Impacts of Deep Hypothermic Circulatory Arrest and Cardiopulmonary Bypass Prime Solutions on Rotational Thromboelastometry measures.

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Background

Congenital heart disease (CHD) and infancy are associated with functional abnormalities of the coagulation system, which are further disrupted by the need for cardiac surgery. The impacts of cardiopulmonary bypass (CPB), deep hypothermic circulatory arrest (DHCA), and the type of CPB prime solution are not fully elucidated. Most prior research has utilized traditional coagulation assays which have been shown to be inadequate in assessing coagulopathy.

Objectives

To assess the impact of DHCA and the use of fresh frozen plasma (FFP) in the CPB prime solution on intraoperative coagulopathy in pediatric CHD patients as measured by rotational Thromboelastometry (ROTEM).

Methods

- Single-center retrospective cohort study analyzing intraoperative ROTEM data collected during the rewarming phase of CPB.
- Compared infants undergoing surgeries with and without DHCA from March 2019 to November 2021 (Figure 1/Table 1).
- Performed additional analyses following an institutional practice change from albumin- to FFP-based prime solution in patients age < 6 months during the same period.

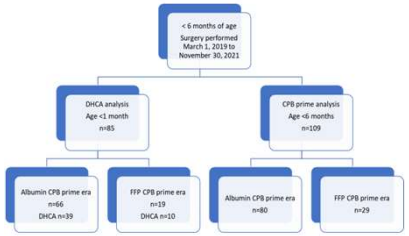

Figure 1. Study group flowchart

Results

Table 1. Patient Demographics and Pre-operative characteristics (N=109)

Male sex	72 (66.1)
Age at surgery, days	5 (4-15)
< 1 month	85 (78.1)
Pre-op O2 saturation, %	95 (91-98)
Baseline hematocrit	
≤ 50%	95 (87.2)
Surgery type	
VSD closure	11 (11.9)
TOF repair	13 (11.9)
Aortic arch repair	21 (19.3)
Norwood	26 (23.9)
ASO (with or without VSD closure)	38 (34.9)
Weight at surgery, kg	3.6 (3.2-4.2)
Total CPB time, minutes	104 (75-150)
Deep hypothermic circulatory arrest (DHCA)	49 (45.0)
DHCA time, minutes (N=49)	42 (34-50)
Intra-op bleeding time, minutes	67 (53-107)

* Data are presented as N (%) for categorical variables and Median (interquartile range) for continuous variables.

In the albumin-prime era DHCA analysis (Figure 2):

- Shorter intraoperative bleeding time from protamine administration to surgical dressing placement in the DHCA group compared to the non-DHCA group (median 61 vs. 107 minutes, p<.0001)
- Increase in coagulation factor usage in the non-DHCA group (40.7% vs. 12.8%, p=0.01).

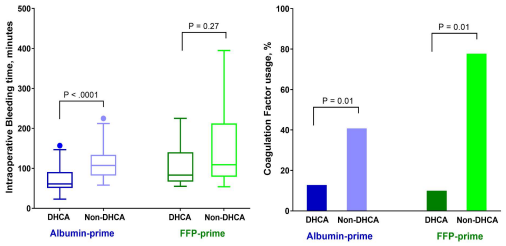

Figure 2. Intraoperative bleeding time and coagulation factor usage in infants with vs. without DHCA

In comparison between albumin- and FFP-based CPB prime (Figure 3):

- Less clotting factor deficiencies, with decreased FibTEM clotting time (median 135 vs. 83 seconds, p=0.001) and ExTEM clotting time (median 109 vs. 91 seconds, p=0.001)
- Increased clot firmness as measured by FibTEM A10 (p=0.001) and ExTEM A10 (p=0.02) as well as FibTEM MCF (p=0.001) and ExTEM MCF (p=0.02)

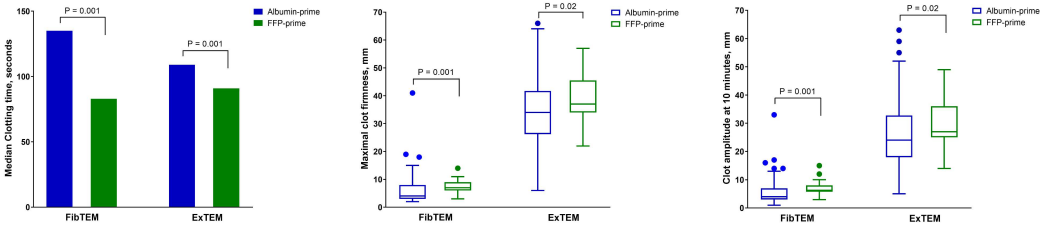

Figure 3. Comparison of FibTEM and ExTEM data between albumin- and FFP-based CPB prime

- No difference in blood product usage
- Less patients had an open sternum at end of surgery in the FFP-prime group (31.3% vs. 13.8%, p=0.07)
- Differences with respect to the CPB prime solution were more profound in the DHCA group.

Conclusions

- Unlike prior studies in adults, we observed shorter bleeding time and decreased coagulation factor usage in patients requiring DHCA compared to those not requiring DHCA.
- Improved indices of clot formation and clot strength when using FFP-based CPB prime.
  - due to reduced dilutional effect or
  - preservation of coagulation factors during CPB due to anti-thrombin III replenishment.
- No difference in blood product usage between albumin- and FFP-based CPB prime .
- Our data supports development of blood management programs to improve clot formation and decrease donor blood product usage
- Further prospective studies are required using viscoelastic-guided transfusion algorithms to assess the clinical impact of these results.

Disclosures

The authors have no financial relationships to disclose.