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INVESTIGATION OF OCCULT HEPATITIS B VIRUS INFECTION AMONG VOLUNTARY BLOOD DONORS IN HARBIN AREA

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Abstract: Objective To understand the situation of occult hepatitis B virus infection among voluntary blood donors in Harbin City, analyze its epidemiological characteristics, and assess the risk of transfusion-transmitted hepatitis B virus infection. Methods The results of hepatitis B surface antigen (HBsAg) ELISA double reagent negative and hepatitis B virus nucleic acid (HBV DNA) positive tests from 1,020,943 voluntary blood donors at the Harbin Blood Center from January 2016 to December 2022 were analyzed. Statistical analysis was performed on the total positive rate of occult HBV infection among voluntary blood donors, in relation to gender and whether it was their first time donating blood. Results Among the 1,020,943 voluntary blood donors at the Harbin Blood Center from January 2016 to December 2022, the overall positive rate of HBV infection was 0.032%, with little difference between genders, which was not statistically significant. However, there was a difference between first-time and repeat donors, which was statistically significant ($P < 0.05$). Conclusion The positive rate of HBV among voluntary blood donors in the Harbin area is related to whether they are repeat donors. Therefore, it is necessary to strengthen the promotion of knowledge about voluntary blood donation and infectious diseases, to avoid high-risk behaviors. It is important to scientifically compile recruitment guidelines and conduct health consultations before blood donation. Developing a low-risk group of voluntary blood donors can reduce transfusion risks and improve blood safety quality.

Keywords: HBV DNA nucleic acid testing (NAT); Blood screening; Occult hepatitis B virus infection (OBI); Transfusion risk

1 INTRODUCTION

In the process of patient rescue in medical institutions, blood transfusion has gradually become an important treatment method, playing a significant role in improving the efficiency of patient rescue. In recent years, with the rapid development of China's medical industry, the status of blood transfusion treatment has increased, and medical institutions have seen a corresponding increase in the demand for blood. Unsafe blood can endanger patients' lives and health. Therefore, it is of great importance to widely promote the significance of voluntary blood donation, popularize scientific knowledge about blood donation, carry out education on the prevention and control of diseases transmitted through blood, consult and examine donors to ensure the safety and effectiveness of the collected blood. At the same time, in terms of blood testing, using advanced testing equipment and high-quality reagents, continuously improving the testing level of staff, can issue accurate test reports, ensure blood quality, and provide safe and effective blood products for clinical use. However, looking at the qualified rate of blood tests, the qualified rate of repeat blood donors is often higher than that of first-time donors. In response to this situation, this study focuses on analysis, analyzes the correlation factors of the accuracy of blood tests for voluntary blood donors, and lays a good foundation for the subsequent work of voluntary blood donation.

Hepatitis B is a disease that can be transmitted through blood. Hepatitis B virus (HBV) infection is a worldwide epidemic and one of the important public health issues[1]. According to the World Health Organization, about one-third of the world's population has been infected with HBV, and its prevalence characteristics vary by region[2]. China is located in a high and medium prevalence area of HBV infection, with an average infection rate of 8%. Among them, hepatitis B surface antigen (HBsAg) serological testing is negative, but molecular biology testing HBV DNA is positive, this special infection mode has attracted widespread attention, and thus developed the concept of occult hepatitis B virus infection (OBI). With the continuous improvement of the sensitivity of HBV serological testing methods, most

HBV infections have been excluded among voluntary blood donors through screening for hepatitis B surface antigen (HBsAg), and the risk of transmitting HBV through blood transfusion has been reduced to a lower level. However, at present, the risk of transmitting HBV through blood transfusion mainly comes from HBsAg-negative but infectious blood donors, some of whom are in the serological transformation window period after HBV infection, and others are from occult HBV infection donors. Using ELISA alone for HBsAg testing cannot eliminate the risk of post-transfusion infection with HBV caused by the hepatitis B window period and OBI. Using nucleic acid testing (NAT) technology to detect HBV can effectively screen for occult hepatitis B virus infection in blood donors and reduce the risk of HBV. To understand the situation and population characteristics of occult hepatitis B virus infection among voluntary blood donors in Harbin from January 2016 to December 2022, a retrospective analysis was conducted on 1,020,943 voluntary blood donors in Harbin. The report is as follows:

2 MATERIALS AND METHODS

2.1 Research

subjects selected from 1,020,943 voluntary blood donor specimens collected by the Harbin Blood Center database from January 2016 to December 2022. Three samples were taken from each blood donor, one 5ml sample was taken with an EDTA-K3 vacuum collection tube (produced by VACUETTE Greiner Bio-One) for serological testing; two 5ml samples were taken with an EDTA-2K vacuum collection tube (produced by BD Pharmingen) for nucleic acid testing. All specimens were collected and stored according to the requirements of the "Blood Station Technical Operation Procedures (2015 Edition)". The age of blood donors ranged from 18 to 60 years old, and all voluntary blood donors met the health standards in the current "Blood Station Management Methods".

2.2 Method

Firstly, colloidal gold immunochromatography was used for rapid detection of HBsAg before donation. After passing the test, specimens were collected for two enzyme-linked immunosorbent assays (ELISA), and after both results were negative, one nucleic acid test (NAT) was performed. Nucleic acid testing was first performed in a combined form of 6 mixtures, and reactive specimens from combined testing were then subjected to individual identification experiments.

2.3 Reagents and Instruments

2.3.1 Serological testing system

ELISA reagents were from Zhuhai Livzon Reagent Co., Ltd. and France BioRad; using TECAN freedom evo fully automatic sampler (Switzerland Tecan Company) and Microlab FAME24/30 (Switzerland Hamilton Company) fully automatic enzyme immunoassay system for specimen testing.

2.3.2 Nucleic acid testing system

Nucleic acid testing reagents were from cobas TaqScreen MPX Test, cobas TaqScreen MPX Control Kit (ROCHE); using MICRLOAB STAR fully automatic sampler, Roche Cobas s 201 nucleic acid testing system (cobas AmpliPrep nucleic acid extraction instrument and cobas TaqMan nucleic acid amplification detector). All reagents were tested and qualified by the Chinese Drug Biological Products Identification Institute, within the validity period and strictly operated according to the reagent kit instructions.

2.4 Judging Rules for HBsAg

ELISA double reagent negative specimens, HBV/HCV/HIV (hepatitis B virus/hepatitis C virus/human immunodeficiency virus) nucleic acid joint detection was performed in a combined form of 6 mixtures. Reactive specimens from combined testing were then subjected to individual identification experiments for HBV/HCV/HIV, screening out HBV DNA reactive specimens, which were determined as HBV-DNA positive specimens.

2.5 Statistical Treatment

The organization of data in this study relied on SPSS20.0 statistical software to complete, % as the manifestation of counting data, using X^2 test for analysis, when the difference between groups meets the requirement of $P < 0.05$, it is considered statistically significant.

3 Results

3.1 From January 2016 to December 2022, a total of 1,020,943 voluntary blood donors had overall positive results for HBV screening, as shown in Table 1.

Table 1 Overall positive results for HBV screening among voluntary blood donors from January 2016 to December 2022.

Year	Number of Voluntary Blood Donors	OBI	Positive Rate（%）
2016	141917	44	0.031
2017	148648	54	0.036
2018	156701	62	0.040
2019	167254	68	0.041
2020	138808	41	0.030
2021	143234	30	0.021
2022	124381	27	0.022
Total	1020943	326	0.032

3.2 HBV Screening Results

Among Blood Donors of Different Genders: From January 2016 to December 2022, among the 1,020,943 voluntary blood donors, 604,944 male donors were tested, with 201 cases positive for HBV DNA, resulting in a positivity rate of 0.033%. In contrast, out of 415,999 female donors, 125 cases were positive for HBV DNA, yielding a positivity rate of 0.030%. The detection rate of HBV DNA positivity was slightly higher in males than in females, as shown in Table 2.

Table 2 Gender Proportion in Positive HBV Screening Results Among Voluntary Blood Donors

Year	Male			Female		
	Number of Voluntary Blood Donors	OBI	Positive Rate（%）	Number of Voluntary Blood Donors	OBI	Positive Rate（%）
2016	82311	26	0.032	59606	18	0.030
2017	90675	34	0.037	57973	20	0.034
2018	92465	38	0.041	64236	24	0.037
2019	91989	40	0.043	75265	28	0.037
2020	74956	23	0.031	63852	18	0.028
2021	92545	21	0.023	50689	9	0.018
2022	80003	19	0.024	44378	8	0.018
Total	604944	201	0.033	415999	125	0.030

3.3 HBV Detection in First-Time and Repeat Blood Donors:

From January 2016 to December 2022, among the 1,020,943 voluntary blood donors, 571,782 first-time donors were tested, with 246 cases positive for HBV DNA, resulting in a positivity rate of 0.043%. In contrast, out of 449,161 repeat donors, 80 cases were positive for HBV DNA, yielding a positivity rate of 0.018%. Statistical analysis indicates that the positivity rate among first-time donors is higher than that of repeat donors ($P<0.05$). See Table 3.

Table 3 Comparison of Positivity Rates Between First-Time and Repeat Blood Donors

Year	First time blood donor			Repeat blood donor		
	Number of Voluntary Blood Donors	OBI	Positive Rate（%）	Number of Voluntary Blood Donors	OBI	Positive Rate（%）
2016	78054	37	0.047	63863	7	0.011

2017	87702	43	0.049	60946	11	0.018
2018	81484	44	0.054	75217	18	0.024
2019	90317	48	0.053	76937	20	0.026
2020	77732	33	0.042	61076	8	0.013
2021	80602	20	0.025	62632	10	0.016
2022	75891	21	0.028	48490	6	0.012
Total	571782	246	0.043	449161	80	0.018

4 DISCUSSION

Voluntary blood donation, advocated by the World Health Organization and the International Red Cross, is a form of safe blood donation and an important indicator of a society's level of civilization. With the rapid development of China's medical and health care services and the continuous increase in promotional efforts for voluntary blood donation by blood collection agencies, ensuring the safety of clinical transfusions has become a focal concern. Before nucleic acid testing (NAT) technology was applied to screening in voluntary blood donation, most Chinese blood collection agencies used two different reagents for parallel ELISA testing. Although the sensitivity and specificity of ELISA kits have been continually improved, they still cannot avoid missed detections due to factors such as the window period of viral infection, viral mutation, and immunological silencing. In 2008, a case was reported where a recipient developed typical HBV infection after being transfused with HBsAg-negative, HBV DNA-positive blood during a 12-month window period, highlighting OBI (occult HBV infection) and the window period as two major challenges to transfusion safety[3]. In developed countries, 0.007%-0.05% of HBsAg-negative blood donors test positive for HBV DNA[4. 5. 6]. As China is a high-incidence area for hepatitis B, domestic research reports also show that the proportion of OBI among Chinese blood donors ranges from 0.03%-0.2%, significantly higher than in Western developed countries[7. 8. 9]. Since 1992, China has initiated a comprehensive vaccination program against hepatitis B, which has reduced the risk of transmission to some extent. The survey results indicate a significant difference between first-time and repeat blood donors, with the latter often having higher awareness and trust in voluntary blood donation [10]. Screening blood donors from a pool of regular voluntary donors is crucial for ensuring the safety and sufficient supply of clinical blood use. For first-time donors, it is necessary to strengthen education on blood donation and infectious diseases, focusing on pre-donation consultation and assessment.

Voluntary blood donation is a commendable social welfare activity primarily used for the treatment of clinical diseases. With the rapid development of China's medical and health care services and the increasing promotional efforts for voluntary blood donation by blood collection agencies, obtaining high-quality blood products requires stringent testing of donor blood parameters. To ensure the authenticity and reliability of blood tests, careful selection of reagents and automated testing equipment is essential. Fully leveraging the functional characteristics of testing equipment can improve the accuracy of blood tests, reduce errors, and lower the probability of missed detections. Moreover, considering the risk of transfusion-transmissible diseases, adequate protective measures should be taken to minimize potential hazards during blood collection. Therefore, effective strategies should be adopted to address the issue of "window period" infections, as different testing methods and reagents have varying window periods. Thus, the rational use of NAT technology can shorten the "window period," significantly reducing the safety risks associated with clinical transfusions. The current study shows that, from the perspective of infectious disease infection rates in blood donation, the occurrence rate among repeat donors is significantly lower than that among first-time donors, thus improving the safety level of blood donation; repeat donors are considered a low-risk group for voluntary blood donation. Additionally, undergoing multiple blood tests and health consultations during each donation process means that this group faces a lower risk of transfusion safety issues related to the "window period." Compared to first-time donors, repeat donors have a certain level of understanding about blood donation, can accurately identify risky behaviors, and significantly reduce safety risks in blood collection work. Therefore, maintaining repeat donors and establishing a strong team of regular voluntary blood donors is crucial. Nowadays, China's health administrative departments strictly supervise and manage blood collection agencies, with blood quality being a top priority. To provide patients with sufficient blood products, expanding the team of repeat donors, using modern testing equipment, and high-quality testing reagents to

offer safe and high-quality blood donation services are essential. By collecting blood from low-risk groups, the quality of blood products can be ensured. From the perspective of the "window period," repeat donors have a lower probability of being in this phase, correspondingly reducing safety risks and minimizing blood wastage. This also presents a substantial advantage in terms of cost investment for blood collection agencies.

It is evident that the blood provided to patients is of higher safety, making clinical use more reliable. Before blood collection, medical staff should conduct health consultations, assessments, and examinations on donors, as well as explain relevant knowledge about blood donation, enhancing their understanding of the purpose and significance of voluntary blood donation. This encourages regular, voluntary, unpaid donations and ensures the quality and reliability of the collected blood for better use in the rescue and treatment of patients. Blood collection personnel must take precautions at work, promptly disposing of used equipment to prevent injuries. Voluntary blood donation reflects the selfless spirit of our people, where individuals willingly donate blood without seeking rewards, fulfilling patient needs for blood products. However, everyone's physical condition varies, and with the fast-paced lifestyle nowadays, people's dietary habits and living environments are undergoing significant changes. To ensure the effective implementation of voluntary blood donation efforts, improving blood quality has become a focal point for blood collection agencies. Hepatitis B, C, syphilis, and AIDS are all diseases transmitted through blood. Therefore, every step in the donation process must be handled with caution, with increased control over blood quality. With the aid of modern, intelligent testing equipment, donors' blood indicators can be tested, results analyzed, and health consultations, assessments, and examinations completed to provide effective prevention and control measures for ensuring the safety of clinical blood use. For repeat donors, having donated multiple times, they have received more information about voluntary blood donation, significantly enhancing their awareness of blood testing. They know how to avoid risks and protect their safety when hazards approach. Thus, compared to first-time donors, repeat donors have a lower probability of transmitting infectious diseases, ensuring better blood quality and safety. Furthermore, in the process of carrying out various tasks related to blood donation, the interaction between staff and donors, as well as guidance on health education and other matters, takes up significantly less time for repeat donors, greatly improving efficiency and quality, reducing time wastage, and decreasing costs, benefiting the development of China's blood service and health care industry.

In recent years, the Harbin Blood Center has collaborated with universities to regularly organize mobile blood collection vehicles visiting campuses, providing convenience for college students to donate blood and achieving positive results. College students, being physically healthy and culturally educated, possess a strong sense of social responsibility and enthusiasm for public welfare. Their blood quality and safety are relatively high, making them a reliable and stable source of voluntary blood donations in our country. Developing and consolidating a sufficiently large team of low-risk voluntary blood donors, encouraging more first-time donors to become repeat donors, meeting the growing demand for blood use, and reducing transfusion risks are crucial for promoting the sustainable and healthy development of voluntary blood donation efforts.

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REFERENCES

[1] Kanc M. Global programme for control of hepatitis B infection. Vaccine 1995, 13(Supp; 1): S47-S49.
[2] Zhuang Hui. Epidemiological research progress on hepatitis B. Chinese Medical Frontier Magazine (Electronic Edition), 2009, 1(2): 18-24.
[3] Raimondo G, Allain JP, Brunetto MR, et al. Statements from the Taormina expert meeting on occult hepatitis B virus infection. J Hepatol, 2008, 49(4): 652-657.
[4] Pourkarim MR, Amini-Bavil-Olyaee S, Kurbanov F, et al. Molecular identification of hepatitis B virus genotypes/subgenotypes: Revised classification hurdles and updated resolutions. World J Gastroenterol, 2014, 20(23): 7152-7168.
[5] Gonzalez R, Torres P, Castro E, et al. Efficacy of hepatitis B virus (HBV) DNA screening and characterization of acute and occult HBV infections among blood donors from Madrid, Spain. Transfusion, 2010, 50(1): 221-230.

[6] Katsoulidou A, Paraskevis D, Magiorkinis E, et al. Molecular characterization of occult hepatitis B cases in Greek blood donors. J Med Virol, 2009, 81(5): 815-825.
[7] Ou Shan Hai, Lin Yong Cai, Ni Hong Ying, et al. Study on occult hepatitis B virus infection among voluntary blood donors in Southern Fujian. Chinese Journal of Blood Transfusion, 2010, 23(12): 1033-1036.
[8] Wang Qing Min, Jiang Ni Zhen, Xiao Jian Yu, et al. Investigation on the situation of occult HBV infection among blood donors in Jiangsu area. Clinic Blood Transfusion and Testing, 2012, 14(4): 119-120.
[9] Rong Ying, Deng Xin, Ye Xian Lin. Study on Pre-S/S region mutation of occult hepatitis B virus in voluntary blood donor. Chinese Journal of Blood Transfusion, 2011, 24(7): 565-571.
[10] Yan Zhong Wen. Analysis of knowledge, beliefs, and practices survey among voluntary blood donors on the streets of Dongguan. Journal of Clinical Hematology, 2014, 27(4): 313-315.