

Selection of Blood (Packed RBCs) for Transfusion in Newborn Baby up to the Age of 4 Months

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Abstract

Proper selection of donor's blood group is essential to prevent transfusion hazards. It is known that ABO antigen is fully developed at birth but the newborn baby does not produce ABO antibodies until 3 to 6 months of age. The ABO antibodies present in the serum of newborn babies are derived from mother's blood due to placental transfer. So the blood group of the newborn baby is done by ABO antigen grouping (forward grouping) only, antibody grouping (reverse grouping) is not required. In case of transfusion of blood in newborn under 4 months of age, cross-matching of donor's blood is done with the mother's blood if it is available. We know, recipient's same group of blood is always preferable in case of transfusion in adults or older children. But selection of blood for transfusion in the infants under 4 months of age depends on the mother's blood group as well. If the mother's blood group differs from the infant's blood group, the infant's same group of blood may not be selected for transfusion. For example, if the mother's blood group is "O" and the newborn blood group is "A" or "B", infant's same group "A" or "B" group blood could not be transfused, because the anti-A & anti-B antibodies can be derived in the infant's serum from mother's blood which may react with the "A" or "B" antigen of the donor's blood. In this case "O" group packed RBCs should be selected for transfusion. "O" group whole blood may contain IgG anti-A and anti-B antibodies in the plasma which can react with the "A" or "B" antigen of the infant's blood. So to avoid anti-A & anti-B antibodies in "O" group, plasma should be discarded and the packed RBCs should be transfused.

In case of Rh-negative mother with Rh positive baby, Rh antibody may develop in mother's blood and Rh antibody may enter into baby's circulation, in this case the infant should be transfused with Rh-negative blood to avoid Rh antigen & antibody reaction. So for the selection of blood for transfusion in newborn baby up to the age of 4 months mother's blood group is important to select the appropriate blood.

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Introduction

Transfusion practices vary among neonatologists, largely due to a lack of evidence upon which to base practice.¹ Special protocols are followed for the selection of blood for transfusion of newborn baby up to the age of 4 months. In almost all cases (older infants, children and adults) blood and blood components of patient's own ABO and Rh group

should be selected for transfusion. But occasionally, it is not ideal to transfuse the baby's own group of blood if the baby is under 4 months of age. Infants less than 4 months of age rarely produce antibodies (anti-A or anti-B) against blood group antigens.² ABO antibodies present in the baby's blood at birth are likely to be of maternal origin due to placental

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transfer.³ Therefore standards for pre-transfusion serologic testing for these patients are different from those for older infants, children and adults. The major cross-matching i.e. mixing of donor's red cells with recipient's serum is most likely to be done with mother's serum. If this is not compatible there may be chance of transfusion reaction. If mother's blood group differs from the baby's blood group, even the transfusion of baby's own group of blood may cause transfusion reaction. So the mother's blood group should always be considered for the transfusion of newborn up to the age of 4 months.⁴ The aim of this review is to make a better understanding of proper selection of blood for transfusion in infant less than 4 months of age and to create awareness among the concerned doctors and physicians so that they will give importance to provide information regarding the blood group of mother in the 'Blood Request Form' for transfusion of infants in this age group.

Blood group inheritance

Each individual inherits one ABO gene from each parent and these two genes determine which antigens will be present on the red cells. In each chromosome number⁹, a position or locus is occupied by ABO gene.⁵

There are 3 pairs of Rh allelic genes: *Cc*, *Dd* and *Ee*. These are closely linked genes; they occupy three positions (loci) on chromosome 1 and are inherited as triplets, each triplet containing one gene from each parent.⁶

Production of ABO & Rh antigens

Three allelic (similar) genes, *A*, *B* & *O*, and a pair of allelic genes, *H* & *h* are responsible for the formation of antigen A and B.⁶ Rh allelic genes are responsible for *Cc*, *Dd* & *Ee* antigens. They are direct gene products.⁶ Among these D antigen is most important, because it is strongly immunogenic. If Rh D antigen is present, individuals are termed Rh positive. If the D antigen is not expressed, the individual is termed Rh negative.²

Development of ABO and Rh antigens

ABO antigen begins to develop at 5-6 weeks of intra-uterine life. Adult level is not reached until 1st

year of life. By the age of 2-4 years adult level fully develops. Rh antigens also begin to develop in intra-uterine life and become fully developed at birth.

Development of ABO and Rh antibodies

ABO antibodies usually are not developed in newborn, develop slowly after birth. It needs 3-6 weeks time to develop at detectable level in the blood.

Rh-antibody usually is not present naturally. Most of these are immune antibodies, that means they are only developed by immunization or sensitization by Rh-antigens during pregnancy or following transfusion of blood.

Immunological aspects of blood group antigen and antibody

The ABO antigens and antibodies are the most important for transfusion practice. Most of the ABO antibodies are naturally occurring and are predominantly IgM type.⁵ Unlike other blood groups, 'O' group has both anti-A and anti-B antibodies which are a mixture of IgG and IgM antibodies. Ig M antibodies cannot cross the placenta and cannot enter the foetal circulation normally. The IgG ABO antibodies are usually immune antibodies; they can be produced in the individual by stimulation due to transfusion or pregnancy. These IgG ABO antibodies can cross the placenta and can enter into the foetal circulation. As the new born babies do not produce ABO antibodies at birth, the antibodies present at birth is likely to be of maternal origin. The antigen-antibody reaction may occur in case of incompatible blood transfusion, which may cause the fatal outcome of the infant.

When the Rh negative person is transfused with Rh positive blood, the immune system of the person will be stimulated and will produce anti-Rh antibody. There will be transfusion reaction during subsequent transfusion with Rh positive blood. Rh antibody also can be produced if the Rh negative mother is exposed to Rh positive foetal red cells during pregnancy. This Rh antibody is immune antibody and is IgG type which can cross the placental barrier and may enter into the foetal circulation and can cause haemolytic disease of the newborn.

ABO grouping and compatibility test (cross-matching)

An initial pretransfusion specimen from the infant and donor must be tested for ABO group and Rh type prior to each compatibility test. Blood group determination includes both forward (RBC or antigen) and reverse (serum or antibody) grouping of the patient and the donor.⁷ ABO reverse grouping is omitted from cord blood (blood from umbilical cord of the baby just after delivery) or from newborn baby's blood by heel prick, because their own ABO antibodies are too low for detection.⁵

Cross-match test is to be performed before any blood transfusion to the patient to ensure that donor red cells are compatible with the recipient (patient).⁶ This test includes the major cross-match which is done by mixing of donor's red cells (antigen) with the patient's serum (antibody) and the minor cross-match which is done by mixing of patient's red cells with donor's serum. Antibodies present at birth are of maternal origin. So the cross-matching of the donor's blood should be done with the mother's sample. Cross-match can also be done with infant's sample provided that the donor's blood is not incompatible with maternal ABO & Rh antibody.⁵ If no unexpected antibodies are detected initially in either the mother or infant, the RBC unit is ABO compatible with the infant and mother and either Rh-negative or of the same Rh group as the infant:

1. Repeat ABO/Rh grouping is not required;
2. Repeat antibody screening is not required; and
3. Compatibility testing is not required.⁸

Adverse reactions due to transfusion of packed red blood cells (PRBCs)

Transfusion of blood components present potential risks with more adverse outcomes for ill, high-risk infants than from older patients.⁹⁻¹¹ Apart from other hazards of transfusion, infants of this age group may experience some particular adverse effects.

Due to frequent transfusion there may be allo-immunization in infants against some blood group antigens. Haemolytic transfusion serum contains unexpected antibodies and the transfusion is given without cross-matching the donor's blood with maternal serum. Following transfusion, the prematurred

infants may be infected by CMV if CMV seronegative blood is not transfused.¹² Transfusion associated graft versus host disease has been reported in preterm infants transfused with cellular blood components.

Selection of appropriate blood for the infants under 4 months of age

In the first 4 months of life, infants require repeated transfusion more frequently than older children and adults.¹³ In almost all cases blood and blood components of infant's own ABO and Rh group should be selected for transfusion. The blood should be compatible with any maternal antibodies that have entered the infant's circulation.¹⁴ If the mother is of 'O' group and the infant is of 'A' or 'B' group, the infant's blood may contain Ig G anti-A, anti-B antibody which is derived from mother's blood, so transfusion of infant's own group of blood will be incompatible and it can cause transfusion reaction. In case of transfusion of an ABO group different from that of the infant, packed RBC must be used rather than whole blood. Whole blood contains plasma antibodies that are incompatible with infant's red cells, that is minor cross-match will be incompatible.⁵ Group 'O' packed RBC can be safely used for all patients, but it has some limitations of use and it can be used in special circumstances only.⁵

Rh negative blood can be given to Rh positive patients but it has also some limitations of use. Rh positive blood should not be given to Rh negative female in child bearing age.⁵ It may cause Rh immunization and may damage the Rh positive foetal RBC during pregnancy. Rh positive infant of Rh negative mother containing Rh antibody also should not be transfused with Rh positive blood. Blood should be as fresh as possible and not older than 7 days to reduce the risk and to increase the benefits of the transfusion.¹⁵

For infants with ABO haemolytic disease of the newborn, only group 'O' RBCs should be transfused until compatibility tests are non-reactive with ABO specific units.^{16,17} Irradiated, CMV sero-negative, leuco-reduced, packed RBCs, diluted with fresh frozen plasma should be selected for exchange transfusion of premature infants.¹⁸⁻²¹

Protocol for choice of RBC for newborn exchange and normal transfusion up to the age of 4 months according to the American Association of Blood Banks are shown in the following tables (I, II).⁴

Table I: Choice of ABO blood groups

Newborn's blood group	Mother's Blood group	Choice of Blood	
		1st Choice	2nd Choice
A	A	A	O
	B	O	-
	AB	A	O
	O	O	-
B	A	O	-
	B	B	O
	AB	B	O
	O	O	-
AB	A	A	O
	B	B	O
	AB	AB	A,B,O
	O	O	-
O	A	O	-
	B	O	-
	AB	O	-
	O	O	-

If the infant and the mother have same ABO blood group, the infant's own blood group should be selected for transfusion. If any one is of 'O' blood group or if infant's blood group differs from mother's blood group, 'O' group blood should be selected. If infant is of AB group, mother's group should be selected and if mother is of AB group, infant's group should be selected.

Table II: Choice of Rh blood groups

Newborn's Rh D group	Mother's Rh D group	Choice of Blood	
		1st choice	2nd choice
Rh +	Rh +	Rh +	Rh-
Rh-	Rh-	Rh-	-
Rh +	Rh-	Rh-	-
Rh-	Rh +	Rh-	-

If both the infant and mother are of same Rh group, infant's own group can be selected. If any one is Rh negative, Rh negative blood should be selected. An infant suffering from haemolytic disease due to Rh immunization of Rh negative mother should be transfused with Rh negative blood.^{6,22}

Note

1. For the transfusion of newborn: cross-match donor's blood (RBC) with mother's serum; if mother's sample is not available, cross-match with newborn's serum.
2. For exchange transfusion: if mother's group is not known, cross-match O-PRBC with newborn.
3. For exchange transfusion of newborn: dilute PRBCs with AB plasma.

Conclusion

If the transfusion of infant less than 4 months of age is needed, it is essential to mention the mother's blood group in the blood request form for safe blood transfusion in infants less than 4 months of age. If the mother is not available, infant's own blood group can be selected provided that the blood is not incompatible with mother's Rh and ABO antibody which is present in infant's blood at birth. When packed RBCs other than group 'O' is selected for transfusion, the infants serum or plasma must be tested for anti-A and anti-B antibodies. As long as the infant's serum contain significant amount of mother's ABO antibodies, packed RBCs lacking the corresponding antigens must be selected for transfusion.⁵

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