Original Article

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The Prevalence of Transfusion-Transmitted Infections among Blood Donors at Kuala Terengganu and Its Associated Factors

Marini Ramli, M.D., M.Path[1], Zefarina Zulkafli, M.D., M.Path[1], Adibah Daud, M.B.B.S., M.Path[1,2], Mohd Muhaimin Kambali, M.D., M.Med[3], Azly Sumanty Ab Ghani, M.D., M.Path[4], Wan Suriana Wan Ab Rahman, M.D., M.Path[5], Mohd Nazri Hassan, M.D., M.Path[1], Noor Haslina Mohd Noor, M.D., M.Path[1], Shafini Mohamed Yusoff, M.D., M.Path[1], Salfarina Iberahim, M.D., M.Path[1], Rosnah Bahar, M.D., M.Path[1]

[1]Haematology Department, School of Medical Sciences, Universiti Sains Malaysia, Kubang Kerian, Kelantan 16150, Malaysia.
[2]Department of Pathology and Medical Laboratory, Faculty of Medicine, Universiti Sultan Zainal Abidin, Kuala Terengganu, Terengganu 20400, Malaysia.
[3]Department of Transfusion Medicine, Hospital Sultanah Nur Zahirah, Kuala Terengganu, Terengganu 20400, Malaysia.
[4]Pathology Department, Hospital Sultanah Nur Zahirah, Kuala Terengganu, Terengganu 20400, Malaysia.
[5]School of Dental Sciences, Health Campus, Universiti Sains Malaysia, Kubang Kerian, Kelantan 16150, Malaysia.

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Abstract:

Objective: Blood transfusion is a widely used measure in modern medicine. It is, however, not without risk. One of the risks is transfusion-transmitted infections (TTIs). This study aimed to determine the prevalence of these infections among blood donors in a tertiary hospital in Kuala Terengganu and the associated factors.

Materials and Methods: This study involved retrospective data collection of all blood donations from 2011 until 2017, retrieved from the registry at the Transfusion Medicine Unit. The association of the identified risk factors with each TTI was checked for significance using Fisher's exact test. The association between seropositivity and sociodemographic characteristics was checked for significance by simple and multiple logistic regressions.

Results: There was a total of 330 (0.3%) seropositive donations and 13 (0.014%) seroconvert donors. The majority of the identified risk factors were unsafe sexual practices (51.7%). The seropositivity was significantly higher in males, first-time donors, occupations other than government servants, and donations at mobiles.

Contact: Adibah Daud, M.B.B.S., M.Path
Pathology Department, Faculty of Medicine, Universiti Sultan Zainal Abidin, Kuala Terengganu, Terengganu 20400, Malaysia.
E-mail: adibahdaud@unisza.edu.my

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Conclusion: The low prevalence of seropositive and seroconvert donors observed in this study reflects the overall effectiveness of donor selection procedures. Nonetheless, strengthening donor recruitment, improving pre-donation counselling, and encouraging repeat donations may further enhance transfusion safety. Strategies that focus on retaining return donors and converting first-time donors into repeat donors should be implemented. A more sensitive screening method, such as nucleic acid testing, would be very beneficial. Findings from this study can be used as a guide for an effective donor recruitment strategy to achieve zero-risk blood transfusion.

Keywords: blood donors, Terengganu, transfusion-transmitted infections

Introduction

In contemporary medical practice, blood transfusion remains a vital intervention, particularly for individuals experiencing severe blood loss or symptomatic anaemia. However, a significant concern linked to this life-saving procedure is the risk of transfusion-transmitted infections (TTIs)[1]. To enhance transfusion safety, blood bank services have adopted a range of preventive strategies aimed at reducing the risk of transmitting infections. These strategies include encouraging voluntary, unpaid donations, promoting regular donors, implementing self-deferral protocols, applying stringent donor eligibility criteria, and performing rigorous screening for infectious agents in donated blood[2,3].

The World Health Organization (WHO) advises that all blood donations be tested for a minimum of four infectious agents: human immunodeficiency virus (HIV), hepatitis B virus (HBV), hepatitis C virus (HCV), and *Treponema pallidum*, the bacterium responsible for syphilis[2]. Serological assays, which detect either antibodies or antigens, are widely used to perform these screenings and have significantly improved the identification of infected blood donations, thereby mitigating the threat of TTIs[4].

According to the WHO's global report on blood safety and availability, the rate of confirmed seropositive donors is a key indicator for assessing the efficacy of donor screening processes[5]. As such, tracking trends in the prevalence of infections among blood donors is crucial to ensure a safe blood supply and to evaluate current screening practices[3-5]. Despite several international studies, there is limited data from Malaysia, particularly the East Coast Region, where cultural, sociodemographic, and healthcare accessibility factors may influence donor characteristics and infection prevalence. Addressing these gaps provides valuable insight for strengthening regional transfusion safety policies. This study, therefore, aimed to: (i) assess the prevalence of seropositivity and seroconversion for HIV, HBV, HCV, and syphilis among blood donors; (ii) identify the risk factors associated with reactive donors; and (iii) analyse the sociodemographic differences between seropositive and seronegative donors at Hospital Sultanah Nur Zahirah (HSNZ), Kuala Terengganu.

Material and Methods

Data collection

The study was conducted at the Transfusion Medicine Unit of Hospital Sultanah Nur Zahirah, a tertiary referral hospital, serving as the main blood transfusion centre for Kuala Terengganu and the surrounding districts. This retrospective study utilised data from voluntary blood donations recorded between 2011 and 2017, which included donations at the hospital and at mobile blood drives. All donors were required to meet the eligibility criteria outlined by the Ministry of Health Malaysia, which excluded individuals with known high-risk behaviours, including

unsafe sexual practices within the preceding 12 months, or a history of intravenous drug use[6]. Risk behaviours were self-reported during the pre-donation health screening; some donors may not have disclosed these behaviours and were, therefore, accepted for blood donation.

Data on the sociodemographic characteristics, including age, gender, marital status, occupation, number of donations, and donation site, as well as the results of the serology tests for syphilis, HIV, HBV, and HCV, were obtained from the Transfusion Medicine Unit registry. Risk factor information, which was not identified during pre-donation screenings, was retrieved retrospectively from confidential post-donation counselling records of seropositive donors.

The seropositive donors were identified as those who were positive for any of the TTIs, while seroconvert donors were defined as individuals who initially tested negative for all TTIs during a donation but subsequently tested positive for the same infection in a later donation. Positive family history was defined as having a first-degree relative (parent, sibling, or child) diagnosed with any of the infections, either by serology or medical history.

Mobile blood drives

In addition to blood donations at the hospital, mobile blood drives were organised in collaboration with educational institutions, government offices, religious centres, factories, and military units, to maximise blood collection. Locations were selected based on donor turnout from previous drives and logistical feasibility.

Serological testing for HBsAg, anti-HCV, and HIV Ag/Ab

Screening for these infections was carried out using enzyme immunoassay technology, specifically the Abbott Architect Immunoassay analyser. A sample was considered seropositive when its optical density value exceeded 1.

Confirmatory serological testing

Samples that initially tested reactive for HBsAg, anti-HCV, or HIV Ag/Ab underwent further confirmatory testing. HBV-reactive samples were validated using a neutralization assay, while confirmatory tests for HCV and HIV were conducted through the Line Immunoassay method.

Screening and confirmation for syphilis

Syphilis screening was conducted using the Rapid Plasma Reagin test. In this test, the presence of antibodies against *Treponema pallidum* was detected via an immunochromatographic test. Confirmatory testing on reactive samples was then done using the *Treponema pallidum* particle agglutination assay.

Statistical analysis

Descriptive statistics were presented as frequencies and percentages. The significance of associations between identified risk variables and each TTI was assessed using Fisher's exact test, with a p-value of less than 0.05 indicating statistical significance. The relationship between donor seropositivity and sociodemographic factors was further examined using both simple and multiple logistic regression models.

Ethical considerations

Approval for this study was granted by the Human Research Ethics Committee of Universiti Sains Malaysia (USM/JEPeM/18020124) and the Medical Research and Ethics Committee under the Ministry of Health Malaysia (NMRR-18-1666-41106 [IIR]). This retrospective study utilised anonymised secondary data; therefore, individual donor consent was not required.

Results

Table 1 presents the demographic characteristics of 94,989 blood donations recorded at HSNZ between

2011 and 2017. Most donations were contributed by repeat donors (61.3%), male donors (66.1%), students (53.4%), and individuals of Malay ethnicity (92.8%). A significantly higher proportion of donations occurred during mobile blood drives (84.7%) compared to those collected at the fixed donation centre. Among all donations, 330 (0.3%) were identified as seropositive, with HBV being the most prevalent (162 cases, 49.1%), followed by HCV (107 cases, 32.4%), syphilis (38 cases, 11.5%), and HIV (23 cases, 7.0%). Among the 13 (0.014%) seroconversion cases, HIV accounted for the largest proportion (5 cases, 38.5%), followed by HCV (4 cases, 30.8%), HBV (3 cases, 23.1%), and syphilis (1 case, 7.7%).

Table 1 Sociodemographic characteristics of blood donations in HSNZ from 2011 – 2017 (n=94 989)

Variable	n (%)
Gender	
Male	62 746 (66.1)
Female	32 243 (33.9)
Race	
Malay	88 133 (92.8)
Chinese	4 724 (4.9)
Indian	983 (1.0)
Others	1 149 (1.2)
Occupation	
Student	50 746 (53.4)
Non-student	44 243 (46.6)
Number of donations	
First time	36 808 (38.7)
Repeat	58 181 (61.3)
Donation site	
Centre	14 553 (15.3)
Mobile	80 436 (84.7)
Seropositive	330 (0.3)
HBV	162 (49.1)
HCV	107 (32.4)
Syphilis	38 (11.5)
HIV	23 (7.0)
Seroconvert	13 (0.014)
HIV	5 (38.5)
HCV	4 (30.8)
HBV	3 (23.1)
Syphilis	1 (7.7)

HBV=hepatitis B virus, HCV=hepatitis C virus, HIV=human immunodeficiency virus

This study identified four primary risk factors associated with seropositivity among blood donors: intravenous drug use (IVDU), engagement in high-risk sexual behavior, previous donation history, and having a family member diagnosed with a specific TTI. Among the 330 donors who tested seropositive, 60 individuals were found to have at least one of these risk factors. The most frequently reported risk factor was unsafe sexual activity, accounting for 51.7% of the cases. Within this group, the majority (74.2%) reported having multiple sexual partners, followed by men who have sex with men (MSM) at 16.1%, and those with sexual partners engaged in high-risk behaviour at 9.7%. Unsafe sexual behaviour was the sole risk factor identified for both HIV and syphilis cases. Conversely, among those with HBV, a positive family history emerged as the most common contributing factor. IVDU was exclusively linked to HCV-positive donors. Statistical analysis using Fisher's exact test revealed significant associations between the identified risk factors and the specific TTIs (p-value<0.05) (Table 2).

As displayed in Table 3, findings from the simple logistic regression (SLR) analysis indicated that age, sex, employment status, donation frequency, and location of donation were all significantly linked to seropositivity (p-value<0.05). Further analysis using multiple logistic regression (MLR), applying both forward and backward selection methods, produced consistent outcomes. In this model, gender, occupation, number of prior donations, and donation site remained significantly associated with seropositivity (p-value<0.05), as detailed in Table 4.

Discussion

The findings of this study demonstrate a low overall rate of seropositivity among blood donors in Terengganu. Globally, the prevalence of TTIs among donors varies significantly[7,8]. Variations in seropositive donor rates across countries may reflect differences in infection rates within

Table 2 The risk factors identified among the seropositive blood donors (n=60)

Risk factors	HIV n (%)	HBV n (%)	HCV n (%)	Syphilis n (%)	Total n (%)
IVDU	0 (0.0)	0 (0.0)	5 (29.4)	0 (0.0)	**5 (8.3)**
Unsafe sexual practices (total):	5 (100.0)	9 (30.0)	9 (52.9)	8 (100.0)	**31 (51.7)**
Multiple sexual partners	1 (20.0)	7 (77.8)	8 (88.9)	7 (87.5)	23 (74.2)
MSM	4 (80.0)	0 (0.0)	0 (0.0)	1 (12.5)	5 (16.1)
Sexual partner with high-risk behaviour	0 (0.0)	2 (22.2)	1 (11.1)	0 (0.0)	3 (9.7)
Previous blood transfusion	0 (0.0)	1 (3.3)	0 (0.0)	0 (0.0)	**1 (1.7)**
Family history	0 (0.0)	20 (66.7)	3 (17.7)	0 (0.0)	**23 (38.3)**
Total, n (%)	**5 (8.3)**	**30 (50.0)**	**17 (28.3)**	**8 (13.3)**	**60 (100)**
†p-value	**<0.001***	**<0.001***	**0.002***	**0.038***	

*p-value<0.05; †Fisher's exact test; IVDU= intravenous drug use, MSM=men who have sex with men, HIV=human immunodeficiency virus, HBV=hepatitis B virus, HCV=hepatitis C virus

Table 3 The association between sociodemographic characteristics and seropositivity by SLR

Variable	Crude b	Crude OR (95% CI)	Wald statistics	p-value
Age (years)				
17–29		1		
30–49	0.376	1.456 (1.003, 2.114)	3.910	0.048*
50–65	1.238	3.447 (1.410, 8.427)	7.365	0.007*
Gender				
Female		1		
Male	1.680	5.367 (3.474, 8.290)	57.339	<0.001*
Race				
Malay		1		
Non-Malay	0.497	1.644 (0.759, 3.557)	1.590	0.207†
Marital status				
Unmarried		1		
Married	0.295	1.343 (0.936, 1.927)	2.563	0.109†
Occupation				
Student		1		
Uniform body	2.180	8.851 (3.327,23.574)	19.030	<0.001*
Government	−0.342	0.711 (0.426, 1.186)	1.710	0.191*
Private sector	0.107	1.113 (0.665, 1.862)	0.166	0.684
Self-employed	0.712	2.038 (1.136, 3.657)	5.695	0.017*
Unemployed	−0.476	0.621 (0.250, 1.542)	1.054	0.305
Number of donations				
Repeat		1		
First	4.521	91.923(41.152,205.333)	121.559	<0.001*
Donation site				
Centre		1		
Mobiles	3.036	20.829 (4.950, 87.651)	17.151	<0.001*

*p-value<0.05; †p-value< 0.25; SLR=single logistic regression, OR=odds ratio

Table 4 The association between sociodemographic characteristics and seropositivity by MLR

Variables	Adjusted b	Adjusted OR (95% CI)	Wald statistics	p-value
Gender				
Female		1		
Male	1.771	5.879 (3.104, 11.134)	29.551	<0.001*
Occupation				
Student		1		
Uniform body	2.977	19.638 (3.500, 110.117)	11.450	0.001*
Government	0.681	1.977 (0.825, 4.736)	2.336	0.126
Private sector	1.075	2.930 (1.211, 7.092)	5.684	0.017*
Self-employed	2.362	10.608 (2.074, 41.617)	11.467	0.001*
Unemployed	2.116	8.297 (1.148, 59.983)	4.396	0.036*
Number of donations				
Repeat		1		
First	5.382	217.429 (75.162, 628.978)	98.612	<0.001*
Donation site				
Centre		1		
Mobile	2.368	10.674 (1.535, 74.231)	5.726	0.017*

*p-value<0.05; MLR=multiple logistic regression, OR=odds ratio, CI=confidence interval
The model reasonably fits well. Model assumptions were met. There was no interaction or multicollinearity problem.

the general population, as well as the types of donors and screening protocols used by different blood procurement services. Regions that permit blood donations from non-voluntary or replacement donors often experience higher rates of seropositivity among their donor pools[9]. Several international studies have reported rates of HIV, HBV, HCV, and syphilis seropositivity that are comparable to the figures observed in this research[10,11].

This study also found a low overall rate of seroconversion among blood donors. Similar findings have been reported globally, particularly among repeat donors, who generally show a lower rate of seropositivity[12–14]. Seroconversion cases, although rare, represent a critical public health concern because they may indicate donations collected during the serological 'window period', when antibodies or antigens are not yet detectable. Such cases pose a potential risk of transmitting infection to recipients despite adherence to current screening protocols. The occurrence of seroconversion underscores the need for comprehensive donor follow-up mechanisms, including post-donation counselling to inform donors of their results, referral for confirmatory testing, and appropriate medical care. In addition, strengthening donor education programs is essential to encourage honest disclosure of risk behaviours and to improve self-deferral among individuals with recent exposures. From a transfusion safety perspective, these findings highlight the residual risk inherent in serology-only screening and strengthen the case for implementing more sensitive assays, such as nucleic acid testing (NAT). NAT significantly reduces the diagnostic window, as an example for HIV, from approximately 22 days with conventional antibody testing to about 9–11 days, thereby lowering the probability of undetected infections[15].

In Malaysia, NAT is not yet routinely implemented due to resource and cost considerations. However, its ability to shorten the diagnostic window period for HIV, HBV, and HCV could markedly improve blood safety. Pilot studies and phased implementation may represent a feasible approach, starting with high-volume centres before nationwide adoption.

This study found that the identified risk factors were significantly linked to all four TTIs examined (p-value<0.05). Among the contributing factors, unsafe sexual behaviour emerged as the most prominent, particularly having multiple sexual partners, followed by MSM. The category of multiple sexual partners included individuals who engaged in sex with commercial sex workers or exchanged sex for money. Prior studies have consistently highlighted that individuals involved in such practices are at increased risk for TTIs[16]. A multi-centre case-control study in China reported notable differences in behavioural risks between HIV-positive and HIV-negative donors. Those testing positive for HIV were more likely to report behaviours such as having multiple sexual partners, engaging in transactional sex, MSM activity, previous diagnoses of sexually transmitted infections, or having tattoos[17]. Similarly, research in the United States showed that sexual contact with an HIV-positive partner was the strongest risk factor, followed by MSM behavior[18]. While IVDU has not been strongly associated with HIV, HBV, or syphilis, it has been consistently identified as a major risk factor for hepatitis C infection[19].

Another important risk factor highlighted in this study was a family history of infection, particularly involving hepatitis viruses. This suggests possible transmission within households through close interpersonal contact, defined as household or caregiving contact involving shared living spaces and potential exposure to blood or body fluids (e.g., shared razors, toothbrushes), as well as mother-to-child transmission during delivery or breastfeeding. Prior research has established a significant link between personal or familial history of jaundice and the occurrence of HBV and HCV infections among blood donors[18].

In this study, only one individual with a reactive HBV result had a documented history of receiving a blood transfusion. Although previous studies have found blood transfusion history among seropositive individuals across all TTIs, the association was statistically significant only for HCV[18]. Our findings suggest that prior transfusions are not a predominant risk factor for TTIs in the current donor population. This could be attributed to the strict eligibility guidelines donors must meet before donating blood. Generally, those who qualify to donate are in good health and are less likely to have undergone transfusions – unless due to exceptional cases like major accidents or trauma[19].

Conversely, the fact that 80% of seropositive donors did not report identifiable risk factors suggests that unmeasured or undisclosed behaviours may contribute to infection risk. This highlights the need for improved pre-donation counselling and more sensitive donor history questionnaires.

The sociodemographic profile of blood donors in Kuala Terengganu demonstrated a predominance of male donors, reflecting both regional population demographics and the generally lower participation of women, which has been attributed to socio-cultural factors and temporary biological ineligibility, such as menstruation, pregnancy, and breastfeeding[20,21]. The donor population largely mirrored the ethnic distribution of the state, with Malays forming the majority. More than half of the donors were students, likely due to the frequent organisation of mobile blood drives in educational institutions as part of outreach efforts to cultivate early donation habits[22]. The higher proportion of repeat donors observed suggests that positive prior experiences and improved awareness encourage continued participation[23]. Notably, over 80% of donations were collected through mobile drives, enhancing accessibility by reducing the need for travel to fixed donation centres. Mobile drives have been widely implemented across the state in collaboration with schools, government agencies, religious organisations, and other institutions.

Our analysis shows that male gender, first-time donation status, and donations at mobile sites were significantly associated with higher odds of seropositivity. These findings suggest that men engage in risky behaviours,

such as multiple sexual partnerships, more frequently than women, and that first-time donors may not always disclose sensitive risk histories during screening. Mobile donation campaigns, while essential for maintaining supply, may attract younger or less experienced donors who are less aware of the deferral criteria. Occupational associations, particularly among private-sector and self-employed donors, may be linked to differences in health education, socioeconomic status, and exposure to higher-risk social environments. These insights highlight the importance of tailored donor education, targeted counselling, and enhanced screening in specific subgroups.

Conclusion

This study found a low rate of both seropositive and seroconverted cases among blood donors, indicating that the current donor screening protocols are generally effective. Nevertheless, enhancements in donor recruitment and screening processes are necessary to further minimise the risk of TTIs. Emphasising strategies that encourage first-time donors to return and become regular donors could improve the overall safety of the donor pool. Although serological testing is useful, it cannot fully eliminate the risk of undetected infections due to the variability of window periods in different TTIs. Hence, integrating more sensitive methods such as NAT could significantly reduce residual risk. The outcomes of this research may serve as a valuable reference for refining blood donor recruitment efforts and moving toward safer transfusion practices.

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Conflict of interest

The authors declare no conflicts of interest and have no ties to any organisation that holds a direct or indirect financial stake in the topic covered in this manuscript.

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