

Original Research Article

Prevalence of transfusion-transmitted infections among blood donors in Hodiedah City, West Yemen

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Abstract

Purpose: To investigate the prevalence of Human Immunodeficiency Virus (HIV), Hepatitis B virus (HBV), Hepatitis C virus (HCV), and Syphilis among blood donors at the National Blood Transfusion and Research Center in Hodiedah, Yemen.

Method: This was a retrospective study to analyze confirmatory test results for HBV, HCV, HIV, and syphilis among blood donor data from January 1, 2014, to December 31, 2015. Socio-demographic data and risk variables were gathered using a standardized questionnaire. Data were presented in frequencies and percentages and compared using Chi-square test. $P < 0.05$ was considered significant.

Results: From a total of 23,010 blood donors, a remarkable 22,896 (99.5 %) were male, while just 28 (0.5 %) were female. Furthermore, 240 (1.04 %) were infected, and 6 (0.03 %) were identified as having multiple illnesses (co-infections of HBV and syphilis). Prevalence rates of HBV, HCV, HIV, and Syphilis were 0.56 %, 0.12 %, 0.07 %, and 0.30 %, respectively.

Conclusion: There has been a significant rise in the number of individuals testing positive for HIV over the duration of the study. Although the overall prevalence of transfusion-transmitted diseases (TTIs) was negligible, it was imperative to conduct thorough screening of all blood units to guarantee the safety of transfusions.

Keywords: Transfusion-transmissible infections (TTIs), Hepatitis B virus, Hepatitis C virus, Human immunodeficiency virus, Syphilis, *Treponema pallidum*

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INTRODUCTION

Blood transfusion is a vital medical operation necessary for the treatment and management of

patients in diverse healthcare domains [1]. However, blood transfusions present possible hazards, including adverse hemolytic responses and spread of infectious diseases through

transfusion [2]. Transfusion-transmissible infections (TTIs) are transmitted through infected blood or its derivatives, leading to acute illnesses, chronic carrier states, or silent infections [3]. Transfusion-transmitted infections (TTIs), primarily hepatitis B virus (HBV), hepatitis C virus (HCV), human immunodeficiency virus (HIV), and syphilis caused by *Treponema pallidum* (TP) in blood donors, pose a significant risk to blood safety [4]. These infections pose a high risk as a result of high transmission rates and rapid spread through infected blood and sexual contact [5]. The prevalence rate of TTIs in low- and middle-income nations exceeds that of high-income countries, likely due to inadequate health services, poor hygiene practices, cultural influences, and constraints in detection methods [6]. Global statistics on the prevalence of TTIs in blood donations show a disparity linked to economic status, with higher rates observed in countries with lower economic indicators. For instance, global rates range from 0.1 % for HIV to 0.35 % for syphilis, while in lower-income settings, these rates rise to 0.992, 4.82, 1.577 and 1.96 % for HIV, HBV, HCV, and syphilis, respectively [7].

In Yemen, blood transfusion services are primarily administered by the National Blood Transfusion and Research Center and the National Center of Public Health Laboratories, supplied by the blood banks of public and private hospitals. Studies in Yemeni cities such as Sana'a, Aden, and Hodeidah indicated that HBV, HCV, and HIV constitute a significant concern among blood donors, and prevalence rates of HBV, HCV, HIV, and syphilis ranged from 2.1 % to 5.1 %, 0.79 % to 3 %, 0.34 % to 0.39 %, and 0.34 % to 0.75 %, respectively [8]. A study conducted in Hodeidah indicated that the rate of occurrence of TTIs among the population was found to be 2.35 %, 0.79 %, 0.14 %, and 0.34 % for HBV, HCV, HIV, and syphilis, respectively [9]. Analyzing TTIs, which encompass HIV, HBV, HCV, and syphilis, among donors allows for evaluation of the infection rates within the donor population and overall safety of blood donations [10]. Therefore, this study investigated the prevalence rate of Human Immunodeficiency Virus (HIV), Hepatitis B virus (HBV), Hepatitis C virus (HCV), and Syphilis among blood donors at the National Blood Transfusion and Research Center in Hodeidah, Yemen.

METHODS

Design

This retrospective study was conducted on data obtained from records of the National Blood

Transfusion and Research Center (NBTRC) Hodeidah Branch, Yemen, from January 1, 2014, to December 31, 2015. The study was a review of 23,010 blood donors who came to NBTRC for blood donation. The collected information encompassed donor names, genders, addresses, blood types, hemoglobin levels, donation dates, donation times, and results from screening tests for HBV, HCV, HIV, and Syphilis.

Subjects

The study included blood donors who met the criteria at the NBTRC - Hodeidah Branch in Yemen. While blood donors in Yemen are predominantly male, with female donors rare, donations are mostly semi-voluntary, involving friends and family members of patients. Voluntary donations are infrequent.

Inclusion criteria

According to NBTRC donor selection criteria, participants were eligible for blood donation if they were clinically fit, aged 18 to 60 years, weighed more than 45 kg, had hemoglobin levels above 12.5 g/dL, and had no remarkable medical or surgical history.

Exclusion criteria

The NBTRC donor selection criteria excluded individuals from blood donation if they were less than 18 years old, weighed less than 50 kg, had anemia, any sexually transmitted diseases, fever, chronic illnesses, jaundice within the past six months, engaged in drug abuse, were undergoing dialysis, or had donated blood within the last three months.

Ethical approval

Ethical approval was obtained from the Research Ethics Committee of Oswaldo Cruz Institute/FIOCRUZ (CONEP/Brazil; approval no. 363-06), Al-Thawra Hospital in Hodeidah, Hodeidah University, and the National Blood Transfusion and Research Center in Hodeidah. It complied with the Declaration of Helsinki [11].

In Yemen, written informed consent is routinely obtained from blood donors before blood donation, including permission to use their information for research purposes. For this study, the requirement for additional consent was waived because the study used existing blood donor records, including demographic data and screening test results, since it was a retrospective study.

Procedures

Data were collected retrospectively from NBTRC records. The protocol for NBTRC blood screening involved collection of 5 mL of venous blood from each donor into a sterile tube. The samples were centrifuged, and the separated serum was tested for serological markers of TTIs using rapid immunochromatographic assay (RICA) kits supplied by ABON Biopharm (Hangzhou) Co, Ltd, China.

Statistical analysis

The data were input using Excel 2010 and analyzed using Statistical Package for Social Science (SPSS Version 20) software to identify trends in HBV, HCV, HIV, and Syphilis infections during two years. This analysis was further based on gender, blood group, and the provinces from which the blood donors originated. Chi-square test was used to compare categorical variables. $P < 0.05$ was considered statistically significant.

RESULTS

Yearly prevalences of HBV, HCV, HIV, and syphilis

A total of 23,010 blood donors, consisting of 22,896 males and 28 females, were screened

over 2 years in a blood bank unit. Also, 240 males (1.04 %) were infected with at least one of the pathogens. Majority of the donors, 128 (0.56 %), were positive for HBV (Table 1).

Provincial prevalences of HBV, HCV, HIV, and syphilis

Blood donors came from four different demographic Yemeni regions, namely, Hodeidah urban areas, Hodeidah rural, Raymah, and the city of Sana. A total of 95 were found to be positive for infections. Hodeidah's urban area had the highest prevalence of HBV cases, accounting for 76.6 % of all positive cases. Similarly, the metropolitan area of Hodeidah had the highest number of cases for HCV, HIV, and syphilis. The distribution showed that Hodeidah urban area had the highest percentage of cases (75.1 %; Table 2).

Gender-based prevalences of HBV, HCV, HIV, and syphilis

The study revealed a significant gender disparity among blood donors, with males accounting for 99.9 % and females for just 0.1 %. Male individuals had much higher prevalence cases for HBV, HCV, HIV, and syphilis, but none of the female donors tested positive (Table 3).

Table 1: Yearly prevalence of HBV, HCV, HIV and syphilis in blood donors

Type	Year	Blood donors	Positive (N, %)	Total 2-year positive (N, %)	P-value
HBV	1 (2014)	12298	0.55(68)	Year 1(2014)	0.802
	2 (2015)	10712	0.57(60)	Year 2(2015)	
HCV	1 (2014)	12298	0.15(18)	Year 1(2014)	0.299
	2 (2015)	10712	0.09(10)	Year 2(2015)	
HIV	1 (2014)	12298	0.03(4)	Year 1(2014)	< 0.012
	2 (2015)	10712	0.11(12)	Year 2(2015)	
Syphilis	1 (2014)	12298	0.28(34)	Year 1(2014)	0.856
	2 (2015)	10712	0.32(34)	Year 2(2015)	

Table 2: Prevalence of HBV, HCV, HIV and syphilis according to provinces

Provinces	Number of subjects	HBV (128) N (%)	HCV (28) N (%)	HIV (16) N (%)	Syphilis (68) N (%)	P-value
Hodeidah Urban	15536	34(50)	8(50)	12(42.9)	66(51.6)	0.308
Hodeidah Rural	4954	26(38.2)	2(12.5)	4(14.3)	30(23.4)	
Raymah	186	2(2.9)	0(0)	2(7.1)	2(1.6)	
Sana'a	12	2(2.9)	0(0)	0(0)	0(0)	

Table 3: Gender-based prevalence of HBV, HCV, HIV and syphilis (N=240)

Gender	Number of subjects	HBV N (%)	HCV N (%)	HIV N (%)	Syphilis N (%)
Male	22896	128(53.3)	28(11.6)	16(6.6)	68(28.3)
Female	28	0(0)	0(0)	0(0)	0(0)

DISCUSSION

Identification of HBV, HCV, HIV, and syphilis relies on detection of the particular antigen or antibodies in blood serum [12]. The study utilized data from screening tests to determine the prevalence of these illnesses among blood donors at the National Blood Transfusion and Research Center, Hodeidah Branch, Yemen, between 2014 and 2015. Blood donation in Yemen predominantly involves male donors; female donors are rare. Donations are primarily semi-voluntary, with blood typically sourced from friends and relatives of patients, although voluntary donations are infrequent. The decline in blood donations between 2014 and 2015 in Hodeidah was primarily attributed to the ongoing war, which deterred patients from visiting local hospitals. Consequently, also resulted in a lower number of blood donors who typically come for regular donations, except in emergencies involving acute bleeding. Such emergencies, where there is a high demand for blood transfusions, are a common cause of death in war-torn areas. On September 21, 2014, the onset of the civil war in Yemen severely impacted the northern and western regions of the Hodeidah province, where this study was conducted. To assess the impact, data from before the war in 2014 and during the war in 2015 were analyzed. In 2014, as the study commenced, issues with data collection were evident in the blood bank records, with 10.1 % having incomplete demographic data.

Most donors came from urban Hodeidah, close to blood transfusion centers, followed by rural Hodeidah, where donations were mostly semi-voluntary, primarily from friends and family members of patients, with voluntary donations being rare. The vast majority of donors were men, accounting for 99.5 % of donations in Hodeidah, a figure that aligns with other local studies in Hodeidah (100 %) [9], but shows a slight decrease compared to Sana'a, which reported 95 % male donors [8]. Male predominance among blood donors is commonly reported in low- and middle-income countries. This is mainly attributed to the greater availability of men to donate blood for family members, friends, or neighbors in urgent need of transfusion, as well as higher likelihood of meeting donation eligibility criteria. On the other hand, female donors are very few in Yemen and constitute about 1 % of donors. That may be as a result of less availability and less awareness of the importance of blood donation. Although there have been notable advances in medicine, like the development of new generations of vaccinations, improved screening techniques, and effective

treatments, hepatitis B continues to be a prevalent viral disease and a substantial public health issue [12,13]. The World Health Organization predicts that the number of individuals with chronic hepatitis B will reach roughly 254 million by 2022, with an estimated 1.2 million new infections annually [14]. These infections are the main cause of approximately 1.1 million deaths, mostly due to cirrhosis and hepatocellular cancer [15]. This study found an HBV prevalence of 0.56 % among blood donors, which is lower than previous rates reported in Yemen, such as 2.35 % in Hodeidah [9] and 1.72 % in Sana'a [16], although among military personnel. This suggests improved blood donation procedures in Hodeidah and across Yemen. This good trend may be attributed to improvements in vaccination coverage and heightened public awareness. From 2014 to 2015, there was a little rise in the prevalence of HBV among individuals who donated blood, with the prevalence increasing from 0.55 % to 0.57 %. However, the observed change was not statistically significant, suggesting that the variance is likely a result of random fluctuations rather than any particular external influence, such as continuous violence.

Approximately 309 million individuals worldwide are affected by chronic hepatitis C virus (HCV) infections, and over 50 million people are currently afflicted. Every year, there are one million newly reported cases. The World Health Organization (WHO) predicts that hepatitis C will cause about 242,000 deaths in 2022, mostly due to cirrhosis and hepatocellular cancer [14]. Prevalence of HCV 312 among participants was lower compared to previous studies [9,16]. These findings agree with those reported in various other countries, including Iraq [18] and Namibia [19]. The HCV prevalence identified in this study is lower than prior regional findings. The variance might be attributable to differences in demographic characteristics, availability of healthcare facilities, or screening procedures in the different areas. It might also indicate advances in public health activities, such as more knowledge and perhaps better use of antiviral drugs that efficiently remove the virus.

The WHO in 2022 estimated that 630,000 HIV-related fatalities and 1.3 million new infections would affect the 39 million individuals living with HIV [20]. Prevalence of HIV in the Middle East is very low compared to global rates [21]. It is worth mentioning that blood transfusions account for around 1 % of newly acquired HIV infections [22]. Despite its limited sensitivity, the HIV Antibody RDT (Determine HIV-1/2) is mostly used to screen blood donors in Yemen, which may be

inadequate to avoid transfusion-transmissible HIV (TT-HIV) in hospital-based services [23]. Prevalence of HIV in this study was lower compared to previous studies [9,17]. The lower rate may be attributed, at least in part, to cultural and religious norms that impact sexual behavior in the area. A marked increase in HIV-reactive cases was observed, rising from 3 % in 2014 to 11 % in 2015 ($p < 0.05$). However, these findings should be interpreted with caution because screening relied primarily on rapid diagnostic tests without confirmatory follow-up testing. Therefore, the observed increase may reflect either a true rise in HIV-reactive donor cases or an increase in false-positive results associated with the prolonged use of RDTs. This finding highlights the major challenges faced by healthcare facilities in conflict settings, particularly regarding the reliability of HIV screening and maintenance of accurate transfusion safety practices.

Furthermore, the World Health Organization (WHO) estimated an annual worldwide prevalence of around 12 million new cases of syphilis, with Asia having the highest rates [24]. Syphilis is a highly infectious and chronic bacterial illness mostly caused by *Treponema pallidum* and other microorganisms. Primary modes of transmission include sexual intercourse, contact with blood, and vertical transfer from mother to child during pregnancy [25]. The study revealed that 0.3 % of blood donors had syphilis. This frequency is similar to Namibia [19] but far lower in other Sub-Saharan African countries such as Burkina Faso [26]. Differences in these inequalities may arise from variations in the sensitivity and specificity of tests, variations in preventative methods, efficacy of screening programs, criteria for selecting donors, and overall accessibility to healthcare. The impact of conflict on the frequency of syphilis among blood donors was assessed. These data showed a slight rise from 0.28 % in 2014 to 0.32 % in 2015 ($p > 0.05$). This implies that there may be more variables at play that are affecting syphilis rates, or that the war had a negligible effect on the spread of syphilis in this particular situation. The prevalence found in this study is lower compared to a previous study in Sana'a [17]. Variability in prevalences between these studies highlights the complex interplay of variables such as public health measures, levels of healthcare accessibility, cultural norms about sexual health, and regional economic circumstances.

Limitations of the study

The findings may not fully represent the true prevalence of HBV, HCV, HIV, and syphilis in the general community, since persons who are aware of their HIV positive status are unlikely to donate their blood. Although the prevalence of transfusion-transmissible illnesses (TTIs) among donors was low, it was necessary to thoroughly test each blood unit for these viruses, even at trace levels.

CONCLUSION

The study has shown that blood donors in Yemen often participate in low-risk behavior, resulting in a low prevalence of HIV, HBV, HCV, and syphilis among donors at the National Blood Transfusion and Research Centre (NBTRC) in Hodeidah. However, further studies are needed to confirm these findings, better understand the variables that led to the growing prevalence of HIV infection among blood donors and the general population, and develop ways to avoid future escalation.

DECLARATIONS

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Ethical approval

Ethical approval was obtained from the Research Ethics Committee of Oswaldo Cruz Institute/FIOCRUZ (CONEP/Brazil; approval no. 363-06), Al-Thawra Hospital in Hodeidah, Hodeidah University, and the National Blood Transfusion and Research Center in Hodeidah.

Use of Artificial intelligence/Large language models

The authors confirm that AI-based tools were used solely for language editing and manuscript polishing purposes (e.g., grammar, phrasing, and clarity). No AI tools were used to generate content, interpret data, or influence study design, results, or conclusions. All intellectual contributions, study analyses, and interpretations reported in the manuscript are the original work of the authors.

Availability of data and materials

The data presented in this study were obtained upon request. The information obtained directly from the National Blood Transfusion and Research Center in Hodeidah is not publicly available due to its confidential nature and must remain private in accordance with National Legislation.

Conflict of interest

No conflict of interest is associated with this work.

Contribution of authors

We declare that this work was done by the author(s) named in this article, and all liabilities pertaining to claims relating to the content of this article will be borne by the authors. Faisal M Awadh: Conceptualization, methodology, validation, formal analysis, investigation, resources, data curation, writing- review and editing, visualization, supervision, and project administration. Hassan AS Yousef: Methodology, software, validation, formal analysis, investigation, data curation, writing-original draft, writing-review and editing, and visualization. Anwar AM Abdu: Methodology, software, writing-original draft, writing-review and editing, and funding acquisition. Fawze Alnadari: Writing, review and editing, and visualization. Zakarya AA Abdullah: Writing, reviewing, editing, and visualization. Tameem AAA Shareef: Writing—review and editing, and visualization. Ammar AA Ebrahim: Writing, reviewing, editing, and visualization. Roqaia AHH Salam: Writing, reviewing, editing, and visualization. Adel MAZ Wahan: Software, investigation, data curation, writing, review, and editing. Maged YM Sabri: Resources and data curation. Abdulmajid AA Ali: Software, investigation, and data curation. All authors have read and approved the final version of the manuscript.

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