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Evaluation of Blood Donors and Transfusion Transmitted Infections and their Association with ABO and Rh Blood Groups in Unaizah, Saudi Arabia: A Retrospective Study

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ABSTRACT

Background: *This study aims to evaluate the percentages of voluntary and female blood donors, prevalence of hepatitis B virus (HBV), hepatitis C virus (HCV), human immunodeficiency virus (HIV), human T-cell lymphotropic virus (HTLV) and syphilis among blood donors and the potential association between them with ABO and Rh blood groups.* ***Methods:*** *A retrospective study was conducted at blood bank, King Saud Hospital, Unaizah, Qassim, Saudi Arabia for a period of 4 years (January 2013 to December 2016). After obtaining the ethical approval, 5 mL of blood each was taken from the volunteers and replacement blood donors for TTIs analysis.* ***Results:*** *A total of 9460 blood donor samples (9120 males (96.4%) and 340 females (3.6%)) were collected and screened. The mean age of donors was 31.4 ± 8.7 years. Seventy-six donors tested positive for TTIs (0.80%). The frequency of HBV, HCV, HIV, HTLV and syphilis were 25 (0.2%), 21 (0.22%), 1 (0.01%), 9 (0.10%) and 20 (0.21%), respectively. Most of the blood donors were found to belong to O blood group (46.45%), while AB group showed the smallest frequency rate of 5.2%. This study found no significant association between ABO and Rh blood groups with TTIs infections.* ***Conclusion:*** *Low percentages of voluntary and female donors were found in this study. High prevalence rates of TTIs among donors with blood group O. It is highly recommended to educate the culture and encourage the voluntary donors and enrollment of female blood donors. Also, advanced methods should be used for proper testing of donor's blood.*

Keywords: Transfusion transmitted infections, Voluntary donors, ABO, Female blood donors, Blood donor, Rh system, Saudi Arabia

INTRODUCTION

The transfusion of blood or its components is considered a life-saving intervention, which rescues millions of lives each year globally. Generally, over 81 million blood units are donated annually [1]. Despite the huge benefit of blood transfusion, certain hazards such as acute or delayed complications and transfusion transmitted infections (TTIs) can occur during blood transfusion [1,2]. The commonly occurring TTIs include hepatitis B virus (HBV), Hepatitis C virus (HCV), human immunodeficiency virus (HIV), human T-cell lymphotropic virus (HTLV) and syphilis [3].

Transfusions of incompetently screened or non-screened blood or blood products are considered the main source of TTIs in developed and developing countries [4]. Acquiring TTIs during blood transfusion process has become a crucial obstacle that deserves high emphasis on ensuring both safety and protection of human life during blood transfusion [5,6]. Moreover, TTIs have attracted immense attention due to their prolonged viraemia and latent state, which could be fatal and possibly lead to chronic and life-threatening disorders [1,3]. Globally, it has been reported that approximately 33 million are infected with HIV, about 2 billion are infected with HBV (240 million of them have chronic infection), and 150 million are infected with HCV (3-4 million infections occur per year) [7,8]. Syphilis, a disease resulting from infection with *Treponema pallidum*, is also a common disease that affects about 12 million every year [9].

The susceptibility of blood transfusion to complications is based on the fact that some blood groups can act as a receptor and ligand for viruses, bacteria and parasites. Research has also revealed that cells lacking ABO antigens are at risk of TTIs because of their inability to block the binding of the causative agents of TTIs to polysaccharide [10]. Accordingly, the blood groups distribution plays a significant role in blood transfusion and organ transplantation due to the relationship between blood groups and certain diseases [11]. Several studies have reported different findings regarding the possible relationship between TTIs and blood groups [12]. In 2014, Mohammad and Pourfathollah revealed that HBV is significantly associated with O blood group, whereas no such association was found for HCV [12].

Taking into account the importance of the issues regarding TTIs and blood groups, this study is an attempt to analyze the data of blood donors at blood bank center at King Saud Hospital, Unaizah, Qassim, Saudi Arabia, to provide useful insights about the practice of blood transfusion in order to optimize the use of blood and blood products. In addition, the association between TTIs and blood groups has not been adequately addressed in the Qassim region of Saudi Arabia. Furthermore, the frequency of TTIs, ABO and Rh blood groups among blood donors needs to be determined in order to reflect the level of adherence to the established guidelines in the practice of blood transfusion, which is a research gap that has been noticed in previous studies. The objectives of this study were to evaluate the percentage of voluntary and female blood donors and to study the frequency rates of ABO and Rh blood groups among blood donors at blood bank center at King Saud Hospital, Qassim, Saudi Arabia. This study also aimed to determine the association between TTIs with ABO and Rh blood groups.

MATERIALS AND METHODS

Subjects

Before donation, written informed consent was obtained for all donors. This study is a retrospective cross-sectional study which was conducted over a period of 4 years from January 2013 to December 2016 at the blood bank center of King Saud hospital, Unaizah, Qassim, Saudi Arabia. King Saud hospital provides several health care services to both local and expatriate resident populations from different countries. Ethical approval (No. 45/87/1649) was obtained from the research ethical committee at Qassim health office and research committee at King Saud hospital at Unaizah. Data was collected from the records at the blood bank center according to the established guidelines.

The blood groupings of donors were determined using standard methods; forward (cell grouping) and reverse (serum grouping) reactions. Afterward, a final group was confirmed only when both forward and reverse grouping were identical.

All donors were screened for any TTIs and serological reports were recorded whether positive or negative. Serological tests were performed to examine the presence of hepatitis B, hepatitis C, HIV1 and 2, HTLV and syphilis. The study made use of National AIDS Control Organization (NACO) approved rapid kits and enzyme linked immunosorbent assay (ELISA) technique supplied by (BioRad, USA). All reactive donors were screened with nucleic acid testing (individual NAT) to rule out false negative or false positive cases. Nonetheless, no false negative or positive cases were detected in this study.

Inclusion Criteria

The population selected for this study comprise physically healthy people aged between 18-60 years with weight not less than 45 kg, hemoglobin not less than 12.5 g/dL, normal pulse and blood pressure who came to donate blood at blood bank center, King Saud Hospital, Unaizah, Qassim, Saudi Arabia.

Exclusion Criteria

Donors excluded from this study include those aged below 18 years old, persons with body weight less than 45 kg and those that have donated blood within the past two months. In addition, those who are suffering from anemia or had jaundice within the past six months as well as those involved in high-risk behaviors such as sexual abusers or drug addicts were excluded.

Statistical Analysis

Data were collected and verified before entering them into Microsoft office excels worksheet to calculate the prevalence rates and percentages. The data were then analyzed using Statistical Package for Social Sciences (SPSS,

version 21). Chi-square test was used for qualitative comparison to study the frequency and association between ABO and Rh blood group with TTIs. Confidence interval was fixed at 95% and $P \leq 0.05$ was considered statistically significant [12].

RESULTS

A total of 9460 persons (9120 males (96.4%) and 340 females (3.6%)) donated their blood at the blood bank center located at King Saud Hospital, Unaizah, Qassim, Saudi Arabia from January 2013 to December 2016. An average of 2365 person donated blood per year and the percentage of replacement and voluntary blood donors were 87.60% and 12.40% respectively. The ages of blood donors were ranged between 18-48 years with an average of 31.4 ± 8.7 years. Most of the blood donors belong to O blood group (4394) with frequency rate of 46.45% (O+ve (3878 (41.00%) and O-ve (516 (5.45%), while AB group showed the smallest frequency rate of 493 (5.2%) (AB+ve 425 (4.49%) and AB-ve 68 (0.72%). Out of the 9460 donors, 76 were found to be positive for TTIs with frequency rate of approximately 0.80%.

Detailed distributions of TTIs frequency rates among blood donors according to ABO and Rh blood groups are illustrated in Table 1. The highest prevalence rate was observed in HBV (0.26%) followed by HCV (0.22%), Syphilis (0.21%), HTLV (0.10%) and HIV (0.01%) and high positivity of TTIs was detected in Rh positive donors compared with Rh negative blood groups (Table 1). Among the 9460 donors, double infections with TTIs were detected in only 5 cases with 4 of them indicating the presence of HBV and HCV, and only one case showed the presence of both HCV and HIV.

Table 1 Distribution of transfusion transmitted infections among blood donors according to ABO and Rh blood groups

Blood Group	No. of donors	HBV (N (%))	HCV (N (%))	HIV (N (%))	HTLV (N (%))	Syphilis (N (%))
O-	516	-	1 (0.19)	-	-	1 (0.19)
A-	255	-	1 (0.39)	-	1 (0.39)	-
B-	194	1 (0.51)	-	-	-	-
AB-	68	-	1 (1.47)	-	-	-
O+	3878	14 (0.36)	6 (0.15)	-	4 (0.10)	7 (0.18)
A+	2095	3 (0.14)	6 (0.29)	-	2 (0.10)	6 (0.29)
B+	2029	7 (0.35)	5 (0.25)	-	2 (0.10)	6 (0.29)
AB+	425	-	1 (1.47)	1 (0.24)	-	-
Total	9460	25 (0.26)	21 (0.22)	1 (0.01)	9 (0.10)	20 (0.21)
HBV: Hepatitis B Virus; HCV: Hepatitis C Virus; HTLV: Human T-Cell Lymphotropic Virus						

Most of the positive cases for HBV, HCV, HTLV and VDRL were detected in O+ve blood group followed by B blood group (Table 1). For HBV, the highest frequency rate was recorded for O+ve blood group, followed by B+ve, A+ve and B-ve blood groups, respectively. For HCV, similar frequency rates were observed in O+ve and A+ve blood groups followed by B+ve blood group, while one positive case were observed in both AB-ve and AB+ve blood groups. In the case of HTLV, similar frequency rates were noted in A+ve and B+ve blood groups followed by A-ve blood group.

Only one case of HIV positive was detected among AB blood donors, whereas comparable prevalence rates were observed among A and B blood groups for syphilis, although no positive cases were detected in AB blood group (Table 1).

The frequency rates of ABO blood groups were 46.40% for O blood group followed by 24.80% for A blood group, 23.50% B blood group and 5.30% for AB blood group in both male and female blood donors. On the other hand, TTIs was found to be highest among O blood group (43.42%) followed by B (27.63%), A (25.00%) and AB (3.95%), as shown in Table 2. Thus, O blood group has the highest frequency rate of TTIs, while AB group has the least frequency rate. The prevalence rate of Rh positive and Rh negative among blood donors was found to be 89.08% and 10.91%, respectively (Table 3).

Table 2 Number and percentage of blood donors and transfusion transmitted infections among ABO blood groups

Blood group	Blood donors (N (%))	TTIs (N (%))
O	4389 (46.40)	33 (43.42)
A	2346 (24.80)	19 (25.00)
B	2223 (23.50)	21 (27.63)
AB	502 (5.30)	03 (3.95)
HBV: Hepatitis B Virus; HCV: Hepatitis C Virus; HTLV: Human T-Cell Lymphotropic Virus		

Table 3 Frequency of Rh system among blood donors

Blood group	Donors (N (%))	HBV (N (%))	HCV (N (%))	HIV (N (%))	HTLV (N (%))	Syphilis (N (%))
Rh D +	8427 (89.08)	24 (0.28)	18 (0.20)	-	8 (0.09)	19 (0.23)
Rh D -	1033 (10.91)	1 (0.10)	3 (0.30)	1 (0.10)	1 (0.10)	1 (0.10)
Total	9460	25 (0.26)	21 (0.22)	1 (0.01)	9 (0.10)	20 (0.21)
HBV: Hepatitis B Virus; HCV: Hepatitis C Virus; HTLV: Human T-Cell Lymphotropic Virus						

The current study showed the distribution of total number of blood donors over a period of 4 years (2013-2016) with the highest number of donors recorded in 2016 (2696) and the least number of donors in 2013 (2066). The average number of donors per year was determined to be 2365. The highest prevalence rate of HBV was noted in 2013, while the highest prevalence rates of HCV, HTLV, HIV and VDRL were observed in 2015 (Table 4). However, the frequency rate of HBV declined from 0.39% in 2013 to 0.08 in 2016, although no significant statistical difference was observed. The prevalence rates of HCV, HIV, HTLV and syphilis showed a degree of fluctuation over the period of 4 years, although with no significant statistical difference (Table 4). Despite the high prevalence of positive cases for HBV among O blood group donors, no significant association was observed between HBsAg and O blood group (χ^2=2.39, P=0.12). Similarly, other ABO and Rh blood groups did not show any statistical association with the TTIs (Table 5).

Table 4 Number and percentage of transfusion transmitted infections among blood donors from 2013-2016

Year	No of donors	HBV (N (%))	HCV (N (%))	HIV (N (%))	HTLV (N (%))	Syphilis (N (%))
2013	2066	8 (0.39)	-	-	-	-
2014	2450	4 (0.16)	2 (0.08)	-	3 (0.12)	-
2015	2248	4 (0.18)	11 (0.50)	1 (0.04)	4 (0.18)	12 (0.5)
2016	2696	2 (0.07)	8 (0.30)	-	2 (0.07)	8 (0.30)
HBV: Hepatitis B Virus; HCV: Hepatitis C Virus; HTLV: Human T-Cell Lymphotropic Virus						

Table 5 Results of association between ABO and Rh blood group with transfusion transmitted infections (χ^2 and P value)

Blood group	HBV	HCV	HIV	HTLV	Syphilis
O	χ^2=2.39	χ^2=1.20	χ^2=0.78	χ^2=0.4	χ^2=0.36
	P=0.12	P=0.27	P=0.38	P=0.95	P=0.55
A	χ^2=3.35	χ^2=1.07	χ^2=0.34	χ^2=0.38	χ^2=0.36
	P=0.67	P=0.30	P=0.56	P=0.54	P=0.54
B	χ^2=0.36	χ^2=0.21	χ^2=0.38	χ^2=0.15	χ^2=1.11
	P=0.55	P=0.65	P=0.53	P=0.69	P=0.29
AB	χ^2=2.38	χ^2=2.38	χ^2=4.12	χ^2=0.42	χ^2=1.11
	P=0.12	P=0.12	P=0.10	P=0.52	P=0.29
HBV: Hepatitis B Virus; HCV; Hepatitis C Virus; HTLV: Human T-Cell Lymphotropic Virus					

DISCUSSION

This study evaluated the prevalence rates and relationship of TTIs with ABO and Rh blood groups among 9460 blood donors at King Saud hospital, Unaizah, Qassim, Saudi Arabia over a period of past 4 years (2013-2016). Most of the blood donors are considered family donors (87.60%), while volunteer donors account for approximately 14.40% of the total donors. This study presented a higher number of male donors compared to female donors, which is consistent with other studies [13-15]. Statistically significant differences were observed between family donors and volunteer donors (P=0.02) and between male and female blood donors (P=0.01).

Prior studies conducted by Talib, et al. and Bashwari, et al. reported that the frequency distributions of O and AB blood group among blood donors in Saudi Arabia are 53% and 3.5%, and 52% and 4%, respectively [16,17]. which is close to the findings of our study which reported frequency rates of 46.45% and 5.2% for O and AB blood groups, respectively. However, a study conducted by Abdullah on 30481 healthy donors in Jazan region reported rates of 62% and 1.7% for O and AB blood groups, respectively, which is slightly different from the results of this study [18]. The result showed that the frequency rates of Rh+ve and Rh-ve account for approximately 89.08% and 10.91%, respectively which is slightly different from the 93% and 7% recorded by Bashwari, et al., and 95% and 5% by Abdullah, respectively [18].

The small differences in the frequency rates between our study and the studies of Bashwari, et al. and Abdullah in 2010 for O, AB blood groups and Rh system could be due to the differences in sample size given that 9460 blood donors were analyzed in this study, while Bashwari, et al. and Abdullah based their studies on 57396 and 30481 blood donors, respectively [17,18].

This study demonstrates that O blood group is the most prevalent blood group among the blood donors followed by A, B and AB, in that order, which is similar to the findings of Talib, et al., Bashwari et al., and Abdullah [16-18]. Conversely, other studies showed that B blood group is the most common blood group of donors in India followed by O, A and AB, sequentially [6,19]. This suggests the prevalence of a blood group among donors varies geographically. Simultaneously, this study displays highest positivity rates of TTIs among O blood group donors followed by B, A and AB, in that order. HBV was found to be more prevalent in Rh+ve blood group compared to Rh-ve blood group.

High positivity rates of TTIs among O blood group and Rh-positive donors as well as high prevalence rate of HBV among O blood group were detected, which is consistent with the findings of Omar, et al. in 2012; Kumer, et al. in 2012; Mohammadali, et al. in 2014 [12,20,21]. On the other hand, the findings of this study are at variance with those of Tyagi and Tyagi and Nigam, et al., who reported that donors with Rh negative and A negative blood groups were more susceptible to TTIs compared to other blood groups [6,19].

Furthermore, the frequency rates of HBV were observed to have declined from 2013 to 2016, which reflects a noticeable improvement in the healthcare system of Saudi Arabia. This point is crucial because HBV constitutes the most prevalent TTIs among blood donors, which in turn reflects the level of effectiveness of health care system of a country [12]. The decline in the prevalence rates of HBV may be attributed to several factors that include implementation of HBV vaccination for all neonates, workers at health care units, medical centers and hospitals, pregnant women, families and relatives of HBV positive donors, repeated donors; the use of technologically advanced methods and machines to detect the presence of HBV, and education of the community about the transmission of TTIs [12,22]. The variation in the frequency rates of other TTIs can be as a result of using different screening reagents and methods, migration of former residents, associated environmental risk, as well as efficacy and accuracy of blood transfusion procedures [23]. At times, several newly positive cases may gain their infection in the past years prior to the examination [23].

The prevalence rates of HBV and HVC among the blood donors were found to be 0.26% and 0.2% respectively. The HBV prevalence rate is considered lower than earlier reported values of 1.5% [13] and 4% [24] in Riyadh, Qassim [25] and 3.3% in Al-Baha [26]. Similarly, prevalence rate of HCV recorded in this study is lower than rates of 1-1.5% [24,27] and 0.4% reported in Riyadh [13], 1.0% in Qassim [25] and 1.2% in Al-Baha [26]. The HBV and HCV frequency rates of 0.26% and 0.22%, respectively, were recorded among Saudi blood donors in this study, which are significantly lower compared with 2.35% and 0.79% in Yemen [28], 3.8% and 0.95% in Syria [29], 1.2% and 13.6% in Egypt [30] for both HBV and HCV, respectively.

The variation in the prevalence rates of HBV and HCV between this study and other studies could be attributed to several factors such as differences in the degree of sensitivity of the reagents and machines used for screening of TTIs, criteria applied for determination of the positivity of TTIs, inclusion and exclusion criteria for blood donors, as well as differences in geography and socio-economic status. It was observed that old generation of HBsAg and anti-HCV ELISA with low sensitivity and specificity were used in previous studies, whereas in this study fourth generation with high specificity and sensitivity was used.

The compilation of data about the prevalence rates of TTIs among ABO and Rh blood groups for blood donors from different regions in Saudi Arabia is highly important for effectively improving transfusion service protocols and the assurance of safe blood transfusion [1]. The importance of the ABO and Rh blood group system in transfusion

medicine is based on its strong relationship with the occurrence of hemolytic transfusion reactions, thus the compiled data will also aid the detection and control of these reactions [18,31].

Several arguments and assertions were reported regarding the possible relationship between ABO and Rh blood group system with the TTIs, although there remains the need for corroboration and validation [11,12,19,32]. Therefore, one of the aims of this study was to evaluate the possible association between the ABO and Rh blood group system with the TTIs using the blood donation center at King Saud hospital, Qassim, Saudi Arabia as a case study. Overall, no statistically significant associations were found between TTIs and ABO and Rh blood group. Nonetheless, O blood group donors were more susceptible to HBV, but no statistically significant association was observed, which is consistent with several earlier studies [11,33,34]. On the other hand, this finding is inconsistent with studies that reported significant association between TTIs and ABO and Rh blood group [12,32]. This variation may be due to several factors that include difference in sample size, type of statistical analysis deployed, number of positive cases, which depends on the results of screening of TTIs using different methods, and the different sensitivity and specificity levels of reagents.

Based on the findings of this study, there is the need for a comprehensive study with large sample size (i.e., the whole country) for a period of at least twenty years in order to efficiently determine the association between ABO and Rh with the TTIs. Instituting a reference blood bank for the whole country to oversee, train, handle, and provide all requisite facilities for the blood bank units in different regions of the country is also highly recommended. The possible risks of TTIs can be reduced or eliminated through constant updates, appraisals and education of workers and community regarding the transmission of infectious agents via blood components, deployment of stringent and efficient criteria for donor selection and using highly sensitive methods and reagents for screening of TTIs. Furthermore, the collaboration of all blood bank units with the reference blood bank, all health institutions involved in transfusion medicine, and national hemovigilance systems, is vital for the safety of blood and blood products.

CONCLUSION

The O positive blood group was the most common blood group among blood donors, which reflects its high positivity for TTIs compared to the other blood groups. Nonetheless, no statistically significant association was established between TTIs and ABO blood group.

Percentage of voluntary donors and female donors were found to be low, so it is highly recommended to educate the culture and encourage the voluntary donors and enrollment of female blood donors. To ensure the safety of patients from infection with TTIs, this study suggests establishing a centralized online data for all blood banking units at Saudi Arabia. Highly accurate and advanced techniques such as nucleic acid amplification techniques should be used for proper screening of donor`s blood. This will aid the early detection of TTIs and further minimize the transmission of TTIs. Emphasizing on the vital points in the transmission of TTIs could help in developing a framework for the future of transfusion medicine and blood bank policy.

DECLARATIONS

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Conflict of Interest

Authors declare that they have no conflict of interest in this research.

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