Markers of Safety in Pediatric Cases Utilizing DHCA and Low Flow Cerebral Perfusion

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“History Teaches Everything Including the Future”
- Alphonso De Lamartine
Universal Cooling Tools Prior to Bypass

- Room Temperature
- Cooling Blanket
- Ice
- Heater Cooler
- Patient Pressure Access
- Directive Temperatures
- Cooling Cap

Deep Hypothermic Circulatory Arrest

- Bloodless Surgical Field*
- DHCA at 18°C
- Safe Circulatory Arrest Time
- Even Cooling
- Twenty Minute Minimum for Cooling
- Neuroprotective Pharmacologic Agents
Low Flow ACP and RCP

- Decrease CMRO₂
- Cannulation Strategy
- ACP Flow Rates
- RCP Flow Rates
- System Pressure Limit
- Patient Pressures
- Cerebral Embolization or Edema

Our Technique of Low Flow

- PH to Cool and Alpha to Rewarm
- Temperature 20 - 25°C
- Hematocrit ≥ 30%
- Migrate Arterial Cannula to Innominate Artery
- SACP Flow Rate of 40 ml/kg/min
- Radial Pressure less than 40 mmHg
- System Line Pressure of 100 mmHg
Perioperative Monitoring During Low Flow ACP

Used at SCH
- Lactate
- CDI
- Point of Care Testing
- CW-NIRS

Should we use?
- EEG
- SJO2
- Trans-cranial Doppler
- FD-NIRS/DCS*

Combined Strategy
- “In the absence of definitive data favoring one strategy over the other, it might be prudent to use a combined strategy in which pH-stat is used while cooling, thus using the benefits of cerebral vasodilatation to enhance the rate and homogeneity of brain cooling; followed by the alpha-stat strategy from the interval immediately before cessation of circulation to the time of rewarming, thus minimizing extracellular acidosis and aiming for the preservation of CBF-CMRO2 coupling during reperfusion and rewarming.”

-Svyatets 2010, JCVA
Variation in Low Flow Technique

- Norwood vs. Isolated Arch Hypoplasia
- DHCA is better than SACP if not delivered correctly
- Literature Range of 15 – 70 ml/kg/min
- Intermittent
- Cerebral Perfusion and Lower Body
- Communication*

Rewarming Period

- Period of Initial Hypothermic Perfusion
- Extra-cranial Temperature
- Perfusate Temperature
- Maximum in Temperature
- Minimize Bypass Time
- Pressure to Rewarm from Surgical Field
Postoperative Outcome to Verify Practice

- Morbidity/Mortality Rates
- Periventricular Leukomalacia
- AKI
- SUMO2/3 Protein Conjugation
- Cognitive Studies


11. Nature. Scientific Reports. March 2017; 7(4417). Non-Invasive Assessment of Cerebral Blood Flow and Oxygen Metabolism during Hypothermic Cardiopulmonary Bypass: Feasibility and Clinical Implications. Ferradal B¹, Yuki M¹, Vyas P¹, Ha C¹, Yi P¹, Stopp C¹, Wyjd D¹, Cheng H¹, Newburger J¹, Kaza A¹, Kusiman B¹, Grant E¹.

12. Int J Clin Exp Med. 2014; 7(11): 4562–4571. Selective antegrade cerebral perfusion reduces brain injury following deep hypothermic circulatory arrest in the piglets’ model by decreasing the levels of protein SUMO2/3ylation. Bin Li¹, Yanxin Zhu¹, Alain Li¹, Wei Li¹, Aineu Xu¹, Jing Zhang¹, Zhijiang Li¹, Yangwei Zhu¹, Bin Li¹