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Frequency of Rh and Kell Antigens Among Blood Donors: A Retrospective Cross-Sectional Study from a Tertiary Care Centre

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Abstract: ***Background**: Knowledge of the frequency of clinically significant red cell antigens, particularly those within the Rh and Kell systems, is essential for maintaining safe transfusion practices and ensuring efficient inventory management. Limited regional data from tertiary care centres highlight the need for detailed evaluation of local antigen distribution. **Aim**: To determine the prevalence of Rh antigens (D, C, c, E, e) and the Kell (K) antigen among blood donors at a tertiary care centre. **Materials and Methods**: A retrospective cross-sectional study was conducted over six months duration from January 2025 to June 2025 encompassing 3,000 healthy blood donors. Antigen typing for Rh (D, C, c, E, e) and Kell (K) was performed using an automated immunohematology analyzer based on standardized column agglutination technology. Commercially validated reagent antisera were used, and all procedures were carried out strictly according to the manufacturer's recommendations. Antigen and phenotype frequencies were calculated to assess their distribution within the donor population. Data was analyzed using descriptive statistics. **Results**: Among the 3,000 donors, Rh(D) positivity was 94.6%, while 5.4% were Rh(D)-negative. The frequencies of other Rh antigens were C - 87.2%, c - 52.3%, E - 18.5%, and e - 98.1%. The most common Rh phenotype identified was R1R1 (DCe/DCe) at 43.4%, followed by R1r (DCe/dce) at 27.0%, and R1R2 (DCe/DcE) at 14.8%. The prevalence of the Kell (K) antigen was low at 2.7%. **Conclusion**: The study shows a high prevalence of Rh(D) and consistently high frequencies of the e and C antigens, indicating that compatible units for these antigens are generally easy to source. In contrast, the moderate frequency of the c antigen and the low frequency of the E antigen may pose challenges when providing matched blood for patients with corresponding antibodies. The low prevalence of the Kell (K) antigen ensures good availability of K-negative units, which is essential for preventing alloimmunization in high-risk groups. Overall, the antigen distribution data support the development of region-specific donor registries, more efficient inventory planning for extended antigen matching, and improved transfusion safety for patients requiring repeated transfusions.*

Keywords: Rh blood group, Kell antigen, Blood donors, Alloimmunization, Phenotype

1. Introduction

The Rh blood group system is the most complex and polymorphic system after ABO. The five principal antigens - D, C, c, E, and e - are responsible for majority of clinically significant alloantibodies. The Kell blood group system is the third most immunogenic system after ABO and Rh. Anti-K can cause severe hemolytic transfusion reactions and hemolytic disease of the fetus and newborn.

Alloimmunization to Rh and Kell antigens is a significant problem in multi-transfused patients such as those with thalassemia, sickle cell disease, and hematological malignancies. Providing antigen-matched blood reduces the risk of alloantibody formation. For this, knowledge of local antigen frequencies is essential to identify and recruit donors with rare phenotypes.

There is limited published data regarding Rh and Kell antigen frequency from this geographical region. Therefore, this study was planned to determine the frequency of Rh and Kell antigens among blood donors at a tertiary care centre.

2. Materials and Methods

This retrospective cross-sectional study was conducted in the Department of Immunohaematology and Transfusion Medicine at a tertiary care teaching hospital.

Study Design: Retrospective cross-sectional study

Study Period: January 2025 to June 2025

Sample Size: 3,000 healthy blood donors

Inclusion Criteria: All healthy blood donors who were found fit during routine donor screening as per national guidelines

Exclusion Criteria: Donors with history of blood transfusion within preceding 3 months

3. Methodology

Antigen typing for Rh (D, C, c, E, e) and Kell (K) was performed on all donor samples using an automated immunohematology analyzer based on standardized column agglutination technology. Commercially validated reagent antisera were used, and all procedures were carried out strictly according to the manufacturer's recommendations. Data regarding donor demographics and antigen profile was retrieved from the blood bank information system.

4. Statistical Analysis

Data was entered in Microsoft Excel and analyzed using descriptive statistics. Categorical variables were expressed as frequency and percentage. Antigen and phenotype frequencies were calculated to assess their distribution within the donor population.

5. Results

A total of 3,000 healthy blood donors were included in the study.

Rh(D) positivity was 94.6% (n=2838), while 5.4% (n=162) were Rh(D)-negative. Among Rh antigens, e antigen was the most common (98.1%) while E antigen was least common (18.5%). The prevalence of the Kell (K) antigen was low at 2.7% (n=81).

The most common Rh phenotype identified was R1R1 (DCe/DCe) at 43.4%, followed by R1r (DCe/dce) at 27.0%, and R1R2 (DCe/DcE) at 14.8%.

6. Discussion

The present study documents the frequency of Rh and Kell antigens among blood donors from a tertiary care center. The Rh D positive frequency of 94.6% observed in our study is in concordance with previous Indian studies which have reported frequencies ranging from 93.3% to 95.6%. The frequency of Rh D negative donors (5.4%) is also similar to the national average of 5-6%.

In our study, e antigen showed the highest frequency (98.1%) followed by D (94.6%), C (87.2%), c (52.3%) and E (18.5%). This pattern of antigen distribution is consistent with studies from other parts of Western India. The low frequency of E antigen and high frequency of e antigen is characteristic of Asian populations.

The Kell antigen frequency was found to be 2.7% in our study. Various Indian studies have reported Kell antigen frequency between 1.8% to 5.5%. The slight variation can be attributed to regional and ethnic differences in the population studied.

The clinical significance of this data lies in its application for providing antigen-matched blood to patients with alloantibodies. The high prevalence of Rh(D) and consistently high frequencies of the e and C antigens indicates that compatible units for these antigens are generally easy to source. In contrast, the moderate frequency of the c antigen and the low frequency of the E antigen may pose challenges when providing matched blood for patients with corresponding antibodies. The low prevalence of the Kell (K) antigen ensures good availability of K-negative units, which is essential for preventing alloimmunization in high-risk groups.

7. Limitations

This was a single-centre retrospective study. The findings may not represent the general population frequency. Further multi-centric studies with larger sample sizes are recommended.

8. Conclusion

This study provides regional data on the frequency of Rh and Kell blood group antigens among blood donors. The antigen distribution data support the development of region-specific donor registries, more efficient inventory planning for extended antigen matching, and improved transfusion safety for patients requiring repeated transfusions. Establishing a rare donor registry is recommended to minimize alloimmunization rates.

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