UDC. 612.11: 616.12-007.2-053.2-089

BLOOD SAVING TECHNOLOGIES IN NEONATAL CARDIAC SURGERY

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A set of blood-saving measures in the correction of complex congenital heart defects in newborns has been investigated and put into practice in the Government institution «The Scientific-Practical Children's Cardiac Center Ministry of Health of Ukraine». The proposed techniques consist in the use of autologous cord blood for initial filling of cardiopulmonary bypass pump as well as the use of the system for intraoperative blood transfusion (AutoLog Cell Saver, Medtronic) with further processing of the remaining perfusate and autologous red blood cells reinfusion in the postperfusion period of the surgical procedure. The influence of blood-saving technologies on the number of donor blood components used in the correction of complex congenital heart defects in newborns has been investigated in the article.
The techniques have been used in treatment of 46 newborns diagnosed with transposition of great arteries who underwent the arterial switch operation.
Key words: *Cell Saver, blood-saving techniques, newborns, transposition of great arteries*

Correction of complex congenital heart defects with the help of cardiopulmonary bypass (CPB) surgery normally requires the intraoperative use of donor packed red blood cells and blood plasma. Blood plasma is used for initial filling of the cardiopulmonary bypass pump contour (CPB pump contour) in order to prevent hemodilution. Currently, in connection with technical features of the CPB pump contour, donor packed red cells in the amount equal to 30-50% of circulating

blood volume which is equivalent to a massive transfusion of packed red cells (≥ 3 liters) in adults [1] is used for patients with a weight that is less than 5 kilograms.

As is well known, transfusion of donor blood components in cardio surgery operative intervention increases the risk of postoperative complications. [2].

One of the methods of prevention of massive blood transfusion that has been investigated and put into practice in our clinic is the use of autologous cord blood in the correction of congenital heart defects with the help of CPB surgery [3,4]. Alongside with this, this method is not applicable to patients with a postnatal diagnosis. That is why investigation of additional effective measures that will allow to reduce the use of donor red blood cells mass is an urgent and important task. One of such measures is the use of the system for intraoperative blood transfusion (AutoLog Cell Saver, Medtronic). Cell Saver is widely used for adult patients. However, the experience of its usage for newborn patients in Ukraine is limited.

Work objective – to investigate how effective it is to use the system for intraoperative blood autotransfusion (AutoLog Cell Saver, Medtronic) combined with the use of autologous cord blood or donor blood components in neonatal cardio surgery.

Materials and methods

The object of the research was 111 newborns diagnosed with transposition of great arteries who underwent an arterial switch operation. The clinical profile of the patients is provided in table 1.

Table 1.

Index		Group I (N=30)	Group II (N= 16)	Group III (n=65)
Weight (kg)		3,4±0,5	3,2±0,37	3,5 ±0,42
Gender	Masculine	23	11	49
	Feminine	7	5	16
Diagnosis	TGA*	29	13	50
	TGA, VSD	5	3	15

*TGA - Transposition of Great Arteries

*TGA, VSD - Transposition of Great Arteries with Ventrical Sept Defect

The main control group consisted of 46 newborns with transposition of great arteries that underwent an operation of arterial switch with the use of Cell Saver from January 2013 to November 2013. The main group was divided into the patients that were operated with the use of donor blood components combined with the use of Cell Saver (Group I, N=30) and the patients that were operated with the use of cord blood combined with Cell Saver (Group II, N=16). The comparison control group consisted of 65 newborns that underwent an arterial switch operation without the use of Cell Saver in the period of time from September 2009 to August 2012. (Group III).

Anesthetic management and CPB were conducted according to a standardized procedure applied in our clinic. [5] During surgery in the study group all of the liquid from the surgical wound that contained blood was evacuated to Cell Saver. If it was necessary, the washed red blood cells were returned to the CPB pump contour or were used for transfusion after CPB surgery. In addition, after CPB was stopped the remaining perfusate from the CPB pump contour was taken into the system of blood autotransfusion in order to obtain the washed red blood cells. After this, the CPB pump contour was additionally washed with the use of a pumping line, a reservoir and an oxygenator with the physiological solution (400ml) for the complete washout of red blood cells. Normally the volume of the obtained red blood cells after such a washout was equal to 120-140 ml with hematokrit 20-23%. Taking into consideration a small volume of the circulating blood of a newborn and a possibility of a volume overload, before transfusion the washed red blood cells were processed in the department of blood transfusion by means of centrifugal separation and division into components. Such measure gave a possibility to obtain an average of 40 ml of autologous red blood cell concentrate additionally, with recourse of further usage within one day.

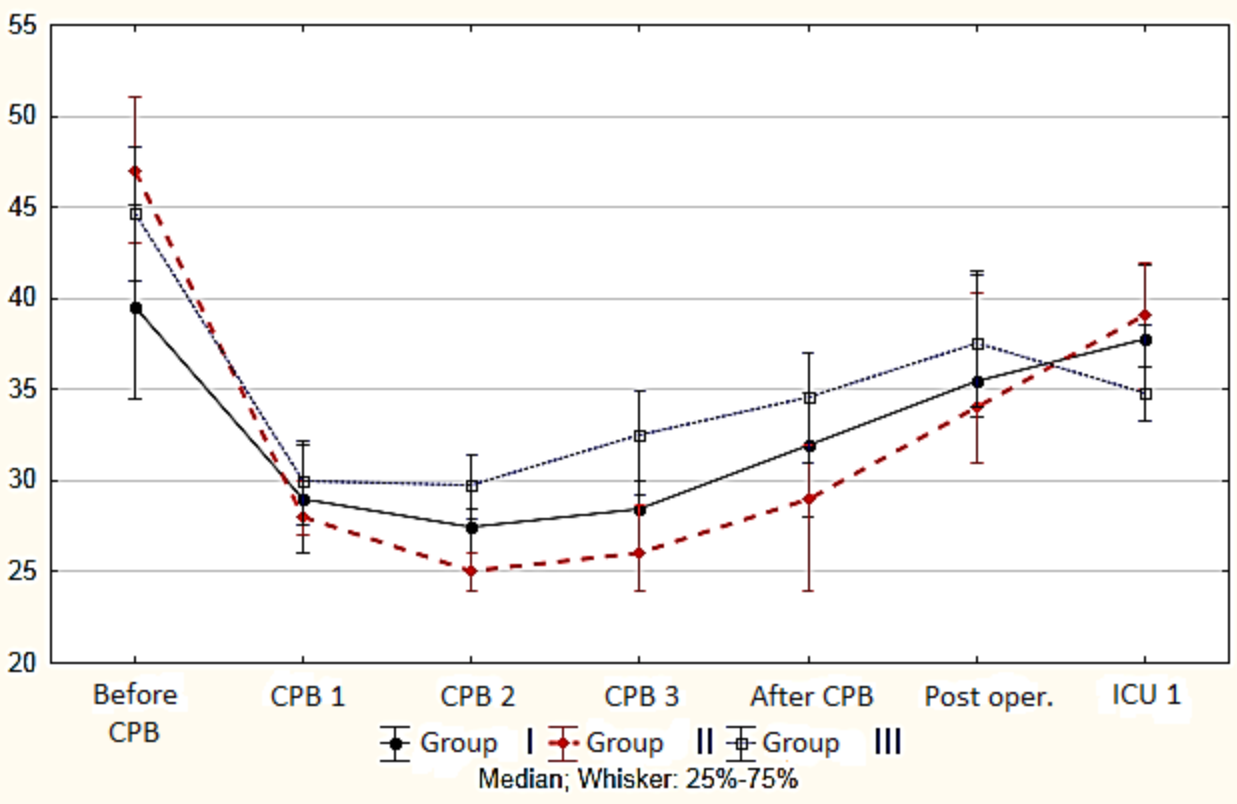
To identify effectiveness and safety of the procedure we measured the level of hematokrit as a high quality indicator of blood components transfusion effectiveness. The measurement was made during the preparatory phase of the operation, on the fifth minute of the CPB surgery, immediately after removing the clamp from aorta, 5

minutes after stopping CPB, at the delivery of the patient to the Emergency and Intensive Care Department (EICD) after the operation and a day after the operation. An additional criterion of Cell Saver effectiveness was measuring the number of donor blood components used for the patients from the main control group.

The findings of the investigation were comparable with the use of modern methods of biomedical statistics. For statistical data processing we used a package of software StatSoft Enterprise 11.0.

Findings and their discussion

Given that blood components of different origins (whole cord blood and donor blood cells) were used in different control groups, perioperative level of hematokrit was measured. (picture 1).



Picture 1. Perioperative hematocrit level dynamics in groups

Analysis of the data presented in picture 1, showed that the hematokrit level didn`t differ in control groups at the initial stage of surgery. However, in groups I and II, starting with CPB and finishing with the end of the surgical operation the hematokrit level was statistically significantly lower ($p<0,05$) in comparison with group III. Despite a statistically significant difference in the hematokrit level starting with CPB surgery and after CPB, the hematokrit level at the delivery of a patient to

the Emergency and Intensive Care Department after the surgical intervention in the main control group was equal to 34% (32-37%). At the same time, the hematokrit level in the comparison control group was higher (p=0,001) starting from the first day after the surgical intervention. It should be noted that donor blood components were not used at all for 16 patients of group II (34%) and were hardly used for the patients of group I at the emergency and intensive care department. (table 2) Such a result was achieved due to the use of the system for intraoperative blood autotranfusion of Cell Saver type. In table 2 we have gathered the data comparing the number of donor blood components used.

Table 2. The use of blood components in the perioperative period in newborns control groups

Groups of patients	Blood components	Surgery stage		EICD	Total
		CPB	After CPB		
Median (25-75%)					
Group 3 2010-2012	Red cell blood mass (ml)	60 (45-80)*	37,5 (30-50)*	36 (30-52)	120 (98-145)
	Fresh frozen plasma (ml)	-	45 (30-60)	20 (20-35)	50 (30-68)
Group 2 2013	Whole cord blood	35(15-40)*	50(40-72,5)*	-	80 (62-100)
Group 1 2013	Red cell blood mass	50(30-70)	35(20-95)	8(0-0)	110(70-90)
	Fresh frozen plasma	-	30(20-50)	-	40(25-70)

* a statistically significant difference

EICD - Emergency and Intensive Care Department

The data presented in the table show that in group I red blood cell mass and fresh frozen plasma were hardly used at EICD. At the same time, in group III blood components were used in the volume which is equivalent to the volume of blood components used during the period of surgical hemostasis in the operating room.

The biggest part of whole cord blood was used after CPB during the hemostasis period (p<0,001). In group III statistically significantly more of red cell blood mass was used at the time of CPB than during the hemostasis period (p<0,001). Alongside

with this, the total number of donor blood components (fresh frozen plasma and red cell blood mass), that were used during the period of hemostasis in group III was statistically significantly bigger ($p<0,001$) than in group II. The data in the table show that the patients from group I and II hardly obtained any donor blood components after the surgical intervention during their stay at the EICD. We believe that such a result was achieved due to the use of the system of Cell Saver type for patients from group I and II. After administration of protamine and aortic decannullation from the remaining blood volume from the CPB pump contour by means of washout and separation 40 ml (25-90) of red blood cells were obtained additionally and used intraoperatively or at the EICD.

Conclusions.

1. The use of the system for blood autotransfusion (AutoLog Cell Saver, Medtronic) during cardio surgery operative interventions in newborns enables to obtain 40 ml (from 25 to 90 ml) of washed autologous red blood cells in postperfusion period.
2. Due to the use of the system of blood autotransfusion for patients from group I and II it was possible to almost completely avoid transfusion of donor blood components at the EICD.

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Кровозбереження в неонатальній кардіохірургії

Кузьменко С.О., Часовський К.С., Ткаченко Я.В.

В ДУ «НПМЦДКК МОЗ України» розроблено та впроваджено в практику комплекс заходів кровозбереження при корекції складних вроджених вад серця у новонароджених. Запропонована методика полягає в застосуванні аутологічної пуповинної крові для первинного заповнення апарату штучного кровообігу та використанні системи для інтраопераційної аутотрансфузії крові (AutoLog Cell Saver, Medtronic) з обробкою залишкового перфузату та реінфузією аутологічних еритроцитів у постперфузійному періоді оперативного втручання. У статті досліджено вплив заходів кровозбереження на кількість використаних компонентів донорської крові при корекції складних вроджених вад серця у новонароджених. Методика застосована у 46 новонароджених з транспозицією магістральних судин, яким була проведена операція артеріального переключення.

Ключові слова: *Селл Сейвер, кровозбереження, новонароджені, транспозиція магістральних судин.*

Кровесбережение в неонатальной кардиохирургии

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В ГУ «НПЦДКК МЗ Украины» разработан и введен в практику комплекс мероприятий по кровесбережению при коррекции врожденных пороков сердца у новорожденных. Предложенная методика заключается в использовании аутологической пуповинной крови для первичного заполнения аппарата искусственного кровообращения и использовании системы для интраоперационной аутотрансфузии крови (AutoLog Cell Saver, Medtronic) с обработкой остаточного перфузата и реинфузией аутологических эритроцитов в постперфузионном периоде оперативного вмешательства. В статье исследовано влияние кровесберегающих мероприятий на количество использованных компонентов донорской крови при коррекции врожденных пороков сердца у новорожденных. Методика применена у 46 новорожденных с транспозицией магистральных сосудов, которым проведена операция артериального переключения.

Ключевые слова: *Селл Сейвер, кровесбережение, новорожденные, транспозиция магистральных сосудов.*