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Distribution of ABO and Rh-D Blood Group among Blood Transfusion Recipients in a Tertiary Health Care Centre: Panacea for an Effective Blood Transfusion Service

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Authors' contributions

This work was carried out in collaboration among all authors. Author JED Designed the study and performed the statistical analysis, Author MVT Wrote the protocol, and wrote the first draft of the manuscript. All authors read and approved the final manuscript.

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ABSTRACT

Aims: This study was designed to determine the distribution of ABO and Rh-D blood group of clients accessing blood transfusion services in Jos University Teaching Hospital.

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Study Design: Retrospective study.
Place and Duration of Study: Blood Bank of the Jos University Teaching Hospital from January 2022 to December 2022.
Methodology: Blood Transfusion request forms of all clients' were reviewed and compared with the Blood Bank in-house records excluding repeat requests.
Results: A total of 8,548 blood transfusion request forms obtained from the blood bank and clients' folders were reviewed and compared with the Blood Bank's in-house records excluding repeat requests. There were 3818(44.70%) males while females accounted for 55.30% of the subjects. Ages 0-9 accounted for 1100(12.87 %) of the study subjects while ages 30-39 had the highest request of 1874 (21.92%). The least request, 7 (0.10%) was among recipients between ages 100-109 with the females dominating. The ABO blood group O was the commonest at 47.00% closely followed by blood group B at 28.00% while blood groups A and AB accounted for 21.00% and 5.00% respectively. Rh-D antigen positive blood group accounted for 96.00% of all the subjects with Rh-D negative at 4.00%.
Conclusion: This study on the distribution of ABO and Rh-D blood group among blood transfusion recipients in our facility followed the O>B>A>AB pattern with Rh-D antigen positive blood group being the commonest. This finding will enhance annual health planning regarding blood needs in our facility towards an effective health care delivery.

Keywords: ABO; blood group; Rh-D; recipients; transfusion.

1. INTRODUCTION

The description of the ABO blood group system in the twentieth century marked a watershed in blood transfusion science. This discovery has led to further description of about 36 blood group systems with over 360 known red blood cell antigens to date [1]. Amidst several other blood group systems, the ABO and Rh-D blood groups are amongst the major blood groups with clinical significance [2]. The vast majorities of the red blood cell antigens has stable characteristics and are acquired via a simple Mendelian pattern of inheritance and hence are useful tools in paternity testing [3]. Another major clinical significance of red blood cell antigens stems from the fact that these antigens are a group of structural proteins and carbohydrates present on the extracellular surface of the red blood cell membrane giving it the ability to stimulate an immune response with antibody expression [4]. Antibodies in the ABO blood group system are typically present in the serum of healthy individuals as immunoglobulin M (Ig-M) and immunoglobulin G (Ig-G) against the ABO antigens and are mostly found in individuals that lack the A and B antigens [5]. The Rh blood group system is coded by complex allelic genes represented as Cc, Ee as well as D while'd' depicts the absence of the D antigen. In blood transfusion medicine, antigens A, B and D have been adjudged the most clinically important red cell antigens where donor-patient mismatch could trigger transfusion reactions of varying degrees with associated complications [6].

Frequencies of ABO and Rh-D blood groups have been studied in different populations Worldwide with each population exhibiting significant variation in characteristics that reflect genetic and ethnic variations notable in human populations [7]. Global distribution of the ABO blood groups A, O, B and AB has been reported as 41.00%, 47.00%, 9.00% and 3.00% respectively with established dominance of the O blood group while some studies in the United States of America, United Kingdom, Greece and Bulgaria also reported the dominant average frequency of blood group O as 46.70%, 46.63%, 34.21% and 35.80% respectively [8]. Studies from Cameroun, Guinea, Morocco, Iran, Bangladesh and Colombia showed varying distribution in ABO and Rh blood groups [9].

Expressions of the ABO antigens have been demonstrated in a variety of human cells and tissues as the platelets, epithelium, vascular endothelium, and sensory neurons among others. ABO blood group has also been associated with several human infectious diseases, neoplasms and metabolic disorders like diabetes. In rare cases, it has also been reported that certain diseases can alter a patient's blood group [10].

Nigeria is considered the largest Black Nation in the World with different tribes and ethnic groups and invariably genetic traits with resultant variation in gene frequency for the ABO and Rh blood groups spanning through the North to the Southern part of the country as well as East to West [11].

Several studies on blood group distribution have been carried out in our environment, especially among blood donors, ethnic groups and in physiologic states like pregnancy. However, little is known about the distribution of ABO and Rh D blood group among blood transfusion recipients in our study area. Given the complexities associated with varying disease conditions and the possible effect they could exact on the blood groups and eventually their distribution, this study seeks to determine the frequency distribution of ABO and Rh-D blood group in these subjects and also compare with previous reports from other studies to enhance data availability that will assist in policy formulation towards effective management of our blood transfusion services which is a major component of medical care globally.

2. MATERIALS AND METHODS

2.1 Study Setting

The study was conducted at the Blood Bank unit of the Department of Haematology and Blood Transfusion, Jos University Teaching Hospital, Jos, Plateau State, Nigeria.

2.2 Study Design

A retrospective review of the completed blood transfusion request forms and Blood Bank records of the Teaching Hospital from January 2022 to December 2022 was carried out excluding repeated requests.

2.3 Data Collection

Information extracted include request date, recipients' age and sex, requesting Department, Unit or Specialty, indications for request, and recipients' ABO and Rh-D blood group.

2.4 Determination of ABO and Rh Blood Groups

ABO and Rh typing were done at the hospital's Blood Bank. The specimen of choice was red blood cells and serum obtained from clotted blood sample that had been centrifuged. Reagents used were Anti-A, Anti-B and Anti-D anti-sera from Biotec Laboratories- United Kingdom. Other materials used were known standard A, B and O red blood cells, 0.9% saline water, 12 x 75 mm test tubes, Pasteur pipette, Centrifuge, positive and negative controls

2.4.1 ABO blood grouping

2.4.1.1 Cell grouping

Controls: Standard known A, B and O red cells were set up with Anti A, and Anti B antisera.

A 5 % suspension of washed test red cells was prepared. Two labelled test tubes 'A' and 'B' were used and a drop of anti-A was placed into the 'A' tube, while anti-B was placed in the 'B' tube. One drop of the red cell suspension was added to each tube using the Pasteur pipette, mixed and centrifuged for 15-20 seconds at 3500 revolution per minute (rpm). These were then gently re-suspended and examined for agglutination macroscopically and microscopically using the light microscope at X10 magnification.

2.4.1.2 Serum grouping

Controls: Anti-A, Anti-B anti sera were set up with the standard A, B and O cells serving as control

Three labelled test tubes 'A', 'B' and 'O' were used for serum grouping. Two drops of test serum were placed into each tube. One drop of known A-cell, B-cell and O-cell was added into the 'A', 'B' and 'O' labelled tubes respectively, mixed, and centrifuged for 15-20 seconds at 3500 rpm.

The mixtures were examined for agglutination and graded depending on the presence or absence of agglutination. Cell grouping results were confirmed with those in the serum grouping and vice versa [12].

Known positive and negative controls were included with every test or batch of manual tests.

2.4.2 Rh-D grouping

Blood samples of the subjects were set up alongside positive and negative controls. Five percent (5%) of washed red cell suspensions of the test sample were prepared. Three glass test tubes were labelled test, positive and negative control. A drop of anti-D is placed in each test tube labelled D-test, D-positive, and D-negative control. One drop of washed subjects' red cells was then added into the D-test tube while control cells were added to D-positive and D-negative tubes. The mixtures were gently mixed, and centrifuged for 15-20 seconds at 3500 rpm.

The mixture was then observed for agglutination and graded as positive or negative depending on the presence or absence of agglutination.

Rh-D positive red cells and Rh-D negative red cells were used as controls for the anti-D with every test or batch of manual tests. Those that were Rh-D negative were further confirmed using anti-human globulin to rule out weakly positive D antigen (*Du)* samples.

2.5 Ethical Approval

Ethical approval was obtained from the Jos University Teaching Hospital Health Research Ethics Committee.

2.6 Data Analysis and Presentation

Information gathered was analyzed using Epi Info Version 7.2.5.0 software. The results were reported in proportions and percentages, and presented in tables and charts respectively. Appropriate statistical test of significance were done using chi-square and as appropriate. *P* value less than 0.05 were considered statistically significant.

3. RESULTS AND DISCUSSION

3.1 Results

Eight thousand, five hundred and forty-eight (8548) blood transfusion request forms obtained from the blood bank and patients' folders were reviewed and compared with the Blood Bank's in-house records excluding repeated requests.

Of the 8548 subjects recruited for this study, 3822(44.70%) were males, while females accounted for 55.30%. While there is a general predominance of females as blood transfusion recipients, there were more males than females among the paediatric age group (Table 1).

Requests for blood were received from several Departments, Units and Specialties of the hospital for 465 different indications with the Department of Obstetrics and Gynaecology having the highest request of 2000 (23.4%). General Surgery followed with a request of 843 (9.9%) while the surgical subunits of Orthopaedics and Neurosurgery had frequencies of request at 674 (7.9%) and 569 (6.7%) respectively. Department of Haematology and Paediatric haemato-oncology unit saddled with the responsibility of managing several haematologic disorders like sickle cell disease and leukaemias accounted for 391 (4.6%) and 373 (4.4%) transfusion requests within the study period. The Nephrology, unit of the Department of Internal Medicine had the highest request of 420 (4.9%) mainly due to chronic kidney disease while the Dermatology unit from the same department had the least request of 4 (0.05%) due to Furunculosis (Table 2).The study demonstrated that the ABO blood group O is the commonest at 47.0% closely followed by blood group B at 28.0% while the A and AB blood groups account for 21.0% and 5.0% respectively (Fig. 1)

Table 1. Demographic characteristics of the subjects

Variables	Frequency (n)	Percentage (%)
Sex		
Males	3822	44.70
Females	4726	55.30
Total	**8548**	**100.00**
Age		
0-9	1100	12.87
10-19	741	8.67
20-29	1633	19.10
30-39	1874	21.92
40-49	1225	14.33
50-59	895	10.47
60-69	610	7.14
70-79	296	3.46
80-89	151	1.77
90-99	16	0.19
100-109	7	0.08
Total	**8548**	**100.00**

A total of 8194 (96.0%) of the subjects were Rh 'D' positive while 354 (4.0%) were Rh 'D' Negative (Fig. 2). The subjects who are of the ABO blood group O were predominantly Rh-D positive followed by those with ABO blood group B (Table 3). The female subjects accounted for the largest population of those with Rh-D positive blood group accounting for 4516(95.6%) while the males accounted for 144(3.8%) of those with the Rh-D negative blood group. No statistically significant difference, *P*= 0.13 (Table 4)

The blood group distribution by age did not demonstrate any statistically significant difference (Fishers exact= 1.0000) but it showed that the subjects within the ages 20-29, 30-39 and 40-49 had the highest frequency of blood transfusion request across all the blood groups (Table 5).

Table 2. Blood transfusion request by departments, units and specialties/indications with highest request

Departments/Units/Specialties	n (%)*	Indication with highest request	n (%)*
Accident and Emergency (A&E)	203(2.4)	Gunshot Injury/**RTA Polytrauma	31(15.3)
Cardiothoracic Surgery	263(3.8	Empyema Thoracis	21(8.0)
Cardiology	141(1.65)	Hypertensive Heart Disease	12(8.5)
Dermatology	4(0.1)	Furunculosis	4(100)
Endocrinology	128(1.5)	Chronic Kidney Disease	24(18.8)
Oto-rhino-laryngology (ENT)	138(1.16)	Tonsillitis	28(20.3)
Emergency Paediatric Unit (EPU)	294(3.4)	Malaria	64(21.8)
Gastroenterology	205(2.4)	Chronic Liver Disease	73(35.6)
Haematology	392(4.6)	Sickle Cell Anaemia	204(52.0)
Infectious disease	164(1.9)	Retroviral Disease	27(16.5)
Maxillo Facial Surgery	182(2.1)	Mandibular Fracture	26(14.3)
Nephrology	420(4.9)	Chronic Kidney Disease	202(48.1)
Neurology	100(1.2)	Cardiovascular Stroke	35(35.0)
Neuro-surgery	569(6.7)	Traumatic Brain Injury	247(43.4)
Obstetrics &Gynaecology (O&G)	2000(23.4)	Caesarean Section	1042(52.1)
Oncology (Adult)	89(1.0)	Cervical Cancer	34(38.2)
Orthopaedic Surgery	674(7.9)	**RTA Polytrauma	109(16.2)
Paediatric (General)	125(1.5)	Sepsis	23(18.4)
Plastic Surgery	300(3.5)	Leg Ulcer	48(16.0)
Paediatric Haemato-oncology	375(4.4)	Sickle Cell Anaemia	272(72.5)
Paediatric Surgery	256(3.0)	Typhoid Perforation	28(10.9)
Pulmonology	46(0.5)	Pulmonary Tuberculosis	15(32.6)
Rheumatology	82(0.9)	Sepsis	24(29.3)
Special Care Baby Unit (SCBU)	276(3.2)	Neonatal Jaundice	81(29.4)
Surgery (General)	835(9.8)	Breast Cancer	144(17.1)
Urology	287(3.4)	Prostate Cancer	61(21.3)
Total	8548(100)		

n (%) = Frequency (Percentage); RTA= Road Traffic Accident*

Table 3. Distribution of ABO blood group in relation to Rh-D blood group among the study population

	Rh-D blood group		
ABO blood group	**Positive n (%)***	**Negative n (%)**	**Total n (%)**
A	1696 (20.70)	94 (26.55)	1790(20.94)
B	2252 (27.48)	108 (4.58)	2360(27.61)
AB	396 (4.83)	12 (3.39)	408 (4.77)
O	3850 (46.99)	140 (39.55)	3990(46.68)
Total	8194 (95.86)	354 (4.14)	854(100.00)

*n= frequency %= Percentage**

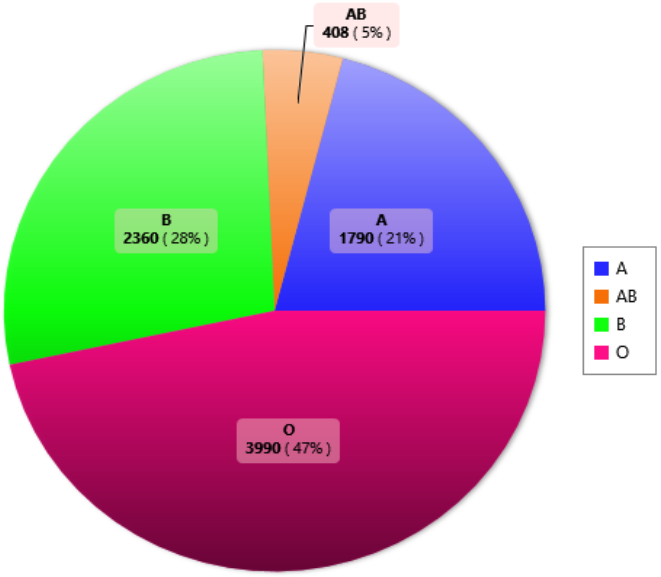

Fig. 1. Distribution of ABO blood group among the study population

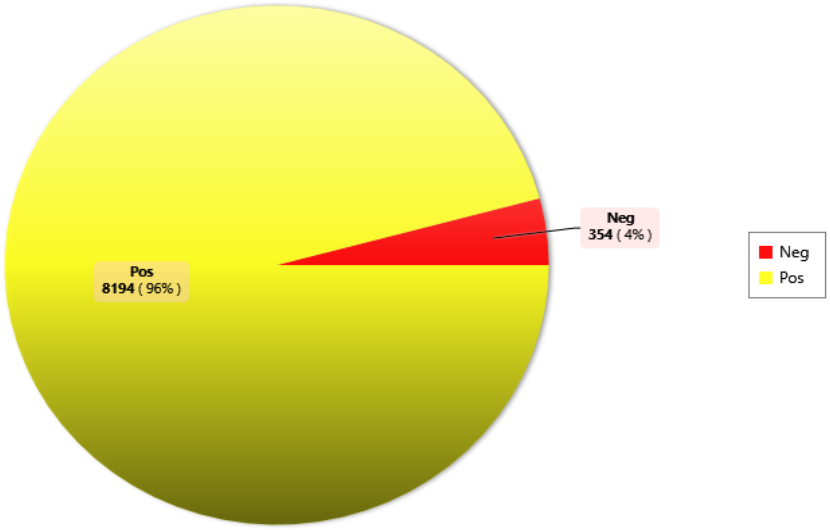

Fig. 2. Distribution of Rh-D blood group among the study population

Table 4. Distribution of ABO and Rh-D blood group in relation to sex

Parameters	**Male**	**Female**	***P* value**
ABO Blood group n (%)*			0.12
A	808(21.1)	982(20.8)	
B	1098(28.7)	1262(26.7)	
AB	174(4.6)	234(5.0)	
O	1742(45.6)	2248(47.6)	
Total	3822(100)	4726(100)	
Rh Blood group n (%)*			0.13
Positive	3678(96.2)	4516(95.6)	
Negative	144(3.8)	210(4.4)	
Total	3822(100)	4726(100)	

**n (%) = Frequency (Percentage)*

Table 5. Distribution of ABO and Rh-D blood group in relation to age

	ABO blood group n (%)*				Rh-D blood group n (%)	
Age (years)	**A**	**B**	**AB**	**O**	**Positive**	**Negative**
0-9	245(13.69)	365(15.47)	24(5.88)	466(11.68)	1018(12.42)	82(23.16)
10-19	144(8.04)	219(9.28)	20(4.90)	358(8.97)	727(8.87)	14(3.95)
20-29	302(16.87)	418(17.71)	131(32.11)	782(19.60)	1585(19.34)	48(13.56)
30-39	386(21.56)	460(19.49)	95(23.28)	933(23.38)	1799(21.96)	75(21.19)
40-49	241(13.46)	377(15.97)	45(11.03)	562(14.09)	1165(14.22)	60(16.95)
50-59	204(11.40)	237(10.04)	53(12.99)	401(10.05)	853(10.41)	42(11.86)
60-69	155(8.66)	160(6.78)	27(6.62)	268(6.72)	590(7.20)	20(5.65)
70-79	81(4.53)	66(2.80)	8(1.96)	141(3.53)	291(3.55)	5(1.41)
80-89	28(1.56)	46(1.95)	5(1.23)	72(1.80)	143(1.75)	8(2.26)
90-99	4(0.22)	8(0.34)	0(0.00)	4(0.10)	16(0.20)	0(0.00)
100-109	0(0.00)	4(0.17)	0(0.00)	3(0.08)	7(0.09)	0(0.00)
Total	1790(100)	2360(100)	408(100)	3990(100)	8194(100)	354(100)

**n= frequency; %= Percentage; Fishers exact= 1.0000*

3.2 Discussion

Distribution of the ABO and Rh blood group phenotypes have been repeatedly studied in various populations bearing in mind considerable variations reflecting the genetic, geographic and ethnic diversity of the human population. This study was carried out among recipients of blood transfusion as a result of several indications arising from medical to surgical cases including childbirth that could be complicated by blood loss or the need for surgical intervention. The study also aimed to determine the variations in the blood group distributions considering reports of some disease conditions especially haematologic malignancies that could cause variations in ABO blood group antigens due to inactivation of either the H tranferase or the A/B transferases [13].

In this study request for transfusion was significantly made for more females compared to the males giving credence to the higher health-seeking behavior of females compared to their male counterparts. This might also be related to high requests for blood transfusion known to be associated with Obstetrics and Gynaecology mainly during pregnancy for possible pregnancy associated bleeding complications and surgical intervention. Worthy of note also is the higher request found among the younger subjects who are within the active age group. While it denotes a higher health seeking behavior, it may also signify danger to the health status of individuals within that age bracket that form the bulk of our society's work force.

Despite these complexities, no sex or age-related variation was observed in the blood group distribution affirming the fact that sex and age do not play any significant role in blood group distribution. The ABO blood group O had the highest distribution followed by blood group B then A and lastly, AB giving the distribution pattern of O>B>A>AB. This finding is similar to frequencies reported by Lugos et al [14] in a study among pregnant women in Jos. A Report from a study carried out in Abuja, another North Central City of Nigeria showed a similar pattern of distribution with slight numerical variation [15]. Several other studies from Kano and Zamfara, which are prominent cities in the North Western part of Nigeria as well as Nguru and Osogbo in the North Eastern and South Western part of the Country had the same pattern of distribution with slight numerical variations that may be related to genetic as well as Ethnic or environmental variations [16-19]. A multicentric study among blood donors in India also reported a similar distribution pattern to our study except for the contrasting fact that our report is among blood transfusion recipients [20]. In contrast to our findings though maintaining the dominance of the ABO blood group O, are reports from other cities across Nigeria and beyond with a reverse pattern for blood groups A and B (O>A>B>AB) in comparison to our pattern of O>B>A>AB [21-25]. Differences encountered from the different studies could be attributed to reasons earlier proffered, intermarriages as well as various push factors enhancing population emigration and immigration. Study population sample size might also be a reason. The predominance of blood group O in a malaria endemic environment like ours has been attributed to the view that blood group O provides a selective advantage against severe malaria [26]. It has been reported that the

O antigen has the ability to impair sequestration, adherence to vascular endothelium and rossete formation of parasitized RBCs with uninfected red cells and so reducing vaso-occlusion and disease severity [27-28].

The ABO antigen is the most common antigen that could undergo variation with the possibility of altering an already established blood group distribution. Acute myeloblastic leukaemia and multiple myeloma are two major haematologic malignancies associated with such alteration [29-30]. Several departments, units and specialties' showed high requests due to some specific explainable indications centred on blood loss like polytrauma from the accident and emergency unit of the surgery department, haemolytic tendencies in malaria and neonatal jaundice as seen from the emergency and special care baby unit of the department of paediatrics as well as chronic kidney disease with anaemia and blood request for dialysis. This study did not demonstrate significant variation in blood group distribution despite the records of some of these diseases especially haematologic malignancies in some of our study subjects.

The Rh blood group system is unarguably one of the most complicated blood groups discovered with a worldwide comparable distribution across all continents. The findings in our study confirm Rh-D positive blood group as the predominant blood group from the Rh blood group system. This finding is not in variances with other reports from studies carried out in Jos, Nigeria and globally [31-35]. It portends lower incidence of Rh-D alloimmunization which comes with dire complication of haemolytic disease of the new born and foetus but also non availability of Rh-D negative blood when needed therefore the call for routine and compulsory maternal and foetal screenings for Rh-D antigens for the purpose of Rh-D antibody prophylaxis among child bearing women and total neonatal care. Blood transfusion centres and blood banks should have a Rh-D negative donors register with contact information of these donors in case of urgent request.

4. CONCLUSION

Data on the patient population requiring blood transfusion within a set period supports the concept of 'counting the cost' without which no blood transfusion services can be effective. This study has been able to afford us the liberty of knowing the quantum of requests we receive per annum and the ratios of the recipients' different ABO and Rh blood groups. It therefore forms a solid base for proper planning for better health care delivery with the intent of reducing morbidity and mortality associated with lack of safe blood in our health institution.

5. RECOMMENDATIONS

Health institutions should make it a duty to monitor blood transfusion request periodically to accord its health planners know quantities of blood required annually for targeted and effective projection and provision towards a viable blood transfusion services. Registers for Rh-Negative blood donors should also be a priority in view of the markedly low Rh-D negative frequency in other to curtail inadequate supplies of this rare blood group when needed for transfusion.

6. LIMITATION

Inability to genotype the blood groups. We hope to explore further on blood group genotype including other red blood cell antigens in subsequent research and to also determine the relationship vis-a-vis impact of blood groups on disease and conversely.

CONSENT

As per international standard or university standard, Participants' written consent has been collected and preserved by the author(s).

ETHICAL APPROVAL

This study was approved by the Jos University Teaching Hospitals Health and Ethics committee

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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