

Leukocyte-depleted erythrocyte transfusion associated with less ICU stay among pediatrics with cardiac surgery

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ABSTRACT

Perioperative transfusion has adverse effects in patients undergoing cardiac surgery. The effect of leukocyte-depleted (LD) erythrocyte transfusion in pediatrics' cardiac surgery was until now unknown. A retrospective cohort study was conducted among pediatric patients who were no more than 3 years old and transfused with red blood cells during an open-heart surgery. Investigations were made into mechanical ventilator treatment duration, length of stay in the intensive care unit (ICU) and 90-day survival. A total of 174 pediatric patients were included in our study. The average age was 21.90 months old and the average weight was 9.18 kg. There were 107 patients received non-leukocyte-depleted (NLD) red blood cell (RBC) transfusion and 67 patients received LD erythrocyte transfusion. No statistically significant differences were detected in the 90-day survival rates between the NLD group and the LD group. Statistically significant differences were detected in the time spent on the mechanical ventilator [(5.3±2.0) d vs. (2.6±1.0) d; $P=0.01$] and the lengths of ICU stay [(9.4±6.0) d vs. (5.6±4.0) d; $P=0.02$] between the NLD group and the LD group. LD blood transfusion was associated with decreased length of stay in ICU and the decreased time on the mechanical ventilator in pediatric cardiac surgery.

Keywords: leukocyte-depleted erythrocyte, transfusion, pediatric cardiac surgery, ICU

INTRODUCTION

The transfusion of allogeneic blood plays an important role in cardiac surgery. Patients undergoing cardiac surgery are at risk of excessive bleeding, leading to increased usage of allogeneic blood and hemostatic blood products. The potential benefits of blood transfusion include an increased oxygen-carrying capacity, volume support of cardiac output, and improved hemostasis associated with blood products^[1,2].

Recent data have emerged highlighting the adverse effect of red blood cell (RBC) transfusion on major outcomes, such as increased intensive care unit (ICU)

length of stay and short-term survival in adults^[3-6]. The mechanism of these adverse reactions may be explained in part by the allogeneic leukocyte material in transfused blood. Indeed, studies have observed a beneficial effect on patient survival among patients receiving leukocyte-depleted (LD) transfusion during or after cardiac surgery^[6-8]. As prolonged duration of mechanical ventilation and ICU stay are associated with longer recovery times, major complications and mortality, increased hospital costs and worsened long-term neurodevelopmental outcomes, early extubation and "fast-tracking" are goals of postoperative care in the current era^[9]. In adults undergoing coronary artery bypass surgery and/or valve operations, as well as in pediatric cardiac surgery patients, perioperative transfusion has been associated with increased postoperative complications including longer duration of mechanical ventilation, longer hospital stay, and higher perioperative mortality^[3, 6, 10-13]. However the benefits of LD blood transfusion for pediatrics re-

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mains unclear^[14]. Due to the differences in the disease states of children and adults, the authors conducted a retrospective cohort study in all pediatrics cardiac surgical patients in the West China Hospital during the year 2014–2015. The goal of the present study was to investigate the possible benefits of LD blood transfusion in terms of decreased time on the mechanical ventilator, length of stay in ICU and prolonged 90-day survival.

MATERIAL AND METHODS

Patients and data collection

A retrospective cohort study was conducted from January 2014 to January 2015 in pediatrics patients undergoing cardiac surgery at the West China Hospital. Pediatric patients who were no more than 3 years old and received blood transfusions were deemed eligible. Data collection consisted of information on patient characteristics, operative details, time spent on the mechanical ventilator, length of stay in ICU and the rates of 90-day survival. Information on all RBC units transfused during their hospitalization was obtained from the blood bank laboratory information system (LIS); while patient characteristics, operative details, time spent on the mechanical ventilator, length of stay in ICU and the 90-day survival were obtained from the hospital information system (HIS). The scoring of operation was assessed retrospectively on the basis of the records.

Blood components supply

All blood components were supplied by the Chengdu Blood Center. Non-leukocyte-depleted blood products (NLD) were blood component that remove plasma and buffy-coat layer from a whole blood unit and add saline-adenine-glucose-mannitol solution. Compared to NLD, LD is a blood component that not only has plasma and buffy-coat layer removed from a whole blood unit but is also filtered to reduce leukocyte to less than 5×10^6 cells/U. The length of storage for the RBCs used for pediatric transfusions was no more than 15 days.

Statistical analysis

The data here are reported as frequencies, means and standard deviations, or medians and quartile. The values are presented as mean \pm standard deviation as well as median (quartile). Baseline characteristics: gender, age, weight, surgical difficulty index and unit per transfusion; time on the mechanical ventilator and the lengths of ICU stay; as well as the 90-day survival rates and patients with infection were analyzed with a

Mann-Whitney *U* test. The analyses were performed by using the SPSS. For statistics, a *P* value < 0.05 was considered significant.

RESULTS

In total, 174 pediatric cardiac surgery patients were included in the study. These patients underwent 24 types of cardiac surgery procedures. The average age was 21.90 months old and the average weight was 9.18 kg. There were 107 patients in the NLD group and 67 in the LD group. As shown in **Table 1**, there were no significant statistic differences between the two groups with respect to baseline characteristics: gender, age, weight, surgical difficulty index and unit per transfusion.

Statistically significant differences were detected in the time spent on the mechanical ventilator [(5.3 \pm 2.0) d vs. (2.6 \pm 1.0) d; *P* = 0.010] and the lengths of ICU stay [(9.4 \pm 6.0) d vs. (5.6 \pm 4.0) d; *P* = 0.020] between the NLD group and the LD group. Patients in LD group were associated with less time on the mechanical ventilator and ICU stay as compare to NLD group.

The 90-day survival rate was 97.6% and the infection rate was 18.4% in all children. No statistically significant differences were detected in the 90-day survival rates (95.3% vs. 98.5%, *P* = 0.260) and patients with infection (16.8% vs. 20.9%, *P* = 0.500) between the NLD group and the LD group.

Table 1 Demographic, surgical, and outcome variables in pediatrics in two groups

Variable	NLD group	LD group	<i>P</i> Value
Boy, <i>n</i> (%)	66(62)	41(61)	0.950
Age, m	21.93 \pm 5.72	21.85 \pm 8.07	0.610
Weight, kg	9.22 \pm 3.01	9.11 \pm 2.87	0.850
Surgery type, <i>n</i>			
VSD repair	15	17	
ASD repair	9	5	
TOF repair	17	11	
Arterial switch operation	2	0	
Other	64	34	
Surgical difficulty index	5.7(5.7–52.9)	5.7(5.7–44.0)	0.887
Unit per transfused	2.5(2.5–3.0)	3.0(1.5–3.0)	0.163
90-days survive, <i>n</i> (%)	102(95.3)	66(98.5)	0.260
Patients with infection, <i>n</i> (%)	18(16.8)	14(20.9)	0.500
Days in the ICU	9.4 \pm 6.0	5.6 \pm 4.0	0.010
Days on the mechanical ventilator	5.3 \pm 2.0	2.6 \pm 1.0	0.020

DISCUSSION

In the present study, favorable effects of LD transfusion were found in the time spent on the mechanical ventilator and length of stay in ICU in pediatric patients undergoing cardiac surgery. This study high-

lighted that transfusing LD to pediatric patients undergoing cardiac surgery was associated with better outcomes of early mechanical ventilator extubation and a shorter length of stay in ICU when compared to patients transfusing NLD erythrocytes. To date, no prospective clinical trials have tested whether LD blood can decrease ventilation time or other postoperative complications in pediatric patients undergoing cardiac surgery.

LD was introduced into cardiac surgery in an effort to alleviate the perioperative inflammatory response. Besides, the incidences of febrile non hemolytic transfusion reactions, HLA alloimmunization, and cytomegalovirus transmission have been decreased by effective reduction of white blood cell (WBC) in blood components^[15,16]. The benefits of the WBC reduction in decreasing postoperative infections or mortality are confirmed in adults in several randomized studies^[7,8]. Although we did not find significant differences in postoperative infections or mortality between the NLD group and the LD group, there was trend for the LD group to have a higher 90-day survival rate.

It is noteworthy that we focused on a group of pediatrics weighing 4 to 10 kg. And these patients received 2.5 RBC units/person averagely, a heavy transfusion. The strengths of our initiative are that we had very limited exclusion criteria and performed a *universally available test*, making our study applicable and possible in other institutions. To our knowledge, this is the only investigation among pediatric cardiac surgical patients that addresses strategies to use LD blood transfusion. Our study demonstrated that pediatric patients who underwent cardiac surgery associated with LD had a decreased time spent on mechanical ventilator and in ICU stay. The result of this study was especially important for pediatric patients undergoing cardiac surgery, who received heavy transfusion.

This is a retrospective clinical study with all the methodological limitations of such a study. And, although our study design appears to have resulted in well-matched groups regarding almost all variables, unrecognized differences between the groups or in the treatment of the patients might have existed and influenced our results. Large size prospective clinical trials to test whether LD blood can decrease ventilation time or other postoperative complications in pediatric patients undergoing cardiac surgery are strongly warranted.

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