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Original Article

Transfusion Medicine Section

Utilisation Pattern of Rh-D Negative Packed Red Blood Cells Inventory at a Tertiary Care Referral Teaching Hospital Blood Centre in Southern India: An Observational Study

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ABSTRACT

Introduction: Rh-D negative Packed Red Blood Cells (PRBCs) are used in a variety of situations like emergency transfusions, exchange transfusions, intrauterine transfusions and for neonatal transfusions. The availability of Rh-D negative blood can vary by region and ethnicity and the demand for Rh-D negative blood is high.

Aim: The present study aimed to evaluate the utilisation patterns of all Rh-D negative PRBCs as part of inventory management.

Materials and Methods: The present cross-sectional observational study was conducted at the Department of Immuno Haematology and Blood Transfusion (IHBT) attached to Sri Venkateswara Institute of Medical Sciences (SVIMS), Tirupati, Andhra Pradesh, India which is a tertiary care referral teaching hospital in South India. The data has been collected and analysed from July, 2021 to December, 2022. Data of Rh-D negative PRBC units including recipient blood groups, age of the unit at the time of issue, and Quality Control (QC) assessments were reviewed. Data has been analysed using Statistical Package for Social Sciences (SPSS) version 21.0. The Chi-square test of independence was applied for analysing categorical data which is represented as percentages.

Results: During the study period a total of 15,322 blood units were collected. Among these 972 (6.34%) were Rh-D negative. After excluding 15 units reactive for different Transfusion Transmissible Infectious diseases (TTIs) and 1 under-collection unit, 956 (6.24%) units were included in the analysis. Majority of the PRBCs were O Rh-D negative 453 (47.39%) units. A total of 908 (94.98%) units were issued to Rh-D negative recipients, 33 (3.45%) units to Rh-D positive recipients and 15 (1.57%) units were subjected for QC.

Conclusion: Effective inventory management of Rh-D negative PRBCs will ensure their optimal utilisation and will prevent the wastage. The study highlighted the importance of strategic transfusion practices to maintain a balance between availability and demand for this scarce resource.

Keywords: Blood transfusion, Quality control, Wastage of blood

INTRODUCTION

Rhesus (Rh) blood group system (International Society of Blood Transfusion- 004) is the most important protein blood group system. The prevalence of the Rh-D negative blood type in the Indian population is approximately 5.87% [1], which is significantly lower compared to its prevalence in Caucasians and the United States population, where it is around 15% [2]. Considering that Rh-D negative blood is a scarce and precious resource, understanding its utilisation is critical to ensure that these units are available for the right recipient at the right time.

Rh system antigens are complex as well as highly immunogenic. The clinical significance of Rh-D is, it is the most antigenic followed by c and E antigens. Exposure to Rh-D positive PRBCs either by blood transfusion or pregnancy can result in the development of anti-D antibodies in Rh-D negative individuals. This occurs due to alloimmunisation, in which the immune system of an Rh-D negative individual recognises the Rh-D antigen on transfused red blood cells as foreign and mounts an immune response. These are IgG type antibodies and implicated in Haemolytic Transfusion Reactions (HTR) and Haemolytic Disease of the Foetus and the Newborn (HDFN). It is important to provide Rh-D Negative PRBCs to recipients who have developed antibodies against Rh-D. Rh-D typing is an important component of pretransfusion testing [3].

Most studies on the utilisation patterns of Rh-D negative PRBC units [4-8] have primarily focused on Group O Rh-D negative units. This focus aligns with guidelines proposed by the Association for the Advancement of Blood and Biotherapies (AABB) and the National Health Service (NHS) Blood and Transplant [9,10], which emphasise the appropriate use of Group O Rh-D negative PRBCs. Group O Rh-D negative PRBCs are widely regarded as the "Universal Blood Donor Type" in emergencies and are often issued to recipients until pretransfusion blood grouping and typing results are available. However, instead of limiting the analysis to Group O Rh-D negative PRBCs the present study aimed to evaluate the utilisation patterns of all other Rh-D negative PRBCs also as part of a comprehensive approach to inventory management.

MATERIALS AND METHODS

The present cross-sectional observational study was conducted at the Department of IHBT attached to Sri Venkateswara Institute of Medical Sciences (SVIMS), Tirupati, Andhra Pradesh, India which is a tertiary care referral teaching hospital in South India. Data regarding the use of every Rh-D negative blood donor unit collected at the blood centre from July, 2021 to December, 2022 was reviewed.

Inclusion criteria: All ABO Rh-D negative blood units collected at the blood centre during the period from July, 2021 to December, 2022 from the eligible donors as per the guidelines of Drugs and Cosmetics Act, 1940 and Rules, 1945 revised from time to time [11].

Exclusion criteria:

- All ABO Rh-D positive donor units collected at the blood centre from July, 2021 to December, 2022.

- Blood units discarded because of sero-reactivity of blood donors tested for mandatory TTIs.
- Under collection or blood units with insufficient blood volume as per the standard guidelines.

For all study included Rh-D negative PRBC units, the ABO groups were recorded and whether the unit is issued to a recipient or is subjected to QC were observed. Individual unit's Days From Expiry (DFE) at the time utilisation was calculated by: Maximum allowable shelf life of the PRBC unit in days -Storage duration of the same PRBC unit in days from the date of collection of that unit. If PRBCs issued to a recipient, recipient ABO group was also recorded.

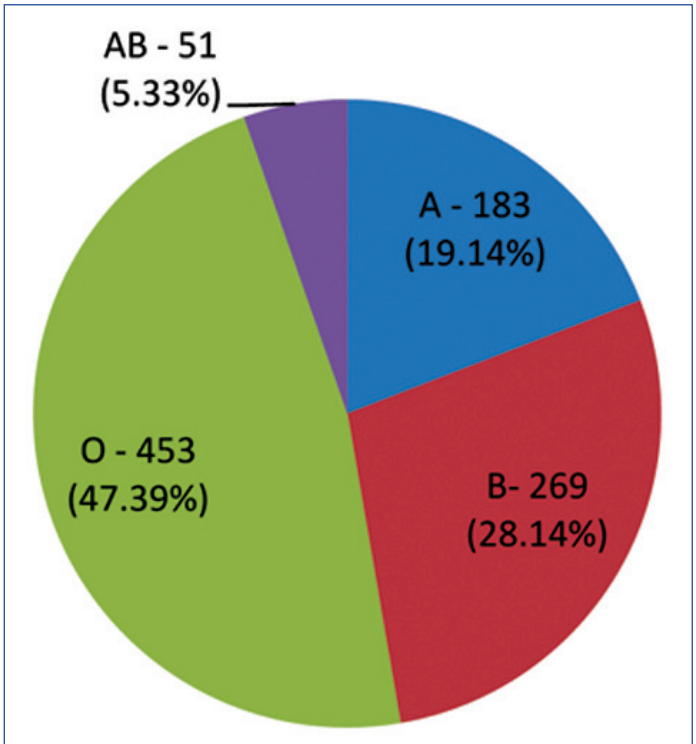
STATISTICAL ANALYSIS

Data was entered to Microsoft Office Excel sheet (Microsoft Corporation, Redmond, WA, USA). All continuous data was expressed as mean (standard deviation) and median (interquartile range), as appropriate. The data was analysed with Statistical Package for the Social Sciences (SPSS) version 21.0 (SPSS, Inc., Chicago, IL). The Chi-square test of independence was applied for analysing categorical data which is represented as percentages.

RESULTS

During the study period, a total of 15,322 blood units were collected. Among these, 14,350 (93.66%) were Rh-D positive, while the remaining 972 (6.34%) were Rh-D negative. Of the 972 Rh-D negative units, 15 (1.54%) were discarded due to donor seroreactivity for different TTIs and 1 (0.1%) unit was discarded due to under-collection. A total of 956 Rh-D negative PRBC units were included in this study to analyse their utilisation patterns.

Among the 956 Rh-D negative units, majority were O Rh-D negative - 453 (47.39%) followed by B Rh-D negative-269 (28.14%), A Rh-D negative- 183 (19.14%) and AB Rh-D Negative- 51 (5.33%) [Table/Fig-1].



[Table/Fig-1]: Rh-D negative ABO group distribution among study population (n=956).

Of the total 956 Rh-D negative PRBC units, the majority (908; 94.98%) were issued to Rh-D negative recipients. Thirty three units (3.45%, 33/956) were issued to Rh-D positive recipients (p<0.05), while 15 units (1.57%, 15/956) were subjected to QC [Table/Fig-2]. Twelve out of these 33 units were issued to Chronic Kidney Disease (CKD) patients undergoing dialysis followed by six units each to neonatal exchange transfusions, patients undergoing emergency surgery, patients with severe anaemia due to medical reasons, and three units to patients with anaemia due to underlying malignancy.

S. No.	Utilisation pattern	Number of units	Percentage	p-value
1	Subjected to QC	15	1.57%	-
2	Units issued to Rh-D positive recipients	33	3.45%	<0.01
3	Units issued to Rh-D negative recipients	908	94.98%	
Total		956	100%	

[Table/Fig-2]: Pattern of utilisation of Rh-D negative PRBC Units (n=956).

Among the 33 units issued to Rh-D positive recipients, the majority (15 units) were A Rh-D negative which were issued to A Rh-D positive patients followed by 7 B Rh-D negative units issued to B Rh-D positive recipients [Table/Fig-3]. There is a statistically significant difference (p<0.05) in the issuance of Rh-D negative PRBC units to Rh-D positive recipients across different ABO blood groups. However, this comparison is generally not applicable to the AB Rh-D negative group, as AB Rh-D negative units can only be issued to AB Rh-D recipients.

ABO group and Rh-D type	ABO group-wise number of units issued to Rh-D positive recipients				Total n (%)	p-value
	Group O n (%)	Group A n (%)	Group B n (%)	Group AB n (%)		
O Neg	5 (71.42)	1 (14.29)	1 (14.29)	0	7 (21.21)	<0.01
A Neg	0	15 (100)	0	0	15 (45.46)	<0.01
B Neg	0	0	7 (100)	0	7 (21.21)	<0.01
AB Neg	0	0	0	4 (100)	4 (12.12)	<0.01
Total	5 (15.15)	16 (48.49)	8 (24.24)	4 (12.12)	33 (100)	

[Table/Fig-3]: Pattern of issue of Rh-D negative Units to Rh-D positive recipients (n=33).

A total 941 ABO Rh-D negative units (O=450 (47.82%), A=179 (19.02%), B=262 (27.84%) and AB=50 (5.31%) were issued to the compatible ABO group recipients, out of which 2 (0.21%) B Rh-D negative and one (0.10%) A Rh-D negative units were issued to AB group recipients [Table/Fig-4]. There is a statistically significant difference (p<0.05) in the issuance of Rh-D negative PRBC units to recipients across different ABO blood groups. Again this comparison is generally not applicable to the AB Rh-D negative group, as these units can only be issued to AB recipients.

Regarding the utilisation of O Rh-D negative (450) PRBCs, 48 out of 450 (10.66%) units were issued to non-O Rh-D negative group recipients. Only 9.11% (41/450) O Rh-D negativeunits were issued to ABO-non-identical (A/B/AB) recipients.

None of the 941 issued units were discarded due to date expiry. The mean time to expiry at the point of issuance was 24.95 days. Of the15 units submitted to QC, 80% (12/15) units were sent for QC in the last seven days before expiry in order to avoid wastage of blood units [Table/Fig-5].

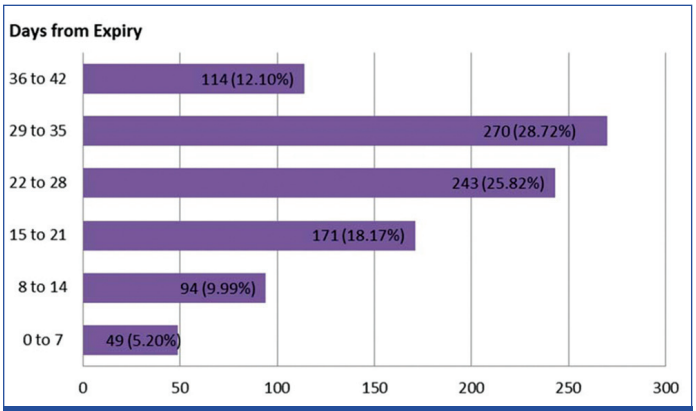
DISCUSSION

The present observational study helps in understanding the utilisation pattern of all Rh-D negative PRBC units and not just limited to O Rh-D negative PRBC units as analysed in some of the recent studies [4-7,12,13].

The Rh-D negative PRBC units prepared from all collections from donors accounted to 6.34% (972/15322) during the study

ABO group and Rh-D type	ABO groupwise number of units issued to recipients				Total n (%)	p-value
	Group-O n (%)	Group-A n (%)	Group-B n (%)	Group-AB n (%)		
O Neg	409 (90.89)	14 (3.11)	25 (5.56)	2 (0.44)	450 (47.82)	<0.01
A Neg	0	178 (99.44)	0	1 (0.56)	179 (19.02)	<0.01
B Neg	0	0	260 (99.24)	2 (0.76)	262 (27.84)	<0.01
AB Neg	0	0	0	50 (100)	50 (5.31)	<0.01
Total	409 (43.46)	192 (20.40)	285 (30.30)	55 (5.84)	941 (100)	

[Table/Fig-4]: Pattern of issue of Rh-D negative units to group and type specific, across the group but type specific recipients (n=941).



[Table/Fig-5]: Categorisation according to the Days From Expiry (DFE) at the time of issue of 941 Rh-D negative PRBC units (n=941).

period. This finding is similar to the prevalence of Rh-D negative blood type observed in India in studies done by Mahapatra S et al., (5.87%), Suresh B et al., (7.20%), Bhutada TB et al., (4.66%), Rao NM et al., (5.07%) [1,14-16]. Among these, 15 (1.54%, 15/972) units and 1 (0.10%, 1/972) unit were discarded because of donor sero-reactivity and under collection respectively during the period of study. Another 15 (1.54%, 15/972) units, were subjected to QC.

In the present study, about 3.51% (33/941) Rh-D negative units were issued to Rh-D positive recipients. This was due to the non-availability of exact ABO Group specific Rh-D Positive PRBC unit at the time of requirement and issue as well as to meet emergencies (CKD patients on dialysis, emergency surgeries etc.,) and obligatory situations (exchange transfusions in neonates etc.,). In the Dunbar NM et al., study in the United States of America [6], 5.2% (24,987/446,656) Rh-D negative units was issued to Rh-D positive recipients.

Regarding the utilisation pattern of O Rh-D negative PRBCs, only 10.66% (48 out of 450) O Rh-D negative units were issued to non O Rh-D negative recipients. This is in contrast to the findings in a prospective study conducted by Ilmakunnas M et al., done in Finland [12]. In the Finland study,it was observed that almost half of the O RhD-negative units (47.9%) were issued to non-O Rh-D negative patients and the most common reason was inventory management as most of these units were issued close to the unit expiry date.

In the above mentioned Finnish study [12] almost one third (32.1%) of O Rh-Dnegative units were issued for ABO-non identical (A/B/AB) transfusions, this is in contrast to the present study in which only 9.11% (41/450 O Rh-D Negative PRBC units) units were issued to ABO-non identical (A/B/AB) transfusions. In the Dunbar NM et al., study, 43.6% (18,732/42960) O Rh-D negative units were transfused to non O- group recipients, which is in contrast with the findings of the present study [6]. Probable causes would be to treat unknown ABO group emergency bleeding patients, and to avoid outdating.

Twelve (80.00%, 12/15) units were sent for QC during the last seven days from the date of expiry as part of the inventory management measure. None of the studies were found in the literature that analysed the Rh-D negative PRBCs subjected for QC as a part of inventory management.

Limitation(s)

The major limitation is that this is done at an academic blood centre which is a single centre study and may not exactly reflect the utilisation practices at other blood centres i.e., non-academic stand-alone blood centres, small Government community health centre blood centres etc. As there was very much limited data available on utilisation pattern of Rh-D negative PRBCs of A, B and AB blood groups, weare unable to discussin details about their utilisation patterns in our study.

CONCLUSION(S)

In the present study, during emergencies, O Rh-D negative PRBCs were issued to recipients whenever necessary following proper pretransfusion testing protocols. Notably none of the Rh-D negative PRBC units were discarded due to expiry during the study period. This highlights the importance of appropriate inventory management, which ensures the optimal utilisation of Rh-D negative PRBC units, avoiding both shortages and wastage of this precious resource.

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