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Distribution And Frequency Of ABO, Rh (D, C, C, E And E) And Kell Blood Groups And Their Phenotypes In The Blood Donors Attending Blood Bank In A Tertiary Care Hospital In North-East India

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Abstract:
Background*: The Rh and Kell blood grouping systems are highly immunogenic and tend to generate alloantibodies responsible for the majority of transfusion reactions. Rh is the second most important blood group in terms of transfusion. It consists of various antigens including D, C, c, E, and e. The distribution and frequency of these antigens may vary among populations, and understanding their prevalence is crucial for efficient blood transfusion practices and the issue of compatible blood in patients who have developed an immune response to these antigens. This study aimed to examine the distribution and frequency of principal Rh (D, C, c, E, and e) and Kell antigens and their phenotypes in blood donors at a blood bank in a tertiary care hospital in Manipur, India.*
Materials and Methods*: This cross-sectional study was conducted in the Department of Transfusion Medicine, Regional Institute of Medical Sciences, Imphal, for 2 years from March 2022 to March 2024. In total, 2298 blood donors were included in the study. Red blood cells from the donors were subjected to antigen typing by using monoclonal antisera, anti-C, anti-c, anti-E, anti-e, and anti-K to determine the corresponding antigens. Tests were conducted using the automated neo-iris method.*
Results*: The samples were analyzed to determine the presence of five primary rhesus antigens. The prevalence of the "D" antigen was determined to be 98.8% (2271), followed by the 'e' antigen at 97.5% (2241), the 'C' antigen at 90.2% (2073), the 'c' antigen at 44.1% (1013), and the 'E' antigen at 28.8% (662). Phenotypes were ranked in descending order of frequency. The most prevalent phenotype was DCe/DCe (R1R1), accounting for 52.2% of the total population. This was followed by DCe/DcE (R1R2) at 27.1%, DCe/ce (R1r) at 15.0%, DcE/ce (R2r) at 2.5%, DcE/DcE (R2R2) at 1.2%, DCe/DCE (R1RZ) at 0.7%, Dce/dce (R0r) at 0.6%, ce/ce (rr) at 0.3%, Ce/ce (r'r; 0.3%), and Ce/Ce (r'r'; 0.1%).*
Conclusion: *The findings establish a database for red cell phenotype distribution in Manipur. Limited data exist on Rh and Kell antigen profiles among blood donors in this region, despite its significance for safe transfusion practices by providing alloimmunized patients with compatible phenotypically matched blood.*
KeyWord*: Rhesus antigen, , Kell antigen, RhC antigen, Rhc antigen, RhD antigen, RhE antigen, Rhe antigen, Rh phenotyping*

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I. Introduction

The Rh blood group is one of the most complex blood groups in humans[1.]. The complexity of Rh blood group antigens begins with the highly polymorphic genes RHD and RHCE that encode them[2]. Numerous genetic rearrangements between them have produced hybrid Rh genes that encode a myriad of distinct Rh antigens[3]. Rh-positive" and "Rh-negative" refer to the D antigen status of red cells. Antigen D is the most immunogenic Rh antigen and the most clinically important[4].

Four theories have been postulated to explain inheritance and classify complex Rh systems.
1. Fisher and Race 1940 [5]
2. Weiner 1939 [6]
3. Rosenfield 1960 [7]
4. International Society of Blood Transfusion (ISBT) [4]

Fisher-Race proposed that the Rh antigens were controlled by three closely linked genes giving rise to eight gene complex or haplotypes: CDe, cDe, cDE, CDE, cde, Cde, cdE, and CdE[5]. Wiener proposed there was

one gene responsible for defining Rh that produced an agglutinogen containing three Rh factors[6]. Rosenfield proposed the Alfa numerical terminology in 1960, based on serologic observations. Each antigen is assigned a number, generally in the order of its discovery or assignment to the Rh system. For the five major antigens, D was assigned as Rh1, C as Rh2, E as Rh3, c as Rh4, and e as Rh5[7]. The International Society of Blood Transfusion (ISBT) committee assigned numerical terminology. Six digit numbers have been adopted for specific antigens; the first three numbers represent the blood group system (004 for the RH system), while the last three represent the antigen specificity (001 for the D antigen); therefore, the D antigen is marked as 004001[4].

Rh antigen variation can cause alloimmunization and adverse transfusion reactions, especially in patients with multiple blood transfusions, cancer, or thalassemia. Complete antigen phenotype matching can help select RBC units with similar antigenic composition, but partial antigen matching of clinically significant antigens Rh [D, C, c, E, e] and K is cost-effective.[8,9] Alloantibodies development increases with frequent transfusions and increasing red cell antigen distribution disparity, with multitransfused sickle cell anaemia patients receiving red cells from their community showing less alloimmunization[10,11]

The Kell system, discovered in 1946, is the third most important blood group system, potentially causing hemolytic disease of foetus and newborn and hemolytic transfusion reaction.[12,13,14] . They described an antibody in the serum of Mrs. Kelleher responsible for HDFN, which was named after her[15.] Levine and colleagues discovered an anti-cellano antibody, also known as anti-k antibody, three years after discovering anti-K. Over 30 antigens were later discovered, with K and k being the most important and highly immunogenic. Anti-K & anti-k antibodies, usually IgG type, are not naturally occurring and are highly immunogenic[16.] Anti-K (IgG) antibodies react strongly with K positive cells at 37°C without dosage effect, indicating it's not essential to have rare phenotype K+k- on red cell panel[17] .

Approximately 80% of pregnant women with anti-K antibodies have a history of red cell transfusion, suggesting Kell-negative blood administration to prevent alloimmunization during reproductive age[18.]

Manipur, a northeastern state of India, is characterized by its unique demographic composition, which encompasses diverse ethnic communities with distinct genetic backgrounds. Despite the importance of understanding the distribution of Rh antigens to ensure safe transfusion practices, there is a paucity of comprehensive data on Rh antigen profiles among blood donors in this region. This study aimed to bridge this gap by investigating the distribution and frequency of the principal Rh blood group antigens and their phenotypes among blood donors attending a tertiary care hospital in Manipur.

II. Material And Methods

This cross-sectional study was conducted in the Department of Transfusion Medicine, Regional Institute of Medical Sciences, Imphal, for a period of two years from March 2022 to March 2024. A total of two thousand two hundred and ninety-eight (2298) samples from blood donors (both male and females) of aged ≥ 18, coming to the department of Transfusion Medicine were collected.

Study Design: cross sectional study

Study Location: This was a tertiary care teaching hospital-based study done in Department of Transfusion Medicine, Regional Institute of Medical Sciences, Imphal, Manipur.

Study Duration: March 2022 to March 2024

Sample size: 2298 donors

Subjects and selection method: Healthy voluntary blood donors who were eligible as per the Drugs and Cosmetics Act, 1940 and Rules, 1945, and willing to donate blood after obtaining informed consent were selected.

Inclusion criteria:
1. Age 18 years- 60 years
2. Weight of donor >45 kg (as per department SOP)
3. Haemoglobin > 12.5 gm%
4. Medical examination and general conditions within normal limits
5. Time interval between two donations at least 12 weeks
6. Donors willing to participate in the study.

Exclusion criteria:
1. Age <18 years
2. Weight of donor <45 kg

3. Donor not giving consent
4. Pregnant women
5. H/O of jaundice in the past
6. Positive history of epilepsy
7. H/O severe allergy
8. H/O unexplained weight loss or sexually transmitted diseases
9. H/O tuberculosis, hypertension, diabetes, cancer
10. H/O long term fever or typhoid in the past 1year or ,malaria in the past 6 months
11. H/O surgeries in past 6 months
12. H/O recent drug intake in last 72 hrs
13. H/O of any recent blood or blood component transfusion
14. H/O abnormal bleeding tendencies or blood coagulation disorders
15. H/O taking antiarrhythmic drugs, anticonvulsants, anticoagulants, anti-thyroid drugs, immunosuppressants, sedatives, tranquilizers in high doses, vasodilators, etc.
16. Various medical/surgical conditions or under medications as per departmental SOP

Procedure methodology

After written informed consent was obtained during the donor questionnaire, blood donation was performed in the double/triple bag from the antecubital vein, following all aseptic measures. Following donation, blood samples were collected in 2 ml vials containing ethylenediaminetetraacetic acid. ABO/Rh grouping, Rh (C, c, E, e, and D) and Kell (K, k) phenotyping were performed using a fully automated system (Neo Iris, Immucor). Units that tested positive for RhD antigen were labelled as Rh-positive, and units that tested negative for RhD were labeled as Rh-negative. All negative samples were subjected to an indirect antiglobulin test using a mix of IgG and IgM anti-D to check for weak D. Neo Iris is is a robotic instrument that is programmed to move all microplates, liquid reagent fluids, and blood sample fluids to the right processing area for an assay in the right order. The microplate reader uses charge-coupled device cameras to capture an image of the microplate underneath. The software then calculated the reaction value for each well based on multi-feature image analysis. The predefined criteria of the calculated reaction value were assigned to the result and interpretation of the respective wells. The mechanism and data processing of Neo Iris are software driven.

Statistical analysis

We determined the frequencies of various blood group antigens and phenotypes in red blood cells by summing up the number of donors exhibiting a specific antigen phenotype, then dividing by the total number of screened donors. The results are expressed as percentages. We tested five major antigens for the Rh system in donor red cells using antisera D, C, E, c, and e and used Wiener's nomenclature to reflect the phenotype. We determined the most probable genotype from gene frequency estimates, as determining the exact genotype without testing parents and other family members or DNA testing is not possible.

III. Result

The sample size of this study was **2298,** as collected from blood donors coming to our Blood Bank during the study period.

Table no 1: Shows Sex distribution of males and females. Out of 2298 samples, males were 2080 (90.51%) while females were 218 (9.49%).

Table no 1: Gender percentage among blood donors

Gender	
Male	Female
2055	216
25	02
2080 (90.5%)	218 (9.5%)

Table no 2: Shows 34.2% of the donors were in the O group, followed by A (32.5%), B (23.5%), and AB (9.8%).

Table no 2: Distribution of Blood Group among donors

Blood group	No of donors n%
O	783 (34.2%)
A	747 (32.5%)
B	541 (23.5%)
AB	226 (9.8%)
Total	2298 (100.0)

Table no 3: Shows the percentage of Rh-D antigen positivity, where D antigen was present in 98.8% (2271) of donors, and the percentage of Rh-D antigen negativity was 1.2% (27). None of the samples was reported to be a weak D variant.

Table no 3: Distribution of Rh-D positive and negative in the present study (2298 samples)

D antigen	No of donors n%
Rh-D positive (%)	2271 (98.8%)
Rh-D negative (%)	27 (1.2 %)
	2298 100

Table no 4: Shows Rh antigens frequency with 'D' antigen to be highest with 98.8% (2271) followed by 'e' antigen 97.5% (2241), 'C' antigen 90.2% (2073), 'c' antigen 44.1% (1013) and 'E' antigen 28.8% (662)

Table no 4: Distribution of 5 major Rh antigen frequency in the present study (2298 samples)

Rh antigen	No of donors (n %)
D (%)	2271 (98.8%)
e (%)	2241 (97.5%)
C (%)	2073 (90.2%)
c (%)	1013 (44.1%)
E (%)	662 (28.8%)

Table no 5 and 6 : show a comparison of Rh antigen frequency in the present study to other studies both inside India and outside India.

Table no 5: Comparison of Rh antigen frequency to other Indian studies

Rh antigen	Present study (%)	Baruah et al.[37]	Sharma et al.[38]	Thakral et al.[39]	Prinja et al.[40]	Ishani gupta[41]	Kahar et al.[42]	Garg et al.[43]	Shah et al.[44]
D (%)	98.8	99.0	91.6	93.3	93.8	94.2	84.3	93.8	90.3
e (%)	97.5	97.14	78.5	98.3	99.3	98.2	100	98.7	99.1
C (%)	90.2	92.3	84	84.8	85.4	88.6	81.7	91.8	84
c (%)	44.1	51.4	58.3	52.8	60.1	54.8	56.3	55.2	59.5
E (%)	28.8	20.9	25.6	17.9	17.5	18.6	21.7	21.1	17.2
K(%)	0.2%								

Table no 6: Comparison of Rh antigen frequency to other studies outside India

Rh antigen	Present study (%)	Lin et al. [45]	Khatun et al.[46]	Felimban et al.[47]	Karim et al[33]	Jeremiah et al.[48]	Taha et al.[49]	Japan[50]	Blacks[51]	Caucasians[51]
D (%)	98.8	99.4	100	87.8	97	95	-	99.5	92	85
e (%)	97.5	94.4	85	95.8	99	98.7	97.3	90.9	98	98
C (%)	90.2	90.2	76.2	62.3	87	17.7	73.2	87.8	27	68
c (%)	44.1	52.9	23.7	81.7	57	99.8	71	57	98	80
E (%)	28.8	42.3	15	31.3	19	20.5	21	50.7	22	29

Table no 7: Shows distribution of Rh phenotype in the present study. We found R1R1 (52.2%) as the most common Rh phenotype, followed by R1R2 (27.1%), and Ror (0.6%) as the least common among Rh positives and among Rh negatives it was ce/ce (rr) and Ce/ce (r'r) as most common with frequency of 0.3%. Ten probable phenotypes were found in our study population: DCe/DCe (R1R1), 52.2%, followed by DCe/DcE (R1R2) – 27.1%, DCe/ce (R1r) – 15.0%, DcE/ce (R2r) – 2.5%, DcE/DcE (R2R2) – 1.2%, DCe/DCE (R1RZ) – 0.7%, Dce/dce (R0r) – 0.6%, ce/ce (rr) - 0.3%, Ce/ce (r'r; 0.3%), and Ce/Ce (r'r'; 0.1%).

Table no 7 : Distribution of Rh phenotype in the present study population

Weiner	Fisher race	No of donors (%)
R1R1	DCCee DCe/DCe	1199 (52.2%)
R1R2	DCcEe DCe/DcE	623 (27.1%)
R1r	DCcee DCe/ce	345 (15.0%)
R2r	DccEe DcE/ce	58 (2.5%)
R2R2	DccEE DcE/DcE	28 (1.2%)
R1Rz	DCCEe DCe/DCE	16 (0.7%)
Ror	Dccee Dce/ce	14 (0.6%)
rr	ccee ce/ce	07 (0.3%)
r' r	Ccee Ce/ce	06 (0.3%)

r' r'	CCee Ce/Ce	02 (0.1%)
	Total	2298

Table no 8: shows comparison of Rh phenotypes to other studies. Many other studies from India have also identified R1R1 as the most common phenotype, whereas other studies outside India have found R1r, R0r, and R1R2 as the most common phenotypes.

Table no 8: Comparation of Rh phenotypes to other studies

Study	Weiner	Fisher race	Prevalence of phenotypes (%)
Present study	R1R1	DCe/DCe	52.2
Baruah et al.2020 (Assam)[37]	R1R1	DCe/DCe	45.7
Sharma D *et al*., 2013 (central India)[38]	R1R1	DCe/DCe	41
Thakral *et al*.,2010 (North India)[39]	R1R1	DCe/DCe	43.8
Prinja N et al., 2020 (Northwestern India)[40]	R1R1	DCe/DCe	39.5
Ishani Gupta, 2018 (Dehradun)[41]	R1R1	DCe/DCe	36.2
Kahar MA et al., 2014 (West India)[42]	R1R1	DCe/DCe	40.9
Garg et al., 2015 (North India)[43]	R1R1	DCe/DCe	44.6
Karim F et al.,2015 (Karachi)[33]	R1R1	DCe/DCe	44%
Khatun A et al. (Bangladesh)[46]	R1R1	DCe/DCe	48.4%
Yu Y et al. (China)[52]	R1R1	DCe/DCe	40.7%
Musa RH et al.,2012 (Malaysia)[53]	R1R1	DCe/DCe	61.5
Caucasians[51]	R1r	DCe/dce	35%
Duran C et al. (Turkish)[54]	R1r	DCe/dce	37.4
Keramati et al., 2011 (Iran)[22]	R1r	DCe/dce	31.8%
Owaidah AY et al.,2020 (Saudi Arabia)[55]	R1r	DCe/dce	36%
Blacks[51]	R0r	Dce/dce	46%
Jeremiah et al (Nigeria)[48]	R0r	Dce/dce	73.6%
Bogui LS et al (West Africa)[56]	R0r	Dce/dce	65.1%
Adewoyin AS et al (Nigeria)[57]	R0r	Dce/Dce	53.3
Rahman et al.(Bangladesh)[58]	R1R2	DCe/DcE	39.7

Table no 9 shows : Frequency of K antigen in donors as 0.2% which was lower than other studies in India which varies from 1.6% by Garg et al.[43] to 6.1% by Kahar et al [42].The study by Elsayid et al.[62] from Saudi Arabia showed a much higher frequency of the K antigen with 18.2 %.

Table no 9: Comparison of K antigen with other studies

Study	K (%)
Present study	0.2%
Karim et al.[33]	0
Lin et al.[45]	0
Adewoyin AS et al.[57]	0
Bogui LS et al.[56]	0.77
Thakral et al.[39]	5.7%

Prinja N et al.[40]	2.7%
Kahar et al.[42]	6.1%
Garg and Singh et al.[43]	1.6%
Singh et al. 2013[59]	4.4%
Caucasians[51]	9%
Elsayid M et al.[62]	18.2%

IV. Discussion

In the present study, the ABO blood group antigen frequencies were in the order of O> A > B> AB. Studies by Anish et al.[19] and Akbar et al.[20] followed the same trend. Mollison et al.[21] and Keramati et al.[22] conducted a study that also found O to be the most common blood group, followed by A, B, and AB. Patel SP, Rao C et al., Pramanik T, Mwangi J from Nigeria, and Bashwari LA et al. from Saudi Arabia reported similar findings[23-27].Other studies conducted by Agarwal et al.[28], Gundrajukuppam et al.[29], and Merikas et al.[30] showed that the most common blood group was B >O> A> AB.

The current study reveals a higher prevalence of males than females, at 90.5% and 9.5%, respectively, in line with the majority of studies conducted in India and abroad.

The most prevalent antigen observed in the present study was RhD. The overall positivity of the RhD antigen was 98.8%, while the RhD-negative blood group accounted for 1.2% of the total blood donors. Its distribution varies ethnically and regionally from one population to another. In a study by Chavhan et al.[31], Roy et al.[32] reported RhD positivity rates of 97.45% and 97.8%, respectively, and Karim et al.[33] reported a Rh D antigen frequency of 97 %.

In Japan and Myanmar, RhD has the highest incidence accounting for 99-100% while it is minimum in the populations of Southern France and Northern Spain, which ranges from 60-80%[34]. In Whites, the frequency of D positivity was 85% and D negativity was 15%; in black, 92% of the population was D positive and 8% was D negative[35].

Studies show RhD positivity is more common than RhD negativity globally, with regional variations contributing to differences. Understanding Rh antigen distribution helps in pretransfusion testing policies. Taiwanese patients with 0.3% Rh negativity have discontinued routine RhD typing[36]. In India, the frequency of D-negative antigens varies from 2% to 10%. Therefore, D-typing is essential for blood donors and patients requiring blood transfusion.

The frequencies of Rh antigens (D, C, c, E, and e) are given in Tables 4 and 5.

The most prevalent antigen in our study is "D" with 98.8%, followed by e > C > c > E with prevalence of 97.5%, 90.2%, 44.1% respectively and the least common antigen was E with 28.8 %. The trend of the prevalence of Rh antigens with the order D > e > C > c > E is similar to studies of Baruah et al[37]. Baruah et al. reported that RhD (99.0%) was the most common Rh antigen, followed by Rhe (97.1%), RhC (92.4%), Rhc (51.4%), and RhE (20.9%), which closely aligned with the findings of our study. Studies by Lin et al.[45] from Taiwanese Chinese, Bangladesh[46], Japanese[50], also documented the same frequency of Rh antigens.

Whereas other Indian studies[39-44],Felimban et al.[44] of Saudi Arabia, Karim et al.[33] from Pakistan and Kaha et al[50] found "e" antigen as the most prevalent antigen.The frequency of Rhe antigen in the present study was 97.5% comparable to Barauh et al.(97.1%)[37], Taha et al.[50] (97. 3%). A similar frequency was also reported by Jeremiah et al.[48] from Nigeria (98.7%), and Blacks and Caucasians[51](98%).Sharma et al from India and Khatun et al from Bangladesh reported a lower frequency of e antigen with 78.5% and 85% respectively. Daniels[51] highlighted the global trend of Rhe antigen being the highest, making it challenging to find a "e" antigen-negative donor for patients alloimmunized against this antigen.

The frequency of RhC antigen in the present study was 90.2%, comparable to the findings reported by Garg et al.[43] (91.8%) and Lin et al.[38] from China (90.2%). However, RhC antigen is less frequent in Caucasians[51](68%), Saudi Arabians[47] (62.3%), Blacks[51] (27%) , and Nigerians[48] (17.7%).

The frequency of Rhc antigen in the present study was 44.1%, which is lower than most other studies both India [37-44] which ranges from 51-60% and aboard [33,45,47-51]. Higher frequency of Rhc antigen was found in studies done by Jeremiah et al.[48] from Nigeria (99.8%), Blacks[51] (98%)and Caucasians[51] (80%.).

RhE is the least common Rhesus antigen worldwide. In the present study, the RhE antigen was the least prevalent Rh antigen with 28.8% which is in concordance with other studies from the rest of India and outside India as given in Table 5 and 6. Among RhD-negative donors, the E antigen was absent.

The most common Rh phenotype found in this study was R1R1(52.2%) among Rh positives and ce/ce (rr) and Ce/ce (r'r) (0.3%) among Rh negatives as given in Table no 7.

Ten probable phenotypes were found in our study population in the order DCe/DCe (R1R1) – 52.2%, followed by DCe/DcE (R1R2) – 27.1%, DCe/ ce (R1r) – 15.0 %, DcE/ ce (R2r) – 2.5%, DcE/DcE (R2R2) – 1.2%, DCe/ DCE (R1RZ) – 0.7%, Dce/dce (R0r) – 0.6%, ce/ce (rr) - 0.3% , Ce/ce (r'r; 0.3%), Ce/Ce (r'r'; 0.1%). [Table 7].

Other Indian studies[37-43] also found R1R1 as the most common phenotype. Karim F et al.,2015 (Karachi)[33], Khatun A et al. (Bangladesh)[46], Yu Y et al. (China)[52], Musa RH et al.,2012 (Malaysia)[53] also found similar results. Whereas this phenotype is found in only 17.6% of white and 2.9% of black population[51]. This emphasizes the variability in Rh phenotypes of the people of different races and geographic location.

In contrast, the predominant Rh phenotype reported in Caucasians[51](35.6%) is R1r.It is also the most common phenotype in the study done by Duran et al.[54] from Turkey (37.4%), Keramati et al.[55] from Iran (31.8%), and Owaidah et al.[56] from Saudi Arabia (36%).

In Blacks[51], the most common phenotype is R0r (46%). Studies by Jeremiah et al.(73.6%) and Adewoyin AS (53.3%) from Nigeria, Bogui et al. (65.1%) from West Africa also reported similar findings.
R1R2 was the most common phenotype found in Bangladesh by Rahman et al. (39.7%).

Prevalence of the Kell antigen varied markedly amongst Indian population. In the present study, the K antigen frequency was 0.2 % (n=5), which is lower than other studies in India[39,40,42,43,59] but comparable to study by Bogui LS et al. (0.77%) from South Africa. Studies by Lin et al.[45] from China, Karim et al.[33] from Pakistan and Adewoyin AS et al.[57] from Nigeria found no Kell antigen in their studies(0%). Kell antigen is highly antigenic and present in low frequency hence responsible for the frequent occurrence of anti-Kell antibody. The percentage prevalence of Kell antigen in India varies from 1.6% by Garg et al.[43] to 6.1% by Kahar et al.[42]. The study by Elsayid et al.[62] from Saudi Arabia showed a much higher frequency of the K antigen with 18.2 %.

Higher frequency of Kell antigen is seen from the Moroccan study by Bhuva DK et al.[63] with 7% , Caucasians with 9%[51] and Arab population by M. Alalshaikh et al.[61] with 13.9% and. This results showed a significant difference compared to other studies conducted in Asia, including the present study.

Rh phenotype variation is observed globally, and blood donors and patients share genetic homogeneity. therefore, the same Rh phenotypes or genotypes observed in donors would also be present in patients. Antigen typing is crucial for creating a donor bank with known phenotypes, useful for rare or multiple-antibodies, and multi-transfused patients (Diedrich et al., 2001; Lamba et al., 2013). In a resource-constrained country like India, the practice of providing at least Rh and Kell antigen-matched red cells can lead to a significant decrease in alloimmunization rates and increased red cell survival, leading to a reduced frequency of transfusions and better clinical outcomes. Singer et al. observed a decreased rate of alloimmunization from 33% to 2.8% by providing Rh- and Kell-matched blood, respectively[64].

V. Conclusion

Nearly 34.2% of the donors were in the O group, followed by A (32.5%), B (23.5%), and AB (9.8%). The prevalence of the blood groups in our study population was O > A > B > AB. D antigen was present in 98.8% of the total donor population.

D antigen was absent in 1.2% of the total donor population. The D antigen was found to have the highest prevalence, which was present in 98.8% of the study population. Gender-wise D positivity was the highest in male (89.4 %) and female (9.4 %). About 97.5% of donors showed e positivity, followed by 90.2 % of the donors with C positivity, and 44.1% were positive for c antigen. The E antigen level was the lowest (28.8 %). The most common Rh phenotype was DCCee followed by DCcEe > DCcee > DccEe > DccEE > DCCEe > Dccee > ccee > Ccee> CCee. The prevalence of K antigens observed in our study population was 0.2%, whereas 99.8% of the population were Kell-negative.

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