THE IMPACT OF RBC’s TRANSFUSION DURING CPB ON POSTOPERATIVE PULMONARY COMPLICATIONS IN NEONATAL OPEN HEART SURGERY

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The aim of this study was to evaluate relationship between the volume of donor red blood cells (RBC’s) transfused during cardiopulmonary bypass (CPB) and development of pulmonary complications in the early postoperative period. Results of the study demonstrated that the quantity of RBC’s used during CPB correlates significantly with the development of pulmonary complications in the early postoperative period (r=0,2; p <0,001). Receive operating curve analysis allowed us to determine that the use of 70 ml of donor RBC’s during CPB is a strong predictor of pulmonary complications in the early postoperative period (p <0,001).

**Keywords**: cardiopulmonary bypass, postoperative complications, neonatal open heart surgery, congenital heart disease

Neonatal open heart surgery usually accompanied by a massive transfusion of donor blood components. That is caused by an underbalanced ratio between circulating blood volume and volume of extracorporeal circuit of the heart-lung machine. Blood components are used to prime the extracorporeal circuit and oxygenator and to correct anemia after CPB.

Several studies have described blood transfusion as a potential cause of numerous immunologic and nonimmunologic complications [1-4]. Moreover, intraoperative transfusion of RBC’s affects the perioperative release of inflammatory

mediators in patients undergoing cardiac surgery. In addition, CPB does result in an inflammatory response [5]. RBC’s transfusions affect the well-known systemic inflammatory response to cardiac surgery both by enhancing part of the response and by direct transfusion of bioactive substances into the circulation [6-8]. The inflammatory injury related to CPB results in increased pulmonary vascular resistance, decreased compliance, decreased functional residual capacity, increased ventilation-perfusion mismatch with intrapulmonary shunting, leakage fluid into the initial space, and reduced surfactant activity [9, 10]. Given the above, we assumed that the use of donor RBC during CPB can lead to a more pronounced imbalance of the immune response and increases the risk of complications in the postoperative period.

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**Material and methods**

Between September 2009 and December 2013 253 neonates underwent arterial switch operation for transposition of the great arteries at Ukrainian Children’s Cardiac Center was enrolled in this study. Patients were managed in accordance to institutional protocol [11].

Perioperative data were abstracted from medical records and our institutional database. Analyzed data included: duration of CPB, volume of transfused donor RBC’s during CPB and after CPB intraoperatively; presence of complications in the early postoperative period, age at surgery, serum lactate level at one hour after surgery.

Continuous data are tested for normality using the Shapiro-Wilks test. Pearson's correlation test (r) or the Spearman rank (R) correlation test were performed to examine the relationship between continuous variables. Individual elements that were determined to be significantly (p<0.05) associated with outcome were entered into a logistic linear regression analysis. For this test, non-normal data

were transformed into approximately normal data using logarithmic transformation. Significance was defined by p<0.05. Statistical analyses were performed Statistical analysis was performed using the software package SPSS 21 (USA).

**Results and discussion**

Complications that we observed in the early postoperative period were divided into two groups. The first group included complications (N = 47, 19%), which were related to surgical technique: 13 cases of cardiac arrhythmias, 12 patients showed complete AV block; delayed sternal closure in eight patients, redo - five patients; four patients diagnosed with diaphragm paresis, accompanied by respiratory failure and needed surgery (diaphragm plication); in five patients wound infection diagnosed after surgery. The second group of complications were associated with extracorporeal circulation and/or blood transfusions (N = 44, 17%). Among them, 37 cases presented with pulmonary complications; in four cases we diagnosed sepsis; three patients were diagnosed with interventricular hemorrhage in postop period.

Development of pulmonary complications in the early postoperative period may be caused by a number of factors associated with CPB and transfusion of donor blood components. In order to determine the factors which may significantly influence the development of complications in the early postoperative period, we used correlation analysis. The results of the correlation analysis are presented in Table 1.

Table 1

Correlation analyze for postoperative pulmonary complications and perioperative data

|  |  |  |
| --- | --- | --- |
| Variables | Pulmonary complications | |
| Correlation coeff. | p value |
| RBC’s during CPB (ml) | 0,2 | <0,001 |
| RBC’s after CPB (ml) | 0,1 | 0,138 |
| Age at surgery (h) | 0,1 | 0,025 |
| ICU stay preop (d) | 0,1 | 0,07 |
| Serum Lactate at one hour after surgery (mmol/l) | 0,04 | 0,549 |
| Surgical complications | 0,1 | 0,034 |
| duration of CPB | -0,3 | 0,538 |

Based on the data from table 2, we conducted a binomial logistic regression analysis to determine how these factors influence the development of pulmonary complications in the postoperative period. Results of regression analysis are presented in Table 2.

Table 2

Logistic regression analyze for postoperative pulmonary complications

|  |  |  |  |
| --- | --- | --- | --- |
| Variables | regression coefficient  b | p value | Odds ratio |
|
| RBC’s during CPB (1-25 ml) | 3,3 | 0,012 | 26,3 |
| RBC’s during CPB (26-50 ml) | 1,9 | 0,082 | 6,9 |
| RBC’s during CPB (51-60 ml) | 1,9 | 0,105 | 6,8 |
| RBC’s during CPB (61-80 ml) | 3,1 | 0,005 | 21,7 |
| RBC’s during CPB (> 80 ml) | 2,9 | 0,009 | 18,3 |
| Surgical Cmplications | 0,7 | 0,163 | 2,1 |
| Constant | -4,5 | <0,001 | 0,01 |
| Characteristics of the model: х2(6) =21,2; р=0,002;  Cox and Snell R2=0,1; Nagelkerke R2=0,17  Lung complications: -4,48+3,27b+1,94c+1,91d+3,08e+2,91f+0,73g | | | |

Logistic regression analysis was used to develop a model for the prediction of increased risk of pulmonary complications in neonates who underwent corrective surgery for TGA. The proposed model is statistically significant. The proposed model correctly classified 89.9% of all cases in this study, with a specificity of 100%.

The strongest predictor for pulmonary complications is transfusion of 61 to 80 ml of RBC’s during CPB with odds ratio 21.7 (p=0,005).

It seems from the ROC curve that quantity of transfused RBC during CPB is a good indicator to anticipate pulmonary complications (area under the ROC curve equal to 0.72, p=0.001). The best cut-off that maximizes (sensitivity + specificity) is 70 ml. At this volume, the sensitivity is 57% and specificity is 78.

In conclusion, the results of this study suggested that the use of donor RBC’s correlated significantly with the development of pulmonary complications in the early postoperative period. The quantity of donor RBC’s transfused during CPB may be you used as a predictor for pulmonary complications in the postoperative period.

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