Title: Variability in Microvascular Hemoglobin Levels during Cardiopulmonary Bypass

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Structured Abstract:

Introduction: Physiological dysfunction in cardiac surgery patients is typically linked to cardiopulmonary bypass (CPB). The inflammatory response and ischemia reperfusion injuries associated with CPB can lead to increased risk of end organ failure postoperatively. This dysfunction originates at the microvascular level, preceding end organ failure and is distinct from any macrovascular hemodynamic derangement. This means that microvascular alterations can exist in the presence of normal macrovascular hemodynamics. Therefore, there is a need for improved microvascular monitors in the operating room that can continuously track dynamic changes in the microvasculature over time. Our goal is to design a custom monitor for use at the bedside to provide real time monitoring of the microvasculature. The purpose of this study is to determine what changes we can detect in microvascular hemoglobin levels in response to various interventions in cardiac surgical patients undergoing CPB.

Methods: This is a prospective cohort study of twenty cardiac surgical patients undergoing non-pulsatile (NP) CPB at University Hospital, London Health Sciences Centre. Assessment of microcirculatory blood flow will be ascertained utilizing near-infrared spectroscopy (NIRS) technology and correlated with physiologic variables and particular events of interest at various time points before, during and after CPB. Our lab uses a variability analysis of total microvascular hemoglobin levels in skeletal muscle of the thigh to assess microvascular function.

Results: NIRS data was collected in 20 patients, all of which were time synched to pump flow and mean arterial blood pressure. Changes in microvascular activity have been identified in association with particular events that occur during the cardiac surgery operation. Interventions such as hemodilution, vasopressor usage, and ischemia reperfusion events can be identified. Along with changes in CPB pump flow and patient mean arterial blood pressure can be observed.

Discussion: When we talk about how we monitor cardiac surgical patients in the operating room we essentially are talking about global perfusion status or macro-hemodynamics. This would include parameters such as heart rate, mean arterial blood pressure, central venous pressure and pulse oximetry. Even blood values such as lactate and venous oxygen saturations are still representative of central perfusion markers. Therefore, there is a need for microvascular monitors to help describe underlying physiology and provide more meaningful information in cardiac surgery patients. The clinical implications are that NIRS may permit earlier, non-invasive detection of significant physiological derangements and allow for more accurate and timely therapeutic interventions in the attenuation of I/R injury and the SIR response linked to CPB.