DOI: https://doi.org/10.53350/pjmhs0202418114

ORIGINAL ARTICLE

Blood Transfusion Cross Match on the basis of Phenotype & Rh Antigen in Donors and Receivers and Analysis of Variations

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ABSTRACT

Background: In brief, knowing the local Rh blood group system frequency helps develop a donor pool for patients who need numerous transfusions and alloantibody-compatible antigen negative blood. Patients have been matched for component blood transfusions using ABO and Rh phenotypes since 2020. Our detection of all blood transfusion-needy patients began.
Aim: Our department began To detect C, E, c, and e Rh-specific antigens in multi-transfused patients in 2020.
Methods: For the aim of this investigation, 2300 patient samples were obtained from patients who required clinical blood transfusions at our hospital between March 2020 and October 2022. These samples were gathered for the purpose of this investigation. One patient was counted as a single sample even though they required repeated blood transfusions. 1900blood donor samples were provided by the Blood Centre of (duplicated samples were removed based on the identification numbers that were provided by the Blood Centre once they were identified).
Results: The study obtained 4200 samples, including 1900donor and 2300patient samples. The allele frequency distribution of blood group antigens in the studied population was compared with the prevalence observed in the present study. The D antigen exhibited a frequency of 99.34% in the studied population, slightly lower than the prevalence observed in the present study at 98.9% (95% CI: 98.5 - 99.0). Conversely, the C antigen was found in 93.1% of the studied population, with a slightly higher prevalence observed in the present study at 99.1% (95% CI: 92.0 - 99.2).
Implication: The study suggests serological testing is a cost-effective method for blood transfusion management, identifying Rh phenotypes. Compiling a database of donor Rh genotypes simplifies transfusion selection, reducing unfavorable responses. Pre-transfusion Rh phenotype examination is crucial for matching patient blood type with donor blood, reducing adverse reactions, and improving patient safety.
Conclusion: In transfusion applications, serological testing are cost-effective for Rh phenotype identification but not genotypes. Creating a database of blood donors' Rh phenotypes and evaluating each patient before their initial transfusion should lessen adverse reactions and speed up antigen-negative blood availability, saving more patients.
Keywords: Blood transfusion, phenotype, Rh antigen, donors, receivers, analysis of variations

INTRODUCTION

In brief, knowing the local Rh blood group system frequency helps develop a donor pool for patients who need numerous transfusions and alloantibody-compatible antigen negative blood.Donors and patients had ABO and Rh tests before transfusions. Microcolumn gel-based antiglobulin testing revealed an unexpected antibody screening and identification during pre-transfusion testing. Historical transfusion adverse events and Rh phenotype-matched blood donation compliance were studied[1]. 4200 specimens included Rh blood group D, C, E, and c antigens. The most prevalent phenotype was 98.99% Rh D antigen.

In order, e, C, c, and E antigens followed. DCe was the most prevalent Rh D-positive phenotype, while DCE was rarest. Ce predominated in Rh D-negative samples, while CE and CcE were missing[2]. Our department has performed Rh-phenotype-matched transfusions since 2020. Transfusion-related adverse events have steadily declined from 18.90% in 2020 to 2.20% in 2022 as Rh phenotype-matched transfusion conformance has been maintained at or above 95%. Rh phenotype-matched blood infusions reduced transfusion responses, unanticipated antibodies, and improved diagnosis and therapy[3]. Many blood group antigens have been known since the 1950s.For numerous transfusion recipients, Rh phenotype-matched blood transfusions minimize alloimmunization and severe transfusion responses.

Testing for other Rh antigens (C, E, c, and e) before transfusion can avoid alloimmunization, especially in multiple transfusion recipients. To detect Rh antigens C, E, c, and e in multi-transfused patients (n >2), our department-initiated component blood infusions with ABO and Rh phenotype-matched blood types in 2020[4]. A pretransfusion test was required for all blood transfusion patients in the second half of 2021. Over several years, our hospital had less transfusion-related adverse reactions after the Rh phenotype-matching transfusion. RBC survival increased, lowering transfusions. Rh antigen D, C, E, and c results from our hospital follow[5].

Calculations were done for Rh-specific antigen frequencies. Rh D-positive specimens were tallied and examined for phenotypic frequencies. Next, the findings were compared to prior research. Study: Rh D phenotypes cross-matched with ABO for pre-transfusion compatibility minimize alloimmunization risk[6].

To aid Rh blood group antibody production and clinical treatments, patient distribution of unexpected antibodies was explored. So far, 43 blood groups exist. ISBT's RBC Antigen Database has 345 items. The ISBT confirmed 55 Rh antigens, the most polymorphic blood group. Within these bloodlines D, C, E, c, and e are the most clinically relevant Rh antigens in order of antigenicity[7]. Clinically, the Rh D and ABO blood type systems are most essential due to their many blood transfusion uses. Blood donors and patients only need to match ABO and Rh D blood group antigens for pretransfusion testing at most hospitals' blood banks. Only these two blood groups are used. After random transfusion of ABO and Rh D compatible blood with unknown Rh phenotypes, alloimmune responses can develop alloantibodies. This applies especially to people with more than two blood transfusions. Hemolytic transfusion reactions (HTRs) and HDFN caused by these alloantibodies can be deadly[8].

Our department began detecting C, E, c, and e Rh-specific antigens in multi-transfused patients in 2020. Patients have been

Received on 04-08-2023
Accepted on 14-12-2023

matched for component blood transfusions using ABO and Rh phenotypes since 2020. Our detection of all blood transfusion-needy patients began.

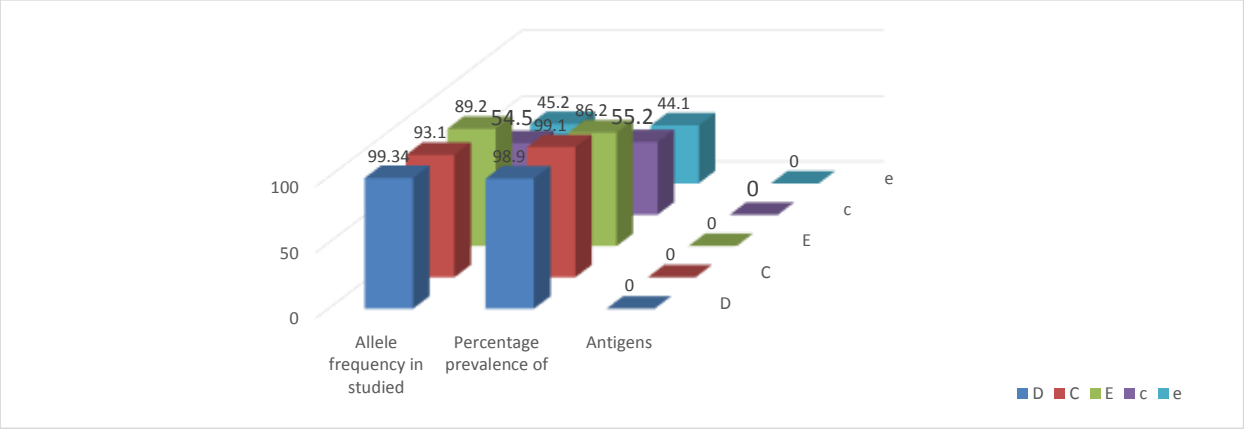
MATERIALS AND METHODS

For the aim of this investigation, 2300 patient samples were obtained from patients who required clinical blood transfusions at our hospital between March 2020 and October 2022. These samples were gathered for the purpose of this investigation. One patient was counted as a single sample even though they required repeated blood transfusions. 1900blood donor samples were provided by the Blood Centre of (duplicated samples were removed based on the identification numbers that were provided by the Blood Centre once they were identified). We got written informed consent from each individual who participated in the trial, and the Institutional Ethics Committee at our hospital gave their approval for the study to proceed. The Rh phenotypes of each and every donor and patient sample were determined in accordance with the procedures that were provided by the providers of the instruments. Using an antiglobulin test that was based on the micro-column gel method, an antibody screening was performed on each and every one of the patients who required clinical blood transfusions. Both the saline approach and the antiglobulin test method were subsequently utilised in order to identify the unexpected antibodies that were checked for by the researchers. The findings of all of the laboratory tests that were discussed before were obtained in a perfectly objective manner by two independent individuals.

RESULT

The study obtained 4200 samples, including 1900donor and 2300 patient samples. The allele frequency distribution of blood group antigens in the studied population was compared with the prevalence observed in the present study. The D antigen exhibited a frequency of 99.34% in the studied population, slightly lower than the prevalence observed in the present study at 98.9% (95% CI: 98.5 - 99.0). Conversely, the C antigen was found in 93.1% of the studied population, with a slightly higher prevalence observed in the present study at 99.1% (95% CI: 92.0 - 99.2). The E antigen was present in 89.2% of the studied population, contrasting with the prevalence of 86.2% observed in the present study (95% CI: 88.0 - 87.0).

Fig 1. Rh antigens



In table and figure 1 Among Rh D-positive samples, the e antigen was predominant at 91.88%, followed by the C antigen at 53.4%. Conversely, in Rh D-negative samples, the prevalence of the e antigen remained high at 98.96%, while the C antigen was less prevalent at 39.05%. Interestingly, the c antigen was present in a similar percentage in Rh D-positive and Rh D-negative samples, at 53.4% and 92.99%, respectively.

Table 1: Rh antigens in the studied population

Antigen	Allele frequency in studied Population(%)	Percentage prevalence of Present study(%)	Antigens 95% CI**
D	99.34	98.9	98.5 - 99.0
C	93.1	99.1	92.0– 99.2
E	89.2	86.2	88.0– 87.0
c	54.5	55.2	53.1– 55.5
e	45.2	44.1	44.0– 45.5

Table 2 Prevalence of other Rh antigens in Rh D positive population

Antigen	Percentage in Rh D-positive samples (%)	Percentage in Rh D-negative samples (%)
e	91.88	98.96
C	53.4	39.05
c	53.4	92.99
E	46.2	6.39

Among Rh D-positive samples, the e antigen was predominant at 91.88%, followed by the C antigen at 53.4%. Conversely, in Rh D-negative samples, the prevalence of the e antigen remained high at 98.96%, while the C antigen was less prevalent at 39.05%. Interestingly, the c antigen was present in a similar percentage in Rh D-positive and Rh D-negative samples, at 53.4% and 92.99%, respectively.

Among individuals with the DCe phenotype, the most prevalent ABO antigen was O (55.3%), followed by AB (17.0%), A (12.5%), and B (15.2%). In contrast, individuals with the DCEe phenotype had a higher prevalence of AB (24.4%) and B (22.1%) antigens, with O (44.8%) and A (8.7%) antigens being less common.

Table 3: Rh phenotypes frequency in the study of Rh D positive population

Antigen ABO	A	B	O	AB	Total
DCe	12.5	15.2	55.3	17.0	100
DCEe	8.7	22.1	44.8	24.4	100
DCE	10.3	18.5	49.2	22.0	100
DCce	16.8	14.6	53.2	15.4	100

Table 4: Rh Phenotype Distribution in Patients Requiring Blood Transfusions

Rh Phenotype	%age
D+C+E+c+e+	48.2
D+C+E+c+e-	20.3
D+C+E-c+e+	15.6
D+C+E-c+e-	8.9
D+C-E+c+e+	6.9

The distribution of Rh phenotypes among patients requiring blood transfusions shows that the most common phenotype is

D+C+E+c+e+, accounting for 48.2% of the cases. Following this, the D+C+E+c+e- phenotype is observed in 20.3% of patients, while the D+C+E-c+e+ phenotype is present in 15.6% of cases. Less frequently encountered are the D+C+E-c+e- and D+C-E+c+e+ phenotypes, comprising 8.9% and 6.9% of the patient population, respectively.

DISCUSSION

The ABO blood group system has been discovered and reported by many since Landsteiner. The Landsteiner discovery was unusual. ISBT detected 345 antigens in 43 blood types. Knowing Rh phenotype frequencies helps clinical applications a donor bank. These findings help improve antigen-negative compatible blood for thalassemia patients with various alloantibodies and transfusions[9]. This may also minimise patient-donor antigen phenotypic mismatch-induced alloimmunization. Several regional or racial/ethnic investigations examined Rh phenotypes and genotypes[10-16]. This report covers local Rh phenotypic distributions from clinical operations at our Zhejiang hospital since 2020. These clinical treatments require Rh phenotype diagnosis and matching before blood transfusions.

This study indicated that blood group O is most prevalent, followed by A. South East Asian, European, and US research agreed[17]. In central Asia and Africa, B outnumbered O[12,13]. In Zhejiang China, 99.4% of people possessed polymorphic Rh D antigen. This was significant compared to whites (85%) and blacks (92%)[14]. But the population's Rh antigen E negative and positive frequencies were remarkably equal to the published studies. This analysis detected 46.2percent Rh antigen E. Nearly half of people reported different Rh antigen E results. We concluded that Rh E blood group members had a much higher rate of incompatibility than other Rh blood groups. Patients getting blood transfusions may produce anti-E antibodies independent of blood volume. This was important in clinical settings, notably for uncommon blood group transfusion patients.

Different populations' incidence rates may depend on Rh phenotype. about allovaccination. Knowing a population's Rh phenotypic distribution could improve clinical blood transfusion guidelines and prevent haemolytic responses. These reactions include difficult donor-recipient crossmatches, lower RBC survival after transfusion, higher blood transfusion needs, and delayed haemolytic reactions. Many Rh blood group antigens triggered alloimmunization. According to Dhawan et al[18]. Alloimmunization may reach 5.64%. Rh antibodies made up 52.17% (anti-E 17%, anti-D 13%, and anti-C 13%). Alloimmunization against other Rh blood group antigens was required. This investigation looked for unexpected antibodies pretransfusion. For all 557 homologous antibodies, Rh blood group antibodies were 57.99% (323/557) and anti-E 82.35% (266/323). Since Rh blood group system antibodies were produced by immune stimulation, the high occurrence of anti-E may have been related to the fact that the positive and negative rates of Rh E antigen were close and that no transfusion with the matched Rh E antigen was used in clinical practise (in our hospital, only ABO and Rh D antigens were tested and matched).

Thus, we proposed Rh phenotypes-matched blood transfusion criteria based on clinically discovered Rh antigens E, C, c, and e and routine Rh antigen D detection. Use classical Rh antigen detection with these guidelines[19]. Level I had the highest priority for Rh phenotype matching, level II next, and level III lowest. A patient whose Rh phenotypes could not be selected using level I and level II matching rules received donor blood with the lowest immunogenicity. An exhaustive list of patient phenotypic rules included in the appendix. To meet with these standards, our division initiated the Rh phenotypes matching blood transfusion initiative in 2020. Transfusion reactions have steadily decreased from 18.90% in 2020 to 2.20% in August 2022 as Rh phenotypic matching has grown from 4.33% in 2020 to more than 90% after 2017.

CONCLUSION

In transfusion applications, serological testing are cost-effective for Rh phenotype identification but not genotypes. Creating a database of blood donors' Rh phenotypes and evaluating each patient before their initial transfusion should lessen adverse reactions and speed up antigen-negative blood availability, saving more patients.

Implication: The study states that serological testing is an affordable way to determine Rh phenotypes and can be used in blood transfusion management. It emphasizes how important it is to have a database of blood donors' Rh genotypes in order to facilitate the selection of compatible blood units for transfusions. Pre-transfusion assessment of Rh phenotype is crucial to match a patient's blood type with compatible donor blood and reduce the risk of adverse transfusion reactions. Locating mobile antigen-negative blood donors might expedite the availability of suitable blood units, hence improving patient outcomes. Putting these recommendations into practice can further enhance patient safety by reducing adverse transfusion reactions and alloimmunization in patients receiving repeated transfusions.

Authorship and contribution declaration: Each author of this article fulfilled following Criteria of Authorship:

1. Conception and design of or acquisition of data or analysis and interpretation of data.
2. Drafting the manuscript or revising it critically for important intellectual content.
3. Final approval of the version for publication.

All authors agree to be responsible for all aspects of their research work.

Conflict of interest: None

Funding: None

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This article may be cited as: Aslam MF, Khan K, Ghafoor J, Immran M, Ishaque N, Saleem A, Rana M: Blood Transfusion cross match on the basis of phenotype & Rh antigen in donors and receivers and analysis of variations. Pak J Med Health Sci, 2024; 18 (1): 14-17.