Evaluation of Cerebral Flow, Oxygenation and Metabolism Coupling during Cardiopulmonary Bypass using a novel optical imaging system

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Background: Mean arterial pressure targets are used to maintain adequate cerebral blood flow (CBF) in patients undergoing cardiac surgery with cardiopulmonary bypass (CPB). However, a fixed hemodynamic targets do not account for variability between patients and neurological injury occurs unpredictably in clinical setting. Prolonged periods of low CPB flow rate or hypotension leading to decreases in CBF, can impede cerebral metabolism, and can cause tissue damage[2,3]. It is important to have better understanding on the relationship between CBF, brain oxygenation and brain metabolism during hypotensive event

Methods: A novel hybrid optical system that combined diffuse correlation spectroscopy with broadband near-infrared spectroscopy was used to continuously monitor CBF, the oxidation state of cytochrome c oxidase (oxCCO) – a direct marker of oxidative metabolism, tissue saturation (S_tO_2), during cardiac surgery. Changes in oxCCO and CBF were evaluated during periods of intraoperative hypoperfusion, due to transient reductions in CPB flow.

Results: Nine adult cardiac surgical patients CPB were monitored. oxCCO and CBF levels are successfully monitored in all patients. During transient hypoperfusion events, CBF changes dropped with decrease in MAP, whereas StO2 remained stable until MAP dropped below 50 mmHg. oxCCO remained stable until MAP fell below 30 mmHg. (Fig 1)

Conclusions: These results demonstrated the ability of the hybrid system to provide continuous monitoring of brain health. During transient hypotensive events, CBF changes preceded StO2 changes, and followed by changes in oxCCO. Future work will investigate the relationship of these markers and the neurological complications associated with CPB.

Figure 1. Correlation boxplots of ΔCBF, StO2, and ΔoxCCO against MAP (mmHg).