Boissière A, et al. Using haematophagous fly blood meals to study the diversity of blood-borne pathogens infecting wild mammals. Mol Ecol Resour. 2022;22(8):2915-27.

12. Ashayeripanah M, Vega-Ramos J, Fernandez-Ruiz D, Valikhani S, Lun ATL, White JT, et al. Systemic inflammatory response syndrome triggered by blood-borne pathogens induces prolonged dendritic cell paralysis and immunosuppression. Cell Rep. 2024;43(2):113754.

13. Nury C, Blais MC, Arsenault J. Risk of transmittable blood-borne pathogens in blood units from blood donor dogs in Canada. J Vet Intern Med. 2021;35(3):1316-24.

14. Kandathil AJ, Cox AL, Page K, Mohr D, Razaghi R, Ghanem KG, et al. Plasma virome and the risk of blood-borne infection in persons with substance use disorder. Nat Commun. 2021;12(1):6909.

15. Sakr CJ, Alameddine R, Hoteit R, Daou C, Doudakian R, Kreidieh K, et al. Occupational Exposure to Blood-Borne Pathogens among Healthcare Workers in a Tertiary Care Center in Lebanon. Ann Work Expo Health. 2021;65(4):475-84.

16. Xie C, Chen S, Zhang L, He X, Ma Y, Wu H, et al. Multiplex detection of blood-borne pathogens on a self-driven microfluidic chip using loop-mediated isothermal amplification. Anal Bioanal Chem. 2021;413(11):2923-31.

17. Carter DJ, Riley B, Evans R, Rahmani A, Vogl A, Stratigos A, et al. The Legal Needs of People Living with a Sexually Transmissible Infection or Blood-Borne Virus: Perspectives From a Sample of the Australian Sexual Health and Blood Borne Virus Workforce. J Law Med. 2023;30(3):706-15.

18. Ji Y, Huang J, Jiang G, Liu Q, Xiao D, Deng J. Investigation of the occupational exposure to blood-borne pathogens of staff at a third-class specialist hospital in 2015-2018: a retrospective study. Sci Rep. 2022;12(1):1498.

19. Batcho EC, Miller S, Cover TL, McClain MS, Marasco C, Bell CS, et al. Inertial-based Fluidic Platform for Rapid Isolation of Blood-borne Pathogens. Mil Med. 2021;186(Suppl 1):129-36.

20. Escolar G, Diaz-Ricart M, McCullough J. Impact of different pathogen reduction technologies on the biochemistry, function, and clinical effectiveness of platelet concentrates: An updated view during a pandemic. Transfusion. 2022;62(1):227-46.

21. Manathunga T, Carbonara M, Nekouei O, Mendoza-Roldan JA, Tam WYJ, Beugnet F, et al. High prevalence of vector-borne pathogens in the blood of clinically healthy dogs in Hong Kong. Parasit Vectors. 2025;18(1):289.

22. Ivanović S, Trgovčević S, Jovanović MC, Kocić B, Milutinović S. The Cross-Sectional Study of attitudes towards risk factors of viral infections transmitted by blood-borne pathogens. Rev Esc Enferm USP. 2023;57:e20220097.

23. Xu Y, Yu B. Blood-borne viruses and neurological manifestations: An overview. Rev Med Virol. 2024;34(4):e2552.

24. Ale S, Hunter E, Kelleher JD. Agent based modelling of blood borne viruses: a scoping review. BMC Infect Dis. 2024;24(1):1411.