Prevalence of Red Cell Alloantibodies Among Cohort of Healthy Blood Donors in a Tertiary Care Hospital – A Step Towards Blood Safety

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ABSTRACT

Background: Red cell antibody screening should be an imperative element in assuring transfusion safety. The aim of the study is to screen healthy donors for clinically significant alloantibodies to prevent risk of adverse reactions in transfusion recipients.

Methods: This prospective cohort study was carried out for a period of one year. Antibody screening of all blood donors was performed as a routine on an automated immunohaematology platform using Immucor Capture R-ready screen (pooled O cells) Galileo Neo (Immucor Inc. Norcross GA, USA). Positive screen was further investigated to identify specificity by 3 cell and 11 cell panel.

Results: Red cell alloantibodies screening was conducted on 26,772 blood samples of healthy donors of which 26,129 (94.9%) were male and 4 (5.1%) were female. The donors were screened from both indoor (blood centre) 79.7% and outdoor collection (camp) 20.3%. 79 (0.3%), were found to be positive for antibody screening. Mean age of donors showing positive screen was 35.14±9.67 years (20-60 years). Mean weight of the donor was 81.59±15.19. On antibody identification 48 (61%) had alloantibodies, 4 (5.1%) warm autoantibodies while 27 (34.2%) were inconclusive. The most common alloantibody identified was Anti M 28 (35.4%), Anti P1 5 (6.3%) followed by Anti E 3 (3.8%). The result showed a high prevalence of RBC alloantibodies in females than males (0.6% / 0.2%).

Conclusion: Type and Screen protocol should be followed for detection of alloantibodies against red cells antigens which adds as an additional layer of safe blood transfusion.

Keywords: Antibody Screening, Autoantibodies, Alloantibodies.

INTRODUCTION

Red cell alloantibodies are immunoglobulins produced by the immune system of individuals in response to exposure to foreign red blood cells (RBC) antigens. These antigens, typically proteins or carbohydrates present on the RBC membrane, differ from the host's own RBC antigens. In normal healthy donors, the presence of red cell alloantibody is rare due to lack of significant exposure to foreign RBC antigens. However, low level of alloantibodies may be detected stemming from environmental exposure or minor antigenic disparities. Alloimmunization may also result from pregnancy, transfusions, transplantations, injection of immunogenic material. Antibodies are sometimes detected in serologic test which can be passively acquired from injected immunoglobulins, passenger lymphocytes in transplanted organs or hematopoietic progenitor cells.[1,2]

The incidence of transfusion reactions due to red cell alloantibodies in donor blood is rarely seen.[3] There are studies reporting detection of alloantibodies ranging from 0.32 to 2.4%.[4-7]

The international society of blood transfusion (ISBT) currently recognized 43 blood group systems containing 349 red cell antigens.[8] Clinical significant antigens belong to blood groups such as ABO & Rh, Kell, Duffy, Kidd, MNS, P, Lewis, Lutheran.

The aim of our present study is to screen for these red cell alloantibodies and their identification in blood donors so as to provide blood that lacks the corresponding antigen in the patient.

MATERIAL AND METHODS

This prospective study was conducted in a tertiary care hospital for a period of one year. A total of 26,772 donors participated in study using convenient sampling technique. Questionnaire was used to collect profiles such as age, sex and address, any history of the previous transfusion and drug intake. The general health conditions of blood donors, jaundice, and any clinically significant diseases related to autoimmune disorders were assessed through medical examination

Age group of 18 to 65, weighing more than 45 kilograms and having normal hemoglobin values (For Male >13g/dl and females >12g/dl) were included in this study. A detailed obstetrics and gynecology history, especially regarding childbirth and abortion, was also taken from all female blood donors.

Laboratory procedure: All donor blood samples were

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How to cite this article: Bableen Kaur Ghotra, Sonia Gupta, Rajesh Kumar. Prevalence of red cell alloantibodies among cohort of healthy blood donors in a tertiary care hospital – a step towards blood safety. International Journal of Contemporary Medical Research 2024;11(9):I1-I5.

collected in Ethylenediaminetetraacetic acid (EDTA) vials for blood grouping and antibody screening from camps and blood center. Blood grouping was performed on fully automated immunohematology system Neo (Immucor Inc., Norcross, GA, USA) using commercially available antisera (Immucor Inc., Norcross, GA, USA). Blood samples were tested for clinically significant antigens using Capture–R select for antibody screen performed using (SPRCA- solid-phase red cell adherence) technology on fully automated system Neo (Immucor Inc., Norcross GA, USA) using pooled "O" cells (Capture-R ready screen). The positive cases were repeatedly tested with a fresh sample. False positives were dropped. True positives were tested on 3-cell antigen panel (ID-Diacell I-II-III, Biorad, Switzerland) for antibody screening and 11-cell antibody identification panel using microtyping card (ID-Diapanel GmbH Cressier FR Switzerland). The testing methodology employed the column agglutination (gel) technique, utilizing the LISS-Coombs ID-Card from Bio-Rad. Each microtube was impregnated with polyspecific AHG, consisting of rabbit anti-IgG and monoclonal anti-C3d antibodies sourced from cell line C139-9, all embedded within the gel matrix. In each microtube, 50 µL of the red cell suspension of the antibody screening cells was added, followed by the addition of 25 µL of the donor's plasma. It was then incubated at 37°C for 15 min in a dedicated incubator (ID-Incubator 37 S I, Bio-Rad, Switzerland), followed by centrifugation at 1030 rpm (85 g) for 10 min (ID-Centrifuge 12 S II, Bio-Rad, Switzerland).[9] Subsequently, the results were graded from 0 (negative) to 4+ (strongly positive) and interpretation regarding the possible alloantibody was done using the respective antigen tables provided with the antibody screening and identification cell panels. An autologous control was performed for each antibody screen, employing both the RBC and plasma from the same donor. Direct antiglobulin test (DAT) was performed on samples in which antibody screen was positive using column agglutination technology on Diamed gel card. The initial positive screened blood was quarantined till further testing results.

Telephonic follow up with the cases was done.

For positive cases that did show up for follow up, repeat sample was taken and tested.

Rare blood group donor cards were made for confirmed cases and they were explained about frequent interval testing to see if antibodies disappear over the period of time.

Blood component of identified and confirmed cases was discarded to prevent any future transfusion reaction.

STATISTICAL ANALYSIS

Data were described in terms of range; mean ±standard deviation (± SD), median, frequencies (number of cases) and relative frequencies (percentages) as appropriate. For comparing categorical data, Chi square ($\chi 2$) test was performed and fisher exact test was used when the expected frequency was less than 5. The Measure of Agreement-Kappa was also calculated. All statistical calculations were done using (Statistical Package for the Social Science) SPSS 21version (SPSS Inc., Chicago, IL, USA) statistical program for Microsoft Windows 10 Pro.

RESULTS

A total of 26,772 donors donated blood during one year study period. 79 (0.3%) were positive for antibody screen. Maximum donors were from blood centre (n=63; 79.7%) and rest were from outdoor camps (n=16; 20.3%). Among the donors with positive antibody screen 94.9% were males and 5.1% were female with M:F of 18.7:1. Mean age of donors was 35.14± 9.67 years (20-62 years). Mean weight was 81.59±15.19 kg. Maximum antibody screen positivity (n=34; 43%) was seen in age group 20-30 years. Our study showed a notable disparity in the prevalence of alloantibodies between females and males (0.6% vs 0.2%). Maximum cases (n=69; 87.3%) were from Punjab. 41.8% were first time donors while 58.2% were repeat donors who had no prior knowledge of alloantibodies present in them before donation. Donor screen positivity was maximum with B blood group (n=24; 30.4%).

Out of 79 donors, 63 (79.7%) had no significant history and were healthy throughout their lives without any major hospital treatment. 6 (7.6%) of them were on regular medication for hypertension and diabetes. 6 (7.6%) had history of previous blood transfusion. These individuals necessitated transfusion to address anemia during surgical intervention as well as in instances such as road side accidents or thrombocytopenia resulting from dengue fever. 3 (3.8%) cases had surgical history. Two were females with history of caesarean section and one was male with history of hernia operation. One female donor had received intravenous immunoglobulins in Rh negative pregnancy. Our study showed maximum positive antibody screen in the month of November (n=11; 13.9%) followed by May and September (n=10; 10.7%) as shown in figure 1a.

Reaction strength distribution in positive Capture R screen showed maximum 2+ reaction with pooled O cells (n=60; 75.9%) as shown in figure 1b.

The results of antibody identification cell panel is shown in [table 1]. Antibody identification showed cold alloantibodies (n=39; 49.3%), warm alloantibodies (n=9; 11.3%), warm autoantibodies (n=4; 5.1%) and rest were inconclusive (n=27; 34.2%). It was seen in our study that warm alloantibodies were common in females (n=3; 33.3%) and cold alloantibodies were common in males (n=38; 97.4%) which was statistically significant (p=0.017) as shown in [table 2].

Out of 79, DAT showed positivity in 3 (3.8%) as shown in [Table 3]. Auto-control was positive in 4 cases showing 3+ reactivity in 5.1% cases. The clinical significance of antibodies was determined by its reactivity at different temperature (4^0, 22^0, 37^0 thermal amplitude) as shown in figure 1c.

DISCUSSION

Donors undergo screening for alloantibodies as an essential component of blood safety protocols, employing advanced

serological techniques. This meticulous process ensures the identification of any clinically significant alloantibodies present in donated blood, thereby mitigating the risk of adverse reactions in transfusion recipients. The National Blood Policy, India, 2007 (National AIDS Control Organization, Ministry of Health and Family Welfare) has laid down the guidelines for the screening of donated blood for the presence of unexpected red cell antibodies. [10] The large variation in prevalence of alloantibodies may be due to the different screening method used, and characteristics of the population studied. The incidence of unexpected RBC antibodies in our study was 0.3%. Comparison of our data with the literature reflected a few differences and few similarities with other studies as shown in [table 4].

In India, as per the DGHS Technical Manual guidelines under the Ministry of Health and Family Welfare, Government of India, donor blood should be tested for RBC alloantibodies by saline albumin/enzyme and anti-human globulin (AHG) tests with screening panel or with pooled fresh O group red cells. [11] In our study positive antibody screen was found to be 79/26772 (0.3%). It was comparable to other studies like Zhu et al[12] 0.28%, Giblett et al[13] 0.32%. Lower incidence has been reported in studies like Makroo et al[14] 0.09%, Pahuja et al[15] 0.05% and Garg et al 0.09%. [16]

The highest frequency of alloantibodies was identified in blood donors between 20-30 years (n=34; 43%) in our study. Similar results were reported by Makroo et al[14] (n=69; 30.39%), Pahuja et al (n=2540; 32.7%).[15] In our study RBC alloantibodies in male (n=75; (94.9%) and female (n=4; 5.1%) donors were observed. When compared to number of donations from both the genders, the prevalence of alloantibodies was higher in female donors 4/643 (0.6%) as compared to male donors 75/26129 (0.3%) which is comparable with study done by Makroo et al[14] according to which it was 13/960 (1.3%) in females and 63/81193 (0.07%) in males. This finding was also consistent with study of Pahuja et al[15] but contradictory with study by Ameen et al. [17] In developing country like India there are lots of myths, social taboos, cultural habits, lack of motivation and fear of donation that prevails in society which contribute to less female participation. Moreover low hemoglobin, underweight and problems of venous access were also the reasons for female donor deferral in our study contributing to low donor pool than males 643/26129. Healthy female donors have high prevalence of alloantibodies than males, due to exposure to non self RBC antigen through pregnancy. A study from Delhi showed prevalence of alloimmunization among multigravida was 1.25%.[18]

The frequency of the blood groups in our study matched with regional data of gene frequency: B+(30.4%), O+(25.3%), A+(21.5%), AB+(7.6%), B-(6.3%), A-(5.1%), AB-(2.5%) and O-(1.3%), Rh positive donors were 24906(93%) while Rh negative donors were 1866(7%).

In El-Faramawy et al[19] study frequency of blood groups in their population were A (35.5%), O (32.5%), B (22%), AB (10%), and Rh positive were 97%, Rh negative were (3%) while in Babaei et al[20] frequency of blood groups were A (52%), O (29.33%), B (14.66%) and AB (4%), Rh+(97.33%) and Rh-(2.67%).

In our study (n=63; 79.7%) healthy blood donors developed alloantibodies inspite of having no significant history. It has been reported that in some cases the immune antibodies are found in nontransfused, healthy, male blood donors. [21] This highlights the complex nature of the immune system response and underscores the importance of regular screening protocol in blood donation to ensure the safety of transfusion recipient.

Out of 79 cases in our study, 48 (61%) had allo-antibodies and 4 (5.1%) had auto-antibodies (warm auto antibodies) while 27 (34.2%) were inconclusive. Anti-M (n =28; 35.4%) was the most common antibody identified, followed by anti-P1 (n = 5; 6.3%) plus one in combination with Anti-Le^b. Anti M was also identified as the most common antibody in studies by Makroo et al[14] (56.57%), Kaur et al[28] (42.8%.) In our study, the most frequent alloantibodies identified were from the MNS blood group system followed by P1 blood group system. M and N antigens are the oldest blood antigens known after the ABO system.[22] Anti-M and anti-P1 are generally naturally occurring alloantibodies which do not react at 37°C, and are not clinically significant for transfusion but can cause a problem in pre-transfusion testing. Anti-M is a common antibody, typically demonstrating cold-reacting IgG characteristics, with its reactivity accentuated during serologic testing under acidic conditions. It is clinically significant when detected at 37°C, wherein, cross-match compatible antigen negative blood should be given to prevent any hemolytic transfusion reaction. [23] The M antigen frequency globally is 75% hence 25% of the individuals lack M antigen. This will result in formation of anti M antibody when exposed to the antigen and could be the best possible explanation of high frequency in our study. In our blood centre units which were positive for anti M and anti-P1, packed red cells were utilized while the plasma component of that unit was quarantined.

The Rh blood group is among the most intricate blood group systems, with the D antigen recognized as highly immunogenic and capable of causing clinically significant Hemolytic Disease of the Fetus and Newborn (HDFN) as well as transfusion reactions.

In our study the most frequent antibody identified after anti M and anti P1 was anti-E 3.8% which belongs to Rh blood group system. Anti-E does not cause HDFN often but if it does, it is mild in nature. Anti-E is an IgG antibody specifically targeting the E antigen within the Rh blood group system. Patients with anti-E should receive only E-negative blood. The frequency of anti-D in our study was found to be 1.3%. The donor with anti-D (n = 1) was a Rh negative female from outdoor camp who had received Rh (D) immunoglobulins during her pregnancy. There is a significant increase in the degree of alloimmunization with increase in gravid status as shown in a study by Pahuja S et al. [24] Approximately 80-85% of D negative female donors make anti-D after exposure to D positive RBCs. [25] In comparison to other studies, frequency of anti-D found in our study was low probably because donor

pool had more number of male donors.

The frequency of clinically significant alloantibodies was anti-E 3.8% and anti-C 2.5%. Other alloantibodies found in our study are anti-Jk^a (1.3%), anti-Le^a +anti-Le^b (1.3%), and anti-Le^b (1.3%) plus one in combination with Anti-P1. However, the results were remarkably different from a study done in Chinese blood donors by Zhu et al. [12], where anti-Le^b were 7.1% and 2.3%, and no anti-Jk^a was found in their donor population. Disparities in antibody prevalence can be attributed to the population's diversity and variations in antigen frequencies based on ethnicity.

In our study frequency of Anti-Jk^a was (n=1; 1.3%). It was seen in a similar study by Makroo et al[14] 2/76 (2.63%). Anti-Jk^a is of IgG type; hemolytic transfusion reactions are very common because Kidd antibodies are often not detected in pre-transfusion testing as their levels in plasma drop below the detectable level and they show dosage effect. Packed red cells and plasma component units were quarantined for donors showing this antibody.

The frequency of Anti-P1 in our study was (n=5; 6.3%). Anti-P1 and anti-Lewis both are of IgM type and occur naturally and are often detected as a weak, room temperature agglutinin. In rare cases, they are reactive at 37° C or shows *in vitro* hemolysis. Both of these antibodies are of the IgM type, incapable of crossing the placenta, and non-causative agents for HDFN. The incidence of anti P was higher in our study as compared to other study by Makroo et al[14] 1/76 (1.3%). The frequency and avidity of anti-P1 is increased in P1 individuals suffering from helminth infestations (parasitic worm e.g. hookworm) which might have been missed during donor screening questionnaire. Anti K in our study was 1.3%. KELL (K) antigen is highly antigenic and present in low frequency. Hence it is responsible for frequent occurrence of anti Kell antibody. Cellano antigen is highly prevalent in our population therefore anti k is not formed. The prevalence of Kell (K) antigen was found to be 2.7% in a study by Prinja et al. [26] Partial phenotyping (Rh D C c E e K) of blood donors plays a vital role in transfusion practice. As per our hospital policy we are giving partial phenotype matched blood to the recipients. It is recommended that all the blood centres should transfuse partial matched phenotype blood thereby reducing the incidence of alloimmunization in non-alloimmunized multitransfused patients who might later on become future blood donors.

In our study, 4/79 (5.06%) donors had autoantibodies (DAT positive) which is much higher than reported by Tiwari et al[27] (0.04%), Kaur et al[28] (0.05%) and Patidar et al[29] (0.01%) as other studies had performed DAT on all donor samples but in our study DAT was performed on samples which were positive on antibody screen. The samples with suspected autoantibodies were sent to reference laboratory for further testing and confirmation. As per institutional policy, these blood units were discarded and the donors were advised to get regular medical check-up.

The clinical significance of an antibody in our study was determined by its reactivity at different temperatures (4^0C, 22^0C, 37^0C thermal amplitude), different phases such as normal saline or in antiglobulin (AHG phase) showing whether the antibodies are warm or cold. Warm antibodies are clinically significant antibodies whereas cold antibodies are clinically insignificant antibodies.

Out of all 79 positive screens, 27 cases were put in inconclusive results as we could not find the evident serological reason. It could be possibly due to low titre antibodies in the donor serum. The other possibility might be due to antibodies directed to the antigens absent in the 3 cell screening panel. The limitation of the study was incomplete immunohaematology work-up in case of inconclusive antibodies due to lack of availability of rare red cells reagents.

CONCLUSION

The identification of alloantibody allows for appropriate matching of donor blood with recipient blood types, optimizing transfusion compatibility and reducing the risk of alloimmunization. By implementing such refined screening protocols, blood center uphold the highest standard of blood safety, safeguarding the wellbeing of transfusion recipients. Type and Screen should be recommended as a part of standard protocol in blood donors to prevent alloimmunization. However, in developing countries it is not a part of standard screening protocol because of decentralized and fragmented blood transfusion services.

REFERENCES

1. Fung MK, Brenda J, Hillyer D, Westhoff M, AABB Technical Manual. 108th ed. Ch. 16 USA: American Association of Blood Bank; 2014.pp.391-3
2. Denise M Harmening, Modern Blood Banking and Transfusion Practices. 6th ed. Ch,9. United State of America: FA. Davis Company Publication; 2012. pp.217-9, 232-3
3. Mohn JF, Lambert RM, Bowman HS, Brason FW. Experimental transfusion of donor plasma containing blood group antibodies into incompatible normal human recipients. I. Absence of destruction of red cell mass with anti Rh, anti-Kell and anti-M. Br J Haematol 1961;7:112.
4. Hamilton JR. Common and frequently encountered antibodies. Transfus Apher Sci 2009;40:189-94.
5. Winters JL, Pineda AA, Gorden LD, Bryant S C , Melton LJ 3rd, Vamvakas EC, et al. RBC alloantibody specificity and antigen potency in Olmsted County, Minnesota. Transfusion 2001;41:1413-20
6. Giblett ER. Blood group alloantibodies: An assessment of some laboratory practices. Transfusion 1977;17:299-308.
7. Ameen R, Al-Eyaadi O, Al-Shemmari S, Chowdhury R, Al-Bashir A. Frequency of red blood cell alloantibody in Kuwaiti population. Med Princ Pract 2005;14:230-4.
8. International Society of Blood Transfusion (ISBT). Red cell immunogenetics and blood group terminology. Accessed 22 July 2022. https://www.isbtweb.org/working-parties/red- ellimmunogenetics- and-blood-group-terminology/.
9. Fung MK, Grossman BJ, Hillyer CD, Westhoff CM, editors. Technical Manual. 18th ed. Maryland, United States. AABB Press; 2014.

10. National Blood Policy (National Aids Control Organization, NACO), Ministry of Health & Family Welfare; 2007.
11. Saran RK. Transfusion Medicine Technical Manual. 2nd ed. New Delhi: Directorate General of Health Services, Ministry of Health and Family Welfare, Government of India; 2003.
12. Zhu JY, Lan JC, Luo HQ. Screening analysis of irregular antibodies from random donor population in Shaoguan area. Zhongguo shi yan xue ye xue za zhi. 2007;15(3):630-1.
13. Giblett ER. Blood group alloantibodies: an assessment of some laboratory practices. Transfusion. 1977;17(4):299-308.
14. Makroo RN, Rajput S, Agarwal S, Chowdhry M, Prakash B, Karna P. Prevalence of irregular red cell antibody in healthy blood donors attending a tertiary care hospital in North India. Asian journal of transfusion science. 2018;12(1):17-20.
15. Pahuja S, Kushwaha S, Sethi N, Pujani M, Jain M. Screening of blood donors for erythrocyte alloantibodies. Hematology. 2012;17(5):302-5.
16. Garg N, Sharma T, Singh B. Prevalence of irregular red blood cell antibodies among healthy blood donors in Delhi population. Transfusion and Apheresis Science. 2014;50(3):415-7.
17. Ameen R, Al-Eyaadi O, Al-Shemmari S, Chowdhury R, Al-Bashir A. Frequency of red blood cell alloantibody in Kuwaiti population. Medical Principles and Practice. 2005;14(4):230-4.
18. Pahuja S. Gupta SK, Pujani M, Jain M. The prevalence of irregular erythrocyte antibodies among antenatal women in Delhi. Blood Transfus 2011;9(4):388-93.
19. El-Faramawy MS, Hashem AE, Mostafa GM. Red Blood Cell Alloantibodies in Healthy Egyptian Blood Donors. The Egyptian Journal of Hospital Medicine. 2018;72(7):4913-8.
20. Babaei K, Esmaeilzadeh A, Asadi S, Sohrabi R. Prevalence of Red Blood Cell Alloantibodies in Blood Donors of Zanjan Province; the Preliminary Report of the North West of Iran. Biosciences Biotechnology Research Asia. 2016;13(4):2207-10.
21. Daniels G. Other blood groups. In: Roback JD, editor. Technical manual of American Association of Blood Banks (or AABB), 17th ed. Bethesda (MD): American Association of Blood Banks; 2011. p. 418-20
22. Beattie KM, Zuelzer WW. The frequency and properties of p+ dependent anti-M. Transfusion 1965; 5: 322-6.
23. Fung MK, Grossman BJ, Hillyer CD, Westhoff CM. ABO, H, and Lewis Blood Groups and Structurally Related Antigens, Rh system and other blood group system. Technical Manual of American association of Blood Banks. 18th ed. Bethesda, Maryland; 2014. p. 304-51.
24. Pahuja S, Gupta SK, Pujani M, Jain M. The prevalence of irregular erythrocyte antibodies among antenatal women in Delhi. Blood Transfus 2011;9(4):388-93
25. Westhoff CM, Reid ME. Blood Banking and Transfusion Medicine. 2nd ed. 2007. Available from: https://www.sciencedirect.com/topics/ medicine-and-dentistry/rhesus-antibody. [Last accessed on 2022 Feb 10].
26. Prinja N, Narain R. ABO Rh and Kell blood group system frequencies in blood donors at the tertiary care hospital of North Western India. Asian J Transfus Sci 2020; p14(2):179-84.
27. Tiwari AK, Pandey P, Sharma J, Shailja K, Dixit S, Raina V. Incidence of clinically significant antibodies in patients and healthy blood donors: A prospective cross-sectional study from a tertiary healthcare center in India. Transfusion and Apheresis Science. 2014; 50(2):230-4.
28. Kaur D, Bains L, Kandwal M, Parmar I. Erythrocyte alloimmunization and autoimmunization among blood donors and recipients visiting a tertiary care hospital. Journal of clinical and diagnostic research. 2017;11(3):EC12-5.
29. Patidar G, Singh K, Karimkhan A, Dhiman Y, Hazarika A. Red cell allo-antibodies in healthy blood donors. Conference Paper. 2018.
30. Promwong C, Siammai S, Hassarin S, Buakaew J, Yeela T, Soisangwan P et al. Frequencies and specificities of red cell alloantibodies in the Southern Thai population. Asian Journal of Transfusion Science. 2013;7(1):16-20.
31. Shafini MY, Haslina N, Rosnah B, Salamah S, Marini R. Prevalence and Specificity of Red Cell Alloantibodies in Regular Blood Donors in a Tertiary Hospital in the East Coast of Malaysia. International Medical Journal. 2017;24(1)10-11.
32. Garcia MA, Bautista L, Palomino F. Should blood donors be routinely screened for irregular antibodies. Immunohematology. 2012;28(2):60-6.
33. Erikstein BS, Hagen KG, Hervig T. RBC alloantibody prevalence and specificity in a Western Norwegian tertiary hospital. Transfusion Medicine. 2019;29(3):169-78.

Source of Support: Nil; **Conflict of Interest:** None

Submitted: 28-07-2024; **Accepted:** 24-08-2024; **Published:** 30-09-2024