Original Article

The Effect of Different Blood Components on Exchange Transfusion Outcomes

Sedigheh Ghaemi,[1] Hosein Saneian,[2] Behjatosadat Mo'ayedi,[3] Abbasali Pourazar[4]

Department of Pediatrics, School of Medicine and Child Health Promotion Research Center,[1,2]

Department of Immunology, School of Medicine,[3,4] Isfahan University of Medical Sciences, Isfahan, Iran.

Corresponding Author: Sedigheh Ghaemi. (s_ghaemi@med.mui.ac.ir).

Abstract

Background: Exchange transfusion (ET) has been known as an effective treatment in sever neonatal jaundice. Prescribing appropriate blood group makes an important role in patient's outcome and no single component is unequivocally the best. The purpose of this study was to evaluate the effect of ABO compatible packed cell, dried O, and routine O groups on exchange transfusion outcomes.

Methods: This multicenter clinical trial study is the combination of two studies which were conducted at three university hospitals (Isfahan University of Medical Sciences, Isfahan, Iran). A hundred full term infants with more than 2.5 kg body weight, serum bilirubin $\geq$ 20 mg/dl and confirmed ABO-Hemolytic Disease of the Newborn (HDN) were participated in first study. Among 40 infants, 20 underwent the exchange transfusion with O packed cell (group 1) and other 20 were transfused with O dried packed cell (Hematocrit = 90%) (group 2). In the second study with the same eligibility criteria with first study, among the 60 infants, 30 had exchange transfusion with O packed cell (group 3) and the rest were transfused with infant isogroup (group 4). Serum bilirubin and hemoglobin (Hb) were evaluated before and 6, 12, 24 and 48 hours after the exchange transfusion.

Results: The means of Hb after the exchange transfusion were 14.3 mg/dl in group 1, 15.62 mg/dl in group 2, 14.98 mg/dl in group 3 and 14.30 mg/dl in group 4 with significantly higher in group 2 compared with others ($p = 0.02$). The mean of the bilirubin after the exchange transfusion had no statistical significant difference between the four groups ($p > 0.05$). The mean of Hb and bilirubin before exchange transfusion had no statistically difference between all groups ($p > 0.05$). The mean of bilirubin before the exchange transfusion in infants who had two transfusion was significantly higher than the mean of the bilirubin before the exchange transfusion in infants with one time transfusion ($p = 0.05$). There was no significant difference between four groups in exchange transfusion frequency ($p > 0.05$).

Discussion: This study indicated that the level of bilirubin before exchange transfusion is the only important factor which sometimes causes the necessity of second or third exchange.

Keywords: Routine packed cell, Dried packed cell, Exchange transfusion, ABO-HDN (JPMA 62: S-45; 2012).

Introduction

Neonatal jaundice is an in-progress problem ted to hospital admission of newborns and approximately 5-10 percent of all newborns require intervention for pathologic jaundice.[1] Exchange transfusion (ET) has been known as an effective treatment for sever neonatal jaundice.[2] The most common indication of exchange transfusion is ABO- Hemolytic Disease of the Newborn (ABO-HDN).[3] Therefore, many infants with severe neonatal jaundice should undergo exchange transfusion, even before identification of the exact cause of ABO-incompatibility.[4,5] ET can be performed using many different combinations of blood components, including whole blood group O with anti A and B titer $\leq$ 1/100, O routine packed cell (with washed O routine packed cell group or O dried packed cell) and AB plasma, infant isogroup routine packed cell and AB plasma, and whole isogroup and compatible blood.[1,6-12]

The appropriate and safest blood kind is an important factor for the exchange transfusion outcomes. Since fresh whole blood of the appropriate blood group is not always readily available, reconstituted blood is an alternative blood component for exchange transfusion; but no single component is unequivocally the best.

All the components have advantages and disadvantages. Routine O packed cell (Hematocrit = 60-70%), contains 30-40 cc of O plasma in every 100 cc which has high titer of anti A-B (± IgG and IgM). So, there is inevitable that after transfusion of the non-group O, infants make a RBC lysis needing to the second exchange transfusion.[13] Using isogroup packed cell may induce reaction with maternal antibodies existed in infant's blood. So, this study was conducted to evaluate the effects of different blood components on exchange transfusion outcomes.

Methods

This multicenter trial study was conducted at three university hospitals (Isfahan University of Medical Sciences, Isfahan, Iran), and the Ethics Committee of Isfahan University

of Medical Sciences approved the study protocol.

Infants who had less than one week age, more than 2.5 kg body weight, serum bilirubin ≥ 20 mg/dl and confirmed ABO-HDN were participated in to two separated studies. Patients who had reasons other than ABO haemolytic disease or who had glucose-6-phosphate dehydrogenase deficiency (G6PD) were excluded,

In the first study, after registering demographic data, 40 infants divided into two groups who were perfectly compatible, each group consisted of 20 infants; the group 1 were transfused with reconstituted blood of O routine packed cell and the second group (group 2) were transfused with reconstituted blood of O dried packed cell (Hematocrit = 90%, with removing out the O plasma of these packed cells and replacing them with AB plasma). Hematocrit, maternal and neonatal blood group tests — including Rhesus, a direct antiglobulin test (Coombs' test) — and serum bilirubin levels were performed routinely in all cases before ET. Used blood group, hematocrit, duration of hospitalization, the frequency of exchange transfusion, Hb and bilirubin 6, 12, 24 and 48 hours after ET were registered. All infants received phototherapy on admission and phototherapy treatment was continued, except ET periods, until bilirubin was reduced to the desired level.

In the second study, 60 infants were randomly divided into two groups (each group 30 infants) who were perfectly compatible and matched. The inclusion and exclusion criteria were the same as first study. The first group (group 3) was underwent the ET with reconstituted blood of O routine packed cell and the second group (group 4) was transfused with reconstituted blood of infant isogroup routine packed cell. All method conditions were similar to the first study and patients' outcomes were measured as like as the first study.

We used Fisher's exact, chi-square and t tests to compare the data statistically. All the analysis was done with SPSS18 software (version 18, SPSS Inc., Chicago, IL). The threshold p-value of 0.05 was used to provide sufficient evidence to reject the null hypothesis and state that the difference is statistically significant.

Results

The results of first (Table-1) and second (Table-2) studies indicated that the mean of Hb and hematocrit after the ET in group 2 was significantly higher than the other groups ($p = 0.02$). The mean of bilirubin before the ET in infants who had two transfusion was significantly higher than the infants with one time transfusion ($p = 0.05$). Three infants in group 1, 2 infants in group 2, 5 infants in group 3, and 4 infants in group 4 underwent the second exchange transfusion. According the statistical analysis, there was no significant difference between four groups in ET frequency ($p > 0.05$). The mean of Hb and bilirubin were almost identical before the exchange transfusion in the groups and there was no significant difference between them ($p > 0.05$).

Frequency distribution of the maternal and neonatal blood groups was also measured. The maternal blood group of O and the neonatal blood groupof A were the most. Almost in the majority of the patients, the reticulocyte percentage, peripheral blood smears in terms of spherocytosis, and infant direct agglutination test (DAT) were in a normal range. A significant number of the infants' blood (almost 10%) -who had blood cultures before negative exchange transfusion- was positive after the exchange transfusion. The frequency of exchange transfusion in males was twofold more than females but the frequency of the second exchange transfusion

Table-1: The results of the measured variables in group who had exchange transfusion using dried packed cell O [intervention group (group 1)] and group who had exchange transfusion using routine packed cell O [control group (group 2)].

		Group	Number	Mean	P-value
Hemoglobin	before exchange transfusion	Intervention	20	15.02	0.64
		Control	20	15.4	
	after exchange transfusion	Intervention	20	15.62	0.02
		Control	20	14.3	
Bilirubin	before exchange transfusion	Intervention	20	25.0	0.6
		Control	20	25.96	
	after exchange transfusion	Intervention	20	10.51	0.44
		Control	20	9.63	
	6 hours after exchange transfusion	Intervention	20	16.67	0.64
		Control	20	17.84	
	12 hours after exchange transfusion	Intervention	20	16.65	0.78
		Control	20	16.22	
	24 hours after exchange transfusion	Intervention	20	13.15	0.21
		Control	20	14.07	
	48 hours after exchange transfusion	Intervention	20	11.4	0.92
		Control	20	11.3	
The frequency of exchange transfusion		Intervention	20	1.10	0.64
		Control	20	1.15	
Percentage of the infants who had exchange transfusion		Intervention	20	10%	0.5
		Control	20	15%	
The average days after which they have been hospitalized or had phototherapy		Intervention	20	2.6	0.61
		Control	20	2.75	

Table-2: The results of the measured variables in group who had exchange transfusion using infant isogroup packed cell [intervention group (group 3)] and group who had exchange transfusion using O routine packed cell [control group (group 4)].

		Group	Number	Mean	P-value
Hemoglobin	before exchange transfusion	Intervention	30	15.06	0.91
		Control	30	15.13	
	after exchange transfusion	Intervention	30	14.30	0.92
		Control	30	14.98	
Bilirubin	before exchange transfusion	Intervention	30	24.43	0.42
		Control	30	23.37	
	after exchange transfusion	Intervention	30	10.05	0.42
		Control	30	9.05	
	6 hours after exchange transfusion	Intervention	30	17.01	0.11
		Control	30	15.91	
	12 hours after exchange transfusion	Intervention	30	15.48	0.47
		Control	30	16.13	
	24 hours after exchange transfusion	Intervention	30	13.86	0.97
		Control	30	13.84	
	48 hours after exchange transfusion	Intervention	30	11.68	0.75
		Control	30	11.89	
The frequency of exchange transfusion		Intervention	30	1.16	0.72
		Control	30	1.13	
Percentage of the infants who had exchange transfusion		Intervention	30	13.3%	0.5
		Control	30	16.7%	
The average days after which they have been hospitalized or had phototherapy		Intervention	30	3.2	0.72
		Control	30	3.1	

in females was twofold more than the males.

Discussion

Unlike the imagination, our results showed that by removing out the O plasma of packed cells and replacing it with AB plasma, no change was occurred in the preliminary results of the exchange transfusion.

The similarity of the results of the first two groups may be because of the following reasons; first of all, 85-90% of the infant's RBCs were the donated globules i.e. O type after the ET[6] which was compatible with O plasma. Secondly, the same volume of O plasma can be more diluted by double exchange.[5] Thirdly, low percentage lysis of infant cells may have no significant effect on the bilirubin in term infants. It should be noted that this volume of plasma may cause no problem for the term infants but the lysis of RBCs in this volume, may be problematic for the preterm infants; moreover, the O plasma antibodies, by inducing the lysis of RBCs, may cause anemia in the subsequent weeks in term and preterm infants.[14]

Similar to first study, none imaginary results were found in the second study. We found no difference in using isogroup packed cell, compared with O routine packed cell, after ET. The reasons may be as followed; firstly, if there was a significant amount of maternal antibodies against donated RBC in infant serum, the initial cross matching test should be positive before the exchange transfusion.[5] Secondly, in rare cases, the cross matching test cannot screen these low titers[9] and the antibodies could be diluted and affectless by the massive transfused blood.[4] It also should be noted that fetal RBCs combined with maternal blood at the 28th pregnancy week; so, there is the possibility of antibody against the fetal antigens which crossing form the placenta. The titers of antibodies gradually increase in serum of the fetus; so in a term infant, the titer of maternal IgG antibody may be higher than mother IgG antibody.[15] Therefore, in preterm infants, the results of using isogroup packed cell may be better than term infants.

In Isfahan, Iran, a study conducted on 96 patients with ABO-HDN and showed that none of them had severe jaundice for ET. It may be because of reduction of the prevalence of severe jaundice caused by ABO-HDN in Isfahan and some of the infants underwent exchange transfusion diagnosed by ABO-HDN might not really be ABO incompatible.[15]

Conclusion

We found that the results of using O routing packed cell, dry packed cell and infant isogroup was similar. According to difficulty of preparing and cost of dry packed cell, many centers could not prepare it and a new strategy should be brought out for these centers. Therefore, it is suggested that for ABO-HDN infants exchange transfusion, whole blood neonatal isogroup could be used or be cross-matched with maternal or neonatal serum.

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