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Distribution of ABO Blood Groups and Rhesus Factor in Fayoum City, Egypt

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Abstract

Background: Blood transfusion is a life-saving procedure, and deficiency of blood groups for transfusion in critically ill patients can be life threatening. This study was done to know the distribution and frequencies of ABO and Rh blood groups among blood donors and recipients and their associated transfusion-transmitted infections (TTIs) among blood donors at Fayoum University Blood Bank and Hospital, Egypt. Thus, the demand and supply ratio of the four blood groups can be maintained so that endangering patients 'lives due to lack of a particular blood group could be overcame. Also, screening of blood products is considered a mandatory protocol implemented in health care facilities in order to reduce the onset of transfusion-transmitted infections (TTIs).

Subjects and methods: The study included blood grouping of total population of 16,972 donors and recipients attending Fayoum University Hospital Blood Bankduring a period of one year from December 2018 to December 2019. Analysis of ABO and Rh-D blood groups was performed by using column-gel agglutination technique for all samples. The blood samples were also screened for hepatitis B surface antigen (HBsAg), anti-, hepatitis C virus (HCV) antibody, human immunodeficiency viruses antibody (HIV), and for syphilis by using chemiluminescent microparticle immunoassay (CMIA) method; performed on ARCHITECT i1000SRImmunoassay System (AbbottTM, Abbott Park, Illinois, U.S.A.).

Conclusion: This study provides the prevalence of ABO and Rh blood group among blood donors and recipients and also their associated transfusion-transmitted infections (TTIs) among blood donors at Fayoum University Blood Bank and Hospital, Egypt. The results showed that blood type (A) had the highest frequency of (37.91%), followed by blood type (O) with a rate of 27.43%. Blood type (B) with a percentage of (24.12%) and the lowest frequency is blood type (AB) with a percentage of (10.54%). Moreover, the frequency of Rh negative was significantly lower compared to that of Rh positive. Collectively, our findings revealed the fact that certain blood groups lack behind the actual needs of recipients. In acute settings and emergencies, this could jeopardize recipient's lives, if suitable blood is not available on time to suffice patient clinical needs, and to prevent disabilities or even death. The results also showed that the serological tests were positive in the donors and it was found that 5.39% of them were 1.37%

positive for hepatitis B surface antigen (HBsAg), 3.89% for hepatitis C virus, 0.02% were positive for HIV and 0.11% were positive for syphilis.

Keywords
ABO, Rh, Blood Group, TTI, hepatitis B virus (HBV), hepatitis C virus (HCV), human immunodeficiency virus (HIV), syphilis

1. Introduction

The distribution and prevalence of ABO and Rh varies in different population groups and an understanding of their distribution helps in an efficient delivery of transfusion services **[1].**

Blood transfusion is an essential part of medicine. It is vital, noble and necessary as it is used in the treatment and management of various life threatening illness. However, it carries with it the risk of transfusion transmitted diseases. This Transfusion Transmitted Infection's (TTI) can be broadly classified as viral, parasitic, bacteria and spirochaetal. Amongst the viral infectionsare those transmitted by Hepatitis Bvirus (HBV), Hepatitis C virus (HCV), Human Immunodeficiency Virus (HIV) , and syphilis **[2].**

Blood transfusion is an essential part of medicine. It is vital, noble and necessary as it is used in the treatment and management of various life threatening illnesses. However, it carries with it the risk of transfusion transmitted diseases.

The ABO Blood Group System is the most common congenital blood group system. It is responsible for the distribution of blood types among individuals through theinheritance of A and B genes **[3]**. H antigen is formed either by the addition of α1-2 fucose by FUT1 or H-glycosyltransferase.H antigen can then serve as a substrate for ABO glycosyltransferase. Group A individuals express an α1-3 N- acetylgalactosamine (GalNAc), while group B individuals express an α1-3 galactose (Gal). Whereas, Group O individuals have inactive ABO genes and express only the H-antigen precursor **[4].**

The Rh blood group system is the most polymorphic blood group antigen, and the most immunogenic after the ABO blood group, and it is the most clinically significant blood group in blood transfusion **[5,6]**. The distribution of the ABO-Rh blood group varies markedly in different races and ethnic groups in different parts of the world **[7].**

The prevalence of TTIs remains high in most regions of Asia and Africa even with the transfusion safety assistance provided by World Health Organization (WHO) and various other organizations to limitthe risk of TTIs **[8]**. To reduce the risk related to TTI exposure during blood transfusion,the WHO endorses compulsory screening of every blood donor for HBV, HIV, HCV, and syphilis infections **[9]**. Implementation of these recommendations along with the induction of advance and more sensitive screening techniques no doubt have substantially abridged the of risk of exposure of TTIs by blood transfusion in those countries which showed compliance and took serious measures **[10,11]**. However the possibility of exposure to TTIs still remains comparatively high in underdeveloped countries if compared with developed countries mainly because of lack of resources and funds required for implementation of sensitive testing techniques **[10].** Besides taking serious steps to minimize the risk of TTIs associated to exposure from blood transfusion it's also vital to identify the blood group of the person donating blood as mismatched blood transfusion can lead to serious consequences in the patient receiving it, ranging from life threatening anaphylaxis reaction to death. Numerous blood group systems have been identified up to date however classification of blood by ABO and Rhesus factor (Rh) blood groups was considered as most imperative categorization **[12].** The first human ABO blood group system was discovered by an Austrian immunologist named Karl Landsteiner in 1901 and later in 1941 Landsteiner and Wiener defined the Rh system, the second most important blood group system after ABO system **[12, 13]**.

Hepatitis C virus (HCV), hepatitis B virus (HBV), and human immunodeficiency virus (HIV) are chief causes of death, worldwide **[14]**. Globally, it was reported that 36.70 million people are infected with HIV infection, 25.70 million /people areinfected with HBV infection, and 71.0 million people are infected with HCV infection. It was assessed that 2.30 million and 2.70 million people are infected with HIV/HCV and HIV/HBV co-infection due to their same mode of transmission **[15]**.

HCV and HBV infections are known among cases with HIV infection due to their shared course of viral transmission. Co-morbidities such as liver problems due to HCV or HBV infection are an important concern in HIV-infected cases [**16]**.

Syphilis is due to Treponema pallidum that may infect an individual by entering into the mouth lining of the genital area. The prevalence rate of syphilis has increasedworldwide, especially in homosexual men and in HIV donors **[17]**. The risk of transmission of transfusion transmitted diseases (TTD) is 1% per transfusion **[18]**.

The present study is an attempt to describe the distribution of ABO, Rh blood groups and TTIs among blood donors at Fayoum University Hospital Blood Bank, Fayoum; as a step to improve blood transfusion services at Fayoum city.

2. Methodology

2.1. Sample Collection and Blood Group Testing

This is an observational retrospectiveresearch carried out at the Fayoum University Hospital Blood Bank in Fayoum Egypt, over a one year period (from December 2018 to December 2019). Fayoum University Hospital's research ethicscommittee provided ethical support. The study included 16,972 subjects who were randomly selected from donors and recipients referred to Fayoum University Hospital Blood Bank.ABO and Rh-D blood groups'identification was carried out by usingcolumn-gel agglutination technology and the "ABO/D + Reverse Grouping" ID card.Bloodsample for donors, blood was collected in a tube containing ethylenediamine tetra ethyl acetic acid (EDTA) after the collection of blood unit.For recipients, 3.5 ml of venous blood were collected by venipuncture under complete sterile conditions in a tube containing ethylenediamine tetra ethyl acetic acid (EDTA).

The conventional method of blood grouping was used to identify theblood group of subjects. It was performed by using anti-sera (A, B and D) for agglutination test.

The obtained results were recorded and were further confirmed according to the standard procedure. Thesamples were centrifuged at a high speed toobtain a clear supernatant serum.

2.2. Chemiluminescent MicroparticleImmunoassay

Chemiluminescent Microparticle Immunoassay (CMIA) was used to screen for HBV,HCV, HIV, and syphilis. CMIA is a formof immunoassay which is performed in two steps using chemiluminescent microparticles. Anti HCV and HBV antigens are determined by

comparing thechemiluminescent signal in the reaction to the cutoff signal. Reactive and non-reactive results were interpreted on the basis of the observed signal to the cutoff ratio (S/Co ratio) as defined by the manufacturer. All samples with the S/Co ratio of ≥ 1.0 weredeclared as anti HCV reactive **[19]**.

2.3. Data Analysis

The data was first recorded in Microsoft Excel for Windows 10 software and then analysed via SPSS 20.

3. Results

A. Demographics of study population

Our study included a total of 16972 study subjects, of which Donors were 8938, and Recipients were 8034, all attended Fayoum University Hospital Blood Bank. Of 16972 total blood samples, 12408 (73.11%) belonged to males while 4564 (26.89%) belonged to females (**Table 1)**. Considering donors and recipients separately, of 8938 total donors, our results showed that the prevalence of males among donors was 7929 (88.71%) while the prevalence of females was 1009 (11.29%). Likewise, of 8034 total recipients, our results showed that the prevalence of males among recipients was 4392 (54.67%) while the prevalence of females was 3642 (45.33%) (**Table 1)**. Our data showed that number of male donors greatly outnumbers those of female donors, although numbers of both genders are almost equal among donors and recipients.

Table (1): Gender distribution in the studied population.

Gender	**Study group (n=16972)**	
Male	12408	73.11
Female	4564	26.89
Gender	**Donors (n=8938)**	**Recipients (n=8034)**

	No.	%	No.	%
Male	7929	88.71	4392	54.67
Female	1009	11.29	3642	45.33

B. ABO blood group and Rh (D) factor distribution among donors and recipients

Our data showed that out of 16972 total subjects, blood group A, 6434 (37.91%) appeared to be the most common phenotype, followed by O, 4656 (27.43%), B, 4094 (24.12%) and AB, 1788 (10.54%). Also, our study showed that Rh positive was found in 15515 (91.42%) while Rh negative was found in 1457 (8.58%) (**table 2)**.

Considering donors and recipients separately, of 8938 collected blood donor samples, 3500 (39.16%) belonged to group A, 2460 (27.52%) were group O, 2186 (24.46%) were group B and 792 (8.86%) belonged to group AB. While Of 8034 recipients, blood group A, 2934 (36.52%) appeared to be the most common phenotype, followed by O, 2196 (27.33%), B, 1908 (23.75%) and AB, 996 (12.40%) **(table 2)**.

Regarding Rh blood group, of 8938 total donors, 8213 (91.89%) were Rh D-positive and 725 (8.11%) were Rh D-negative. As for recipients, out of 8034, 7302 (90.89%) were, Rh positive while 732 (9.11%) were Rh negative **(table 2)**.

Table (2): ABO blood group, Rh (D) factor distribution in donors and recipients

ABO and Rh(D) blood group	Number of donors	Percentage	Number of recipients	Percentage
A positive	3233	36.17%	2634	32.79%
	5867 (34.56%)			
A negative	267	2.99%	300	3.73%
	567 (3.34%)			
Total "A"	***3500***	***39.16***	***2934***	***36.52***
	6434 (37.91%)			
O positive	2223	24.87%	1962	24.42%
	4185 (24.65%)			
O negative	237	2.65%	234	2.91%
	471 (2.77%)			
Total "O"	***2460***	***27.52***	***2196***	***27.33***
	4656 (27.43%)			
B positive	2011	22.50%	1746	21.73%
	3757 (22.13%)			
B negative	175	1.96%	162	2.02%
	337 (1.98%)			
Total "B"	***2186***	***24.46***	***1908***	***23.75***
	4094 (24.12%)			
AB positive	746	8.35%	960	**11.95%**
	1706 (10.05%)			
AB negative	46	0.51 %	36	0.45%
	82 (0.48%)			
Total "AB"	***792***	***8.86***	***996***	***12.40***
	1788 (10.54%)			
Rh D-positive	8213	91.89	7302	90.89
	15515 (91.42%)			
Rh D-negative	725	8.11	732	9.11
	1457 (8.58%)			
Total	**8938**	**100%**	**8034**	**100%**

C. Frequency of distribution of transfusion-transmitted infections (TTIs) among blood donors

As shown in **table (3)** out of total studied blood donors (n = 8938), The prevalence of seropositive donors was considered to be significantly low. In 482(5.39%)Out of which 348

(3.89 %) was tested positive for HCV, 122 (1.37%) for HBsAg and 10 (0.11%) were positive for syphilis. and 2 (0.02 %) were positive for HIV.

Table (3): Frequency of distribution of transfusion-transmitted infections (TTIs) among blood donors at at Fayoum University Hospitals, Fayoum, Egypt.

Parameters	Study group (n=8938)	
	No.	%
Seropositive donors	482	5.39
Seronegative donors	8456	94.61
HCV	348	3.89
HBsAg	122	1.37
Syphilis	10	0.11
HIV	2	0.02

4. Discussion

Blood transfusion is a life-saving procedure, and deficiency of blood groups for transfusion in critically ill patients can be life threatening. Knowledge of the distribution of ABO groups among any population is useful in healthcare planning and appropriate allocation of resources. This study was done to know the distribution and frequencies of blood groups among blood donors and recipients attending Fayoum university hospital. Thus, the demand and supply ratio of the four blood groups can be maintained so that endangering patients' lives due to lack of a particular blood group could be overcame.

The current study comprised 16,972 subjects who were selected randomly from both blood donors and recipients who attended Fayoum University Hospitals in the period from December 2018 till December 2019 to evaluate the frequency of distribution of ABO and Rh blood groups

in both groups, and the associated TTIs among blood donors. Samples were typed for ABO and Rh blood groups. Screening the donor blood was performed for common infections which can be transmitted via blood transfusion (TTIs), namely HBV, HCV, HIV and Syphilis.

In this study, 'A' blood group showed the highest frequency (37.91%) followed by O (27.43 %), then B (24.12%) and lastly AB (10.54%).

There is wide variation in the frequencies of ABO antigens throughout the world, and throughout Egypt governorates, and there is insufficient published data from Fayoum governorate about this issue.

The current study results agreed with a study conducted in Egypt, Ismailia, Suez Canal University Hospital, **[20].** in which the frequencies of A, O, B and AB groups were 39.4%, 25.9%, 24.1%, and 10.6%, respectively

Another study done in Egypt **[21]** also showed that A was the most common blood group (35.12%) followed by O at 31.94%, B at 23.12%, while AB had the least prevalence at 9.74%.

Moreover, the current study results agreed with a study conducted in Egypt, Tanta having group A to be the most common group (36.9%) followed by O (30.7%) then B (23.2%) and the least common was AB (9.2%) **[22].**

On the other hand, a Saudi Arabia study conducted on 4590 donors reported different frequencies having blood group O as the most common (47.45%) followed by A (26.2%), B (23%) and the least common AB (3.9%)**[23]**.

Another study in the Greater-Accra region of Ghana reported different frequencies, having O, A, B and AB to be 50.0%, 24.3%, 20.7% and 5.0%, respectively **[24].**

In another study in Uganda, the frequencies of ABO blood groups were; blood group O (50.3%); blood group A (24.6%); blood group B (20.7%) and blood group AB (4.5%) **[25].**

The National Health Service's ability to function efficiently depends on having up-to-date knowledge of the distribution of blood types in a given area. Our research gives comprehensive data on the blood types and demographics of blood donors in Fayoum City, Upper Egypt.

In the current study we also tested the blood of the donors for common illnesses that can be transferred by blood transfusions (TTIs). Infection with HBV, HCV, HIV, and syphilis is a major public health concern around the world. The presence of the appropriate antigens or antibodies in blood serum is used to diagnose HBV, HCV, HIV, and syphilis **[26]**.

In our study we revealed that the overall cumulative frequency of TTIs in blood of donors was 5.39%. In same context to our study, other studies that were conducted in different countries showed nearly similar prevalence. The studies done in central region of Saudi Arabia **[23]**, Equatorial New Guinea **[27]**, Ethiopia **[28]**, Mozambique **[29]** and Burkina Faso **[30]** revealed a frequency of 1.002%, 18.7%, 6.55%, 37.39% and 24%, respectively.

In our study we also revealed that the frequency of HIV and syphilis were 0.02% and 0.11%, but HCV and HBV were 3.89% and 1.37%, respectively. Data from Egypt, in Suez Canal University hospital, blood bank in Ismailia **[31]** indicated that the prevalence of HIV and syphilis among blood donors were extremely low [0%] but HCV and HBV were 7.2% and 2.3%, respectively, still posed a significant risk of blood transmission.

Similar results were reported from Egypt in Beni-Seuf University hospital blood bank, where the seroprevalence of HCV, HBV, HIV and syphilis among blood donors were (9.4%, 1.6%, 0.1% and 0.0002%, respectively) **[32]**.

Egypt has the highest rate of hepatitis C virus (HCV) infection in the world, and there is a pressing need to raise public awareness and information about the disease. Given the low level of information about HCV among infected patients, Egyptian healthcare authorities should create national awareness campaigns urging HCV testing based on educational interventions and efforts to raise awareness. More research funding is also required to keep the HCV disease burden in Egypt from worsening **[33].**

Regarding RhD antigen, Rh positive subjects were (91.42%) and Rh-negative subjects were (8.58%). Notably, the number of female donors is much less (11.29%) compared to male donors (88.71%).

Considering ABO and Rh blood group altogether, in donors, AB positive blood group was 746 (8.35%), while in recipients AB positive blood group was 960 (11.95%). Also, among donors, O negative blood group was 237 (2.65%) while in recipients, O negative blood group was 234 (2.91%) and among donors, B negative blood group was 175 (1.96%) while in recipients, B negative blood group was 162 (2.02%). Thus, these blood groups availability lags behind what is expected to be available for recipients. Also, the frequency of Rh (D) negative groups was 8.11% among donors, while it was 9.11% among recipients.

Collectively, our findings revealed the fact that certain blood groups lack behind the actual needs of recipients. In acute settings and emergencies, this could jeopardize recipient's lives, if suitable blood is not available on time to suffice patient clinical needs, and to prevent disabilities or even death.

Patients who need blood transfusions as part of their clinical management have the right to expect that there will be enough and safe blood available to meet their needs. As a result, increased efforts are required to ensure the availability of specific blood types, particularly during crises.

As a result, it's critical to keep improving blood donation tactics based on accurate statistical analysis of the needs. One of the techniques is to persuade existing donors to keep giving blood. Research and evidence are required to inform future changes to blood donation policies and tactics in order to make the necessary adjustments to these policies and strategies.

5. Conclusion

The information collected for the frequency of ABO blood phenotypic groups has a vital significance in establishing a simple blood group database. This study provides a step to create a donor data bank for frequencies and distributions of blood groups among blood donors and recipients attending Fayoum University Hospital. This is essential to maintain sufficient to

provide compatible safe blood transfused patients. Also, This study clearly determined significantly lower rate of seropositive TTIs among the studied blood donors but still steps are needed to improve the knowledge and to prevent the seropositive occurrence of TTIs.

Further studies should be conducted on larger Egyptian populations to confirm the frequency of A blood group and its subgroups found in this study. More efforts should be done to recruit more donors, with special care towards female donors.

Policies should be established and followed to recruit voluntary, non-remunerated donors especially Rh-negative blood donors, servingtwo main aims: 1- maintain sufficient Rh-negative inventory, 2- Ensure better safety of blood units.

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