Prevalence of ABO and Rh blood groups and their association with Transfusion-Transmissible Infections (TTIs) among Blood Donors in Islamabad, Pakistan

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Abstract

Certain Rh positive blood groups showed a link between the ABO blood grouping and susceptibility to some infectious ailments. Study was carried out to find the association of
ABO Blood Group System / Rh type with different viral infection. A retrospective observational study was carried in 7631 blood donors to find the association of ABO Blood Group System / Rh type with viral infection due to hepatitis B virus, hepatitis C virus, human immunodeficiency virus and Syphilis. Data of the study indicate that the highest incidence of blood group in blood donor was B followed by O, A and AB. The incidence of HBsAg +ve, HCV Ab +ve and infection of Syphilis was also highest in donor with blood group B followed by O, A and AB. Blood group A were more susceptible to HIV Ab +ve followed by blood group B, O and AB. The group B donors had the greatest risk of viral infection with HBV, HCV, HIV, and Syphilis; followed by the groups O, A, and AB. Donors in group AB had the lowest incidence rate of all viral infection. The study revealed that blood group B is most prevalent among donors, followed by blood groups O, A, and AB. On the other side, the rate of HBV, HCV, HIV, and Syphilis infection was greatest among group B donors, followed by group O, group A, and group AB.

**Key Words:** ABO Blood Group System, HBV, HCV, HIV, Syphilis

1. **Introduction**

Blood group antigens signify polymorphic characteristics inherited among people. Variances in expression of blood group antigen may enhance or decrease susceptibility of host to numerous infections [1]. The role of Blood groups in infection is that they may serve as receptor / co-receptor for bacteria, virus and parasites. Additionally, antigens of some blood group enable uptake in cell, signal transduction, or hold micro-domains of membrane. Blood groups can also alter the innate immune reaction to infection [2, 3].

The ABO system is the most common congenital blood group system, and it is responsible for the distribution of blood types to individuals through the inheritance of A and B genes [4]. The glycosyl-transferase gene genes for an enzyme that assigns N-acetyl D-galactosamine (group A) and D-galactose (group B) to glycans found on glycoproteins and glycolipids. Group O persons, on the other hand, have dormant ABO genes and merely display the precursor of the H antigen [2].

Microbes also have the ability to stimulate antibodies against antigens of ABO blood group. The ABO antibodies can be taken as the portion of the innate immune system against some pathogenic bacteria and covered viruses that bring ABO-active antigens. Besides Blood groups have the ability to behave as false receptors, block the binding to target tissue. ABO is the main inherited blood group system responsible for the distribution of blood groups among people through the inheritance of A and B genes. Some blood groups have been found to be able to serve as receptors and ligands for bacteria, viruses and parasites. Research has also
revealed that ABO antigens can block the binding of TTI agents to polysaccharide, but cells that lack these antigens are at risk for TTIs [5, 2].

Hepatitis C virus (HCV), hepatitis B virus (HBV), and human immunodeficiency virus (HIV), are the chief causes of death worldwide [6]. Globally, 36.70 million persons were infected with HIV infection; 25.70 million persons were infected with HBV infection, and 71.0 million people with infection of HCV. It is assessed that 2.30 million and 2.70 million persons are infected with HIV/HCV and HIV/HBV co-infection correspondingly due to their same mode of transmission [7]. According to a Pakistani study, the prevalence rate of hepatitis B and hepatitis C was 6.7 and 14.3% respectively with 80% Co-morbidities of HIV/HCV and 20% of HBV/HCV [8, 9].

Individuals with chronic infection of hepatitis have increases chances of cirrhosis of liver and cancer with risk of other diseases. These infections are highly transmissible and a main task for clinician [10]. HCV and HBV infections are known among cases with infection of HIV due to shared course of viral transmission. Comorbidities like liver problems due to infection of HCV or HBV is an important issue in HIV-infected cases [11].

Syphilis is due to the *Treponema pallidum* that may infect by entering into the mouth lining of genital area. Prevalence rates of Syphilis have increased worldwide especially in homosexual men and in HIV donors [12].

In Pakistan, viral hepatitis (HCV, HBV) is a grave health problem affecting millions of individual in all parts of Pakistan, including Punjab. Besides an increase rate of occurrence of Syphilis is also observed. To date, the prevalence rates of TTIs and the frequency of ABO and Rh blood groups in Islamabad, Pakistan have not yet been studied. Thus, the aim of this study was to assess the sero-prevalence of HBV HCV, HIV and Syphilis in association with blood groups and the possible association between blood groups and viral infection.
2. Methodology

This is an observational retrospective research done at the Pakistan Institute of Medical Sciences (PIMS) in Islamabad, Pakistan, during a 5-year period (from 2016 to 2021). The PIMS Islamabad's research ethical committee provided ethical support. The trial comprised 7631 consenting donors with just HCV, HBV, HIV, or Syphilis ranging in age from 18 to 60 years. The chemiluminescent microparticle immunoassay was used to screen for HBV, HCV, HIV, and Syphilis (CMIA) [13].

2.1 Data Analysis

Data was analyzed by SPSS 20. The frequency and percentages of HCV, HBV, HIV and Syphilis infected donors was assessed by descriptive statistics. Correlation between blood group and viral infections was estimated by Pearson Regression analysis.
3. Results

Distribution of HBV & HCV infection among donors based on blood group borderline positive and positive out of the 7631 donors for every blood group is tabulated as table 1. It is observed that among 7631 donors, 8.4% donors with blood group A were infected with HBV, 10.6% cases with blood group B, 9.8% cases with blood group O and 3.2% cases belong to blood group AB.

Among 643 blood group A donors infected with border line HBsAg +ve were 7.9%, HBsAg +ve were 83.8%. Among 809 blood group B donors infected with border line HBsAg +ve were 7.29%, HBsAg +ve were 83.9%. Among 753 blood group O donors infected with border line HBsAg +ve were 6.3%, HBsAg +ve were 80.5%. Among 247 blood group AB donors infected with border line HBsAg +ve were 6.8%, HBsAg +ve were 83.8%.

Among 878 blood group A donors infected with border line HCV Ab +ve were 23.9%, HCV Ab +ve were 67.99%. Among 1201 blood group B donors infected with border line HCV Ab +ve were 22.89%, HCV Ab +ve were 68.4%. Among 1063 blood group O donors infected with border line HCV Ab +ve were 35.4%, HCV Ab +ve were 67.16%. Among 78 blood group AB donors infected with border line HCV Ab +ve were 31.6%, HCV Ab +ve were 69.61%.

Distribution HIV & Syphilis among donors based on blood group baseline positive and positive out of the total no of donors for every blood group is tabulated as table 2.

Among 77 blood groups A donors infected with border line HIV Ab +ve were 44.1%, HIV Ab +ve were 45.45%. Among 69 blood group B donors infected with border line HIV Ab +ve were 40.57%, HIV Ab +ve were 43.47%. Among 65 blood group O donors infected with border line HIV Ab +ve were 58.46%, HIV Ab +ve were 33.84%. Among 26 blood group AB donors infected with border line HIV Ab +ve were 53.84%, HIV Ab +ve were 46.15%.

Among 353 blood group A donors infected with border line Syphilis Ab +ve were 6.79%, and Syphilis Ab +ve were 85.26%. Among 551 blood group B donors infected with border line Syphilis Ab +ve were 3.26%, and Syphilis Ab +ve were 86.93%. Among 446 blood group O donors infected with border line Syphilis Ab +ve were 3.81%, and Syphilis Ab +ve were 86.77%. Among 111 blood group AB donors infected with border line Syphilis Ab +ve were 4.50%, and Syphilis Ab +ve were 86.48%.

Table 3 and Figure 1 show the prevalence of serologic and clinically confirmed viral infection in susceptible donors. The incidence rate of viral infection with HBV, HCV, HIV,
and Syphilis was greatest among blood group B donors, followed by blood groups O, A, and AB. Donors in group AB had the lowest prevalence of viral infection overall.

Among ABO blood system based on A–ve, B–ve, O–ve and AB–ve, we observed the rate of incidence of viral infection due to HBV, HCV, HIV and Syphilis is very low. It is found that donors with blood group A and blood group O were highly infected with HBV followed by HCV, Syphilis and HIV. On the other hand donors with blood group B and blood group AB were highly infected with HCV followed by HBV, Syphilis and HIV (data not shown).

Table 1: Distribution of HBV & HCV infection among donors based on blood group baseline positive and positive out of the total no of donors for every blood group.

<table>
<thead>
<tr>
<th>Blood Group</th>
<th>Total No Donors With HBV</th>
<th>BL HBsAg + ve (%)</th>
<th>HBsAg + ve (%)</th>
<th>Total No Donors With HCV</th>
<th>BL HCV Ab + ve (%)</th>
<th>HCV Ab + ve (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blood group A</td>
<td>643 (8.4%)</td>
<td>51 (7.9%)</td>
<td>526 (81.8%)</td>
<td>878 (11.5%)</td>
<td>210 (23.91%)</td>
<td>597 (67.99%)</td>
</tr>
<tr>
<td>Blood group B</td>
<td>809 (10.6%)</td>
<td>59 (7.29%)</td>
<td>679 (83.9%)</td>
<td>1201 (15.7%)</td>
<td>275 (22.89%)</td>
<td>822 (68.44%)</td>
</tr>
<tr>
<td>Blood group O</td>
<td>753 (9.8%)</td>
<td>48 (6.37%)</td>
<td>606 (80.5%)</td>
<td>1063 (13.9%)</td>
<td>267 (35.4%)</td>
<td>714 (67.16%)</td>
</tr>
<tr>
<td>Blood group AB</td>
<td>247 (3.2%)</td>
<td>17 (6.88%)</td>
<td>207 (83.8%)</td>
<td>339 (4.4%)</td>
<td>78 (31.6%)</td>
<td>236 (69.61%)</td>
</tr>
<tr>
<td>Total</td>
<td>2452</td>
<td>175</td>
<td>2018</td>
<td>3481</td>
<td>830</td>
<td>2369</td>
</tr>
</tbody>
</table>

BL=Border line

Table 2: Distribution HIV & Syphilis among donors based on blood group baseline positive and positive out of the total no of donors for every blood group
Table 3: Distribution of Serologic and Clinically confirmed viral infection in susceptible donors

<table>
<thead>
<tr>
<th>Blood Group</th>
<th>Total No Donors With HIV</th>
<th>BL HIV Ab + ve (%)</th>
<th>HIV Ab + ve (%)</th>
<th>Total No Donors With Syphilis</th>
<th>BL Syphilis Ab + ve (%)</th>
<th>Syphilis Ab + ve (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blood group A</td>
<td>77 (1.0%)</td>
<td>34 (44.15%)</td>
<td>35 (45.45%)</td>
<td>353 (4.6%)</td>
<td>24 (6.79%)</td>
<td>301 (85.26%)</td>
</tr>
<tr>
<td>Blood group B</td>
<td>69 (0.9%)</td>
<td>28 (40.57%)</td>
<td>30 (43.47%)</td>
<td>551 (7.2%)</td>
<td>18 (3.26%)</td>
<td>479 (86.93%)</td>
</tr>
<tr>
<td>Blood group O</td>
<td>65 (0.8%)</td>
<td>38 (58.46%)</td>
<td>22 (33.84%)</td>
<td>446 (5.8%)</td>
<td>17 (3.81%)</td>
<td>387 (86.77%)</td>
</tr>
<tr>
<td>Blood group AB</td>
<td>26 (0.3%)</td>
<td>14 (53.84%)</td>
<td>12 (46.15%)</td>
<td>111 (1.45%)</td>
<td>5 (4.50%)</td>
<td>96 (86.48%)</td>
</tr>
<tr>
<td>Total</td>
<td>237</td>
<td>114</td>
<td>99</td>
<td>1461</td>
<td>64</td>
<td>1263</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Blood group</th>
<th>Serologic effect HBV (freq and % ages)</th>
<th>Total No HBV</th>
<th>Serologic effect HCV</th>
<th>Total no HCV</th>
<th>Serologic effect HIV</th>
<th>Total no HIV</th>
<th>Serologic effect Syphilis</th>
<th>Total No Syphilis</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>HBV +ve = 526 (89%)</td>
<td>HBV +ve = 597 (92%)</td>
<td>HCV +ve = 597 (92%)</td>
<td>HIV +ve = 43 (81%)</td>
<td>Syphilis +ve=301</td>
<td>326 (92%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>HBV +ve</td>
<td>HBV –ve</td>
<td>HCV +ve</td>
<td>HCV –ve</td>
<td>HIV +ve =</td>
<td>HIV –ve =</td>
<td>Syphilis +ve</td>
<td>Syphilis –ve</td>
</tr>
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<td>---------</td>
<td>-----------</td>
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<td>-------------</td>
<td>--------------</td>
</tr>
<tr>
<td>B</td>
<td>679 (91.7%)</td>
<td>61</td>
<td>822 (92%)</td>
<td>71</td>
<td>30 (73%)</td>
<td>11</td>
<td>479 (90%)</td>
<td>49</td>
</tr>
<tr>
<td>O</td>
<td>606 (87%)</td>
<td>89</td>
<td>714 (91.5%)</td>
<td>66</td>
<td>22 (81%)</td>
<td>5</td>
<td>387 (90%)</td>
<td>42</td>
</tr>
<tr>
<td>AB</td>
<td>207 (90%)</td>
<td>22</td>
<td>236 (92.5%)</td>
<td>19</td>
<td>12 (100%)</td>
<td>0</td>
<td>96 (92%)</td>
<td>8</td>
</tr>
</tbody>
</table>

Figure 1: Distribution of Serologic and Clinically confirmed viral infection in susceptible donors

4. Discussion
HIV alters the immunity of cells resulting in increased HBV replication, and in turn HBV increases the replication of HIV by stimulating the secretion of cytokines and factors associated with transcription. This upsurge in replication both HBV & HCV may help the alteration of body immune system [14].

We observed 7631 donors visited PIMS hospital with viral infection (HBV, HCV, HIV, and Syphilis). Among these donors, highest frequency and percentage was of blood group antigen B (10.6%) followed by blood group O antigen (9.8%), blood group A antigen (8.4%) and blood group AB antigen (3.2%). According to an Indian study carried out on 9280 people the, blood group B (37.39%) was the most known blood group, followed by blood group O (31.85%) (15). A lowermost frequency of blood group AB⁻ was observed all over the world (16). However, a study carried out in ABO blood group of 4,744 people of Gabon. Study found that phenotypic percentages of blood group antigens O, A, B and AB were 58.9%, 21%, 17% and 2.6% [17]. The incidence of the ABO blood groups were compared with data of a study in Gabon that found the frequencies of blood group was 20.0 % for A blood group, 17.30% for B blood group, 4.10% for AB blood group and 58.60% for blood group O (18).

It is proposed that worldwide distribution array of blood groups depends on many environmental factors, like climate, humidity, altitude etc. Like type B allele is highest in people of Central Asia and lowermost among the native peoples of Australia and America [19]. Prevalence of ABO phenotypic is different in different countries that may be due to the genetic distance between different populations [17, 18].

Based on the infection, the most common infection in our study groups was Syphilis followed by HBV, HCV and HIV. A study of ABO blood groups concerned with 4,744 donors residing in Gabon. Study found HBV seroprevalence was two time high among O negative donors as compared to O +ve donors. Study suggested a significant correlation between ABO blood group and HBV infection [17]. However a study carried out on 365,029 Jordanian people and found that among all blood groups, HBsAg was the highly predominant viral infection followed by HCV, Syphilis, and HIV [20].

We found that on the basis of viral infection, donors with blood group B were infected mostly with HCV, Syphilis followed by HBV and HIV. A study carried out in country of central Africa and also found that HCV was highly detected in B + ve followed by A + ve, AB + ve and O + ve [17]. A cross-sectional study was carried out in Brazil between periods of eleven years and reported that there is high percentage of anti-hepatitis B surface / core antigens of HIV donors [21]. However a survey based on thirty studies was include 241 868 HBV-infected subjects and suggested that there is low rate of HBV infection in blood group B [22].
According to our study donors with blood group A were infected equally with HCV, Syphilis followed by HBV and HIV. A study was carried out in the city of Peshawar on 41033 seemingly healthy subjects. Study observed that blood group A people are at risk to develop HIV and HBV [23].

Our data showed that donors with blood group O were infected equally with HCV, Syphilis followed by HBV and HIV. However, a study carried out in Central Africa and found higher incidence of HBsAg in subjects with blood group O + ve followed by HCV, Syphilis and HIV [20]. A Pakistani study found Blood group O may have a role in prevention of blood spread infection [23].

We observed that donors with blood group AB were infected equally with HCV, Syphilis followed by HBV and HIV. According to a research, persons with blood group AB + ve had the greatest risk of Syphilis infections, followed by O + ve, A + ve, and B + ve groups [23].

We agreed with the findings of a research conducted at Iraq's Alanbar University, which comprised 430 healthy people. According to the study, patients with blood group O had the greatest proportion of HBsAg and HCV Ab, while those with blood group AB with Rh positive had the lowest rate. The percentages of HBsAg and HCV Ab were found to be greater in blood group B donors and lower in blood group AB donors, respectively, whereas the distribution of Rh in hepatitis infected donors was found to be higher among Rh positive donors [24].

A retrospective study carried out in Iran for a period of six years. Study reported that individuals with AB blood group are more at risk of developing Hepatitis B and C infection in comparison with other blood groups. The reason is that this blood group has no antibodies against antigens A and B. These realities have an important role in defining the usual resistance of body of human against infectious agents with the similar surface antigens [25].

We observed that all blood groups were least affected by HIV. In regard to HIV infection, the highest infection was noted in AB + ve followed by O + ve, B + ve and A +ve.

According to our study the incidence rate of Syphilis is equally high to HCV followed by HBV and lowermost rate of incidence of HIV. A study was carried out on 57,308 Indian people for screening the venereal disease Syphilis. Study observed that prevalence rate of Syphilis was 1.27 %, and false positive rate was 0.14 %. It is concluded that though the general sero-prevalence of Syphilis is small; the frequency of incidence of false positive reactions is alarming [26]. A study suggested that high incidence rate of Syphilis may be a reason of loss of vision [27]. Prevalence rates of Syphilis have increased all over the world, typically homosexual men and the individual with HIV [12]. A study demonstrated that most
of the reports of Syphilis were based on false-negative serologic results and late presence of sero-reactivity [28].

Direct significant correlation was observed between incidence of all blood groups with viral infections HBV, HCV, HIV and Syphilis (Fig 2-5). However, a study observed no correlation between the incidence of HBV, HCV, HIV & Syphilis and ABO blood groups [17].

Limitation of study: Only ABO system with Rh positive groups was included in the study. Additionally blood donors with occult viral infection of HBV, HCV, HIV and Syphilis (Viral DNA +ve, but viral Ag –ve) were unnoticed. There is a need to use sensitive test for the detection of all types of viral DNA +ve.
5. Conclusion

According to the findings, blood group B has the highest prevalence among blood donors, followed by blood groups O, A, and AB. The incidence of HBV, HCV, HIV, and Syphilis infection was highest among group B donors, followed by group O, group A, and group AB. Donors belonging to group AB had the lowest risk of viral infection overall.

It is proposed that research be conducted on a large number of instances in order to avoid viral infections that might cause hepatitis and other illnesses. A greater level of awareness and vaccination is required.

Conflict of Interest

The authors declare no conflict of interest.
References


Fig 2: Strong positive correlation between HCV and different blood groups.

(A) Represents HCV in blood group A, (B) represent HCV in blood group B, (C) represent HCV in blood group O and (D) represent HCV in blood group AB
Fig 3: Strong positive correlation between HBV and different blood groups

(A) Represents HBV in blood group A, (B) represent HBV in blood group B, (C) represent HBV in blood group O and (D) represent HBV in blood group AB
Fig 4: Strong positive correlation between HIV positive cases and different blood groups

(A) Represents HIV in blood group A, (B) represent HIV in blood group B, (C) represent HIV in blood group O and (D) represent HIV in blood group AB
Fig 5: Very strong positive correlation between Syphilis positive cases and different blood groups

(A) Represents Syphilis in blood group A, (B) represent Syphilis in blood group B, (C) represent Syphilis in blood group O and (D) represent Syphilis in blood group AB