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Albumin is a key solution and is administered during paediatric heart surgery

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Abstract
Pediatric heart surgery is a complex and delicate procedure that requires careful management of various physiological parameters, including blood volume and protein levels. Albumin, a key protein found in blood plasma, plays a vital role in maintaining these parameters and is often administered during pediatric heart surgery. This research article aims to explore the importance of albumin in pediatric heart surgery and its role in maintaining blood volume, preventing edema, and transporting essential molecules throughout the body. Based on our clinical observations, the use of human albumin or fresh frozen plasma can be demonstrated in the prime solution. Compared to our small enrolled patients due to the small study designed, we would like to conclude that human albumin may be necessary to prevent acute complications of hemodilution due to the prime solution but, it need future study for confirmation.

Keywords: Albumin, paediatric heart surgery

Introduction
The key factor in blood osmotic pressure is albumin. The body has 4-5 grams of albumin per kilogram, which is mostly found in the extracellular area. The intravascular space houses 30–40% of the body's albumin, which controls plasma volume and the fluid balance of the tissues [1].
Human albumin is a sterile water-based solution that may be injected intravenously. It is made from blood donor plasma and functions as a physiological plasma expander. This product is created using the alcohol fractionation process, and infectious pathogens are rendered inactive by heating it to 60 °C for 10 hours [1-2].
Human albumin possesses osmotic or oncotic characteristics, which is the primary basis for its therapeutic use, and it raises plasma volume similarly to crystalloid and colloidal solutions. The distribution of intravascular fluid and interstitial compartment is determined by hydrostatic pressure across the capillary wall, which is also known as the balance of capillary gradient. The two main purposes of using human albumin are to make up for the decrease in plasma volume and the drop in oncotic pressure brought on by hypoproteinemia or severe acute hemodilution. A liter of human albumin solution contains 130 to 160 mEq of sodium, allowing fluid to stay in the arterial region for longer [1-3].
Non-nutritional variables, such as hepatic and renal insufficiency, gastrointestinal dysfunction, right heart failure, dilution owing to fluid overload, and drugs, might impact blood albumin content in individuals with congenital heart disease. The gradual introduction of extravascular albumin into the circulation is a common method of compensating for hypoalbuminemia [3–4].
However, because these patients lack a physiological reserve, they are more susceptible to hypoalbuminemia and decreased plasma oncotic pressure. As a result, the kidneys begin to retain sodium and water to maintain plasma volume within the normal range. However, sodium and water will extravasate during this time, so the plasma volume is maintained at the normal level. Secondary edema to capillary leakage develops in the initial postoperative period as a result of endothelial dysfunction caused by the inflammatory response syndrome brought on by the shock of heart surgery and the use of a cardiopulmonary bypass pump.
The infusion of hypotonic fluids and the volume increase with crystalloids accelerate this series of events and their effects [1–5]. Due to the small volume of circulating blood and the requirement to establish an artificial circulation via cardiopulmonary bypass pump in neonates or children

with congenital heart disease who are scheduled for heart surgery and cardiopulmonary bypass, severe hemodilution is a possible concern. The majority of the time, the hemodilution caused by the primary solution's oncotic deficiency is corrected by adding packed red blood cells to the solution [1-3].

We think the danger of this iatrogenic hypoalbuminemia is underappreciated and not adequately compensated. Adult critically sick patients with septic shock have received human albumin delivery more frequently in meta-analyses and clinical trials, and the findings of these studies have been inconsistent. According to several reports, severely sick individuals who utili albumin have higher fatality rates. These research' statistical power was constrained, and individuals with a range of diseases and blood albumin levels were included in the investigations [6–9].

As a result, patients with underlying heart disease and candidates for heart surgery cannot in any way extrapolate the findings from these investigations. We conducted a small sample study to test our hypothesis because preliminary clinical observations showed that children with congenital heart disease experienced severe impairment of plasma oncotic pressure following heart surgery. Many of these children also experienced secondary renal impairment, hemodynamic shock, and tissue edoema.

This prospective observational sample study was conducted in 24 neonates and pediatrics (age between 10 days up to 3 years old) by congenital heart disease was scheduled to undergo intracardiac repair by cardiopulmonary bypass method (on pump method). Patients were randomly divided into three groups, but subjects were matched in terms of demographic information including age, weight and type of congenital heart disease, coexisting disease, general condition, and laboratory date such as arterial blood oxygen saturation and level of blood hemoglobin as much as possible.

All patients had the same anesthesiologist and surgeon, and the anesthetic technique, medicines provided, and surgical technique were all the same. Electrocardiography and an echocardiogram were done prior to surgery. To enable tracheal intubation, sevoflorane (2–5%), fentanyl (3-5 mcg/kg), and pancuronium (0.2 mg/kg) were used to produce anesthesia. Maintenance of anesthesia was performed with isoflurane (0.4-0.6%) in oxygen-air mixture and fentanyl infusion was continued besides intermittent doses of pancuronium and midazolam were given depending on the patient's condition.

The initial activated clotting time (ACT) before systemic heparinization was reported then 3-4 mg / kg unfractionated heparin was prescribed to achieve the target ACT more than 480 seconds. Monitoring included electrocardiogram, pulse oximeter, arterial line for accurate measurement of blood pressure, cerebral and tissue oximetry, central venous pressure and measurement of urinary output were installed for patients and arterial blood analysis was performed periodically.

Membrane oxygenator with the same brand and characteristics was used for patients during CPB. Conventional CPB circuit was performed which was primed with mannitol (20%) 0.5 g / kg and sodium bicarbonate (7.5%) 1 ml/kg and 100 units/kg unbroken heparin as a fixed component but in first group (traditional prime solution) we used normal saline 20 ml/kg and for second group (Albumin group) we used Albumin and normal saline in 1 to 4 ratio and total volume considered 20 ml/kg and in the third group (FFP group) we used Fresh Frozen Plasma (FFP) 20 ml/kg. Packed red blood cells were added to the pump volume before CPB to obtain a primary hematocrit of 20% ±2% for the prim fluid and the target hematocrit was maintained at 28% ±5% during the cardiopulmonary bypass pump. 5% human albumin solutions have an osmotic pressure approximately similar to normal plasma.

Since the human Albumin 25% oncotic pressure is four times greater than the normal human serum oncotic pressure, all medications were diluted in Albumin and normal saline in a 1 to 4 ratio for the Albumin group after they were weaned from cardiopulmonary bypass, but only for the traditional and FFP groups. Custodiol cardioplegia was prescribed to induce circulatory arrest and preserve the myocardium.

Arterial blood gas analysis and ACT were performed at 30-45 min intervals and if necessary, during surgery. The systemic pump flow was adjusted between 120 and 200 ml/kg / min based on serum lactate levels and tissue and cerebral oximetry numbers. At the end of surgery, systemic heparinization based on total amount of heparin prescription and the half-life of it in one-by-one ratio, was reversed by protamine. All patients were transferred to the intensive care unit to continue mechanical ventilation and planned extubating in stable conditions. In patients using traditional prime solution the duration of mechanical ventilation, the duration and dose of prescribed inotropes and the length of stay in the ICU was longer. (p Value; 0.04, 0.027, 0.032 and 0.038 respectively) Although these times were longer in the FFP group but, they were not statistically significant. Urine output was better in the albumin group and was like the FFP group. Incidence of oliguria was higher in traditional group. We supported many patients after surgery to compensate for decreased renal function with peritoneal dialysis. (18 patients out of 24 patients) Postoperative bleeding was significantly lower in the FFP group than in the albumin and traditional groups.

Hemodynamic stability after surgery was better in albumin and FFP group. Arterial blood gas parameters in Albumin and FFP group was the same and better than traditional group. We could not evaluate the risk of infection and adverse effects in our sample study. Hypoalbuminemia around the time of congenital heart surgery increases the risk [1-2]. Cardiopulmonary bypass pump that used in routine congenital cardiac surgery is an advanced extracorporeal oxygenation system. Extracorporeal oxygenation triggers a systemic inflammatory response that leads to endothelial damage and microcapillary leakage. It is the main mechanism for capillary leakage of plasma, amino acids and protein into the extravascular space, which causes hypoalbuminemia [1-3].

The half-life of endogenous albumin is about 3 weeks, while human-derived albumin is only 12-16 hours and is significantly reduced under conditions of increased capillary permeability [2]. During major surgery, more than half of the body's albumin, which is normally in the circulatory system, may be lost [3]. Pediatric or neonate suffering from iatrogenic hypoalbuminemia after cardiac surgery are prone to catabolic stress, decreased amino acid supply, additional impaired protein synthesis, degradation and decomposition of proteins, release of protein into the extra vascular space, and retention of water and salt due to changes in the endothelial permeability.

Decreased in serum albumin levels are associated with increased inflammatory and acute reactant proteins, high concentrations of C-reactive protein (CRP), procalcitonin (PCT), interleukin-6 (IL6) and antitrypsin α1 after heart surgery [1-3, 9].

Recent studies have shown that albumin can be used as a postoperative volume enhancer, as a last resort treatment after crystalloids or non-protein colloids, after heart surgery [6, 9]. The researchers believe that the first choice for priming the circuit for extracorporeal circulation is a mixture of crystalloids with

non-protein colloids that can be preferred to prevent fluid accumulation in the interstitial space of the lung [6,9,11- 12]. Some research has shown that adequate blood volume during cardiopulmonary bypass can be maintained with crystalloids as the only priming fluid in the pump, but base on our observation it will be accompany with impaired ABG parameter, hemodynamic instability, and decrease urine output and higher risk of interstitial edema. A commonly used program is human albumin and crystalloid pump prime, which is adjusted to obtain a hematocrit of 20% and a plasma albumin level of 2.5 g / 100 ml, but the level at which each may be safely reduced has not yet been defined [6-13].

It is not known whether there is a concentration threshold for serum albumin levels below which clinical oncotic function is compromised; however, there is an agreement that oncotic activity remains physiologically acceptable at albumin levels greater than 2 g / dL and total proteins more than 3.5 g / dL. There is evidence that serum oncotic pressure close to 20 mmHg indicates a threshold below which the risk of complications increases [1-3, 6, 9, 11-14].

Based on our clinical observations, the use of human albumin or fresh frozen plasma can be demonstrated in the prime solution. Compared to our small enrolled patients due to the small study designed, we would like to conclude that human albumin may be necessary to prevent acute complications of hemodilution due to the prime solution but, it need future study for confirmation.

References

1. Liumbruno GM, Bennardello F, Lattanzio A, Piccoli P, Rossettias G. Italian Society of Transfusion Medicine and Immunohaematology (SIMTI). Recommendations for the use of albumin and immunoglobulins. Blood Transfus. 2009;7(3):216- 34.
2. Kapoor PM, Narula J, Chowdhury UK, Kiran U, Taneja S. Serum albumin perturbations in cyanotics after cardiac surgery: Patterns and predictions. Ann Card Anaesth. 2016;19:300-5.
3. Ballmer PE. Causes and mechanisms of hypoalbuminaemia. Clin Nutr. 2001;20:271-3.
4. Montazerghaem H, Safaie N, Samiei Nezhad V. Body mass index or serum albumin levels: Which is further prognostic following cardiac surgery? J Cardiovasc Thorac Res. 2014;6:123-6.
5. Monteiro FP, de Araujo TL, Lopes MV, Chaves DB, Beltrão BA, Costa AG. Nutritional status of children with congenital heart disease. Rev Lat Am Enfermagem. 2012;20:1024-32.
6. Wilkes M, Navickis RJ. Patient survival after albumin administration. A meta-analysis of randomized, controlled trials. Ann Intern Med. 2001;135:149-64.
7. Liberati A, Moja L, Moschetti I, Gensini GF, Gusinu R. Human albumin solution for resuscitation and volume expansion in critically ill patients. Intern Emerg Med. 2006;1:243-5.
8. Vincent JL, Navickis RJ, Wilkes MM. Morbidity in hospitalized patients receiving human albumin: a metaanalysis of randomized, controlled trials. Crit Care Med. 2004;32:2029-38.
9. Russell JA, Navickis RJ, Wilkes MM. Albumin versus crystalloid for pump priming in cardiac surgery: meta-analysis of controlled trials. J Cardiothorac Vasc Anesth. 2004;18:429-37.
10. Finfer S, Bellomo R, Boyce N, French J, Myburgh J, Norton R. A comparison of albumin and saline for fluid resuscitation in the intensive care unit. N Engl J Med. 2004;350:2247-56.
11. Riegger LQ, Voepel-Lewis T, Kulik TJ, Malviya S, Tait AR, Mosca RS, *et al*. Albumin versus crystalloid prime solution for cardiopulmonary bypass in young children. Crit Care Med. 2002;30:2649-54.