

## **Blood Conservation in Pediatric Cardiac Surgery**

*William C. Oliver, Jr.*

Bleeding and allogeneic transfusion occurs in most pediatric patients that have cardiac surgery with cardiopulmonary bypass (CPB), especially infants less than 2 years of age and neonates. Excessive bleeding is associated with increased morbidity, mortality, and costs. A blood conservation strategy is beneficial to reduce allogeneic blood exposure in children.

Identification of pediatric cardiac patients at increased risk for bleeding will guide the choice of blood sparing techniques. Age and weight (< 8 kg) are very important risk factors for bleeding. The reduced preoperative coagulation factors of neonates and infants in combination with the large priming volumes required for initiation of CPB, result in very low clotting factors that contribute to coagulopathy. Increased cyanosis is associated with greater thrombocytopenia and reduced platelet function. Other important risk factors for bleeding include complexity of surgery, hypothermic circulatory arrest, and previous sternotomy. Preoperative coagulation tests do not appear to correlate with post-CPB bleeding in children less than a year of age, but may be predictive if the child is older.

Preoperative autologous blood donation has been used in children > 3 years of age safely and effectively to reduce transfusion requirements. The minimum amount of donated blood to avoid transfusion is undetermined. Intraoperative cell salvage continues to be an effective conservation technique, particularly to conserve the red blood cells (RBC) of the CPB circuit post-CPB. Re-infusion of shed mediastinal blood is seldom utilized in pediatric patients.

Improved on-site coagulation testing is leading to a real-time diagnosis of coagulopathy resulting in reduced transfusion. The thromboelastogram

(TEG), platelet count, and fibrinogen level, PT and APTT can be used to predict bleeding after CPB as well as guide transfusion.

Reduction in the size of extracorporeal circuits reduces the hemodilution that contributes to excessive bleeding. The use of albumin instead of fresh frozen plasma (FFP) in the priming volume will reduce allogeneic transfusion. Modified ultrafiltration reduces the inflammatory response and is associated with less blood loss.

Pharmacologic hemostatic agents have met variable success. Desmopressin is not efficacious in pediatric cardiac surgical patients undergoing either simple or complex cardiac procedures. Antifibrinolytic agents, tranexamic acid (TA) and aprotinin (AP) are used in pediatric cardiac surgery. Aprotinin reduces the hemostatic abnormalities associated with CPB, but only one randomized trial found a reduction in 24-hr blood loss in children < 10 kg. The development of assays for aprotinin concentration may soon lead to better dosing. TA has also been shown in two studies to reduce the blood loss in pediatric patients but does not possess an anti-inflammatory property.

In conclusion, blood conservation techniques for children undergoing CPB for cardiac surgery has not been able to eliminate significant transfusion of allogeneic blood products. However, a conservation strategy is capable of reducing the exposure to blood products.

---

William C. Oliver, Jr., M.D.  
Department of Anesthesiology  
Mayo Clinic and Foundation  
Rochester, Minnesota, USA