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Room Area D

Real Time Monitoring of Cerebral Blood Flow Autoregulation with NIRS during Cardiac Surgery

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Introduction: There is a rising prevalence of cerebral vascular disease in patients undergoing cardiac surgery. (1) Such patients may be predisposed to cerebral hypoperfusion during surgery particularly during cardiopulmonary bypass (CPB) where blood pressure targets are empirically chosen. Individualizing blood pressure targets to be within a patient's cerebral blood flow (CBF) autoregulatory range might avoid cerebral hypoperfusion at low blood pressure and cerebral hyperemia and edema at high blood pressures. The purpose of this study was to evaluate the accuracy of real-time CBF autoregulation monitoring using near infra-red spectroscopy (NIRS) compared with a validated but more technically challenging method using transcranial Doppler (TCD).(2)

Methods: Sixty patients age > 45 years undergoing CABG and/or valve surgery using CPB were enrolled in this IRB approved protocol after providing informed consent. Bilateral TCD monitoring of the middle cerebral arteries and NIRS monitoring was performed beginning at anesthesia induction. For the latter, the Invos monitor (Somenetics Corp, Troy, MI) was used in 29 patients and the Foresight monitor (CAS Medical Systems, Branford, CT) in 31 patients. Arterial pressure, TCD and NIRS signals were sampled with a analog-to-digital converter at 58 Hz and downloaded to a personal computer. The TCD and NIRS signals were time integrated as non-overlapping 10-sec mean values to eliminate noise from the respiratory and pulse frequencies. A continuous, moving Pearson correlation coefficient was calculated between MAP and TCD CBF velocity and NIRS signals rendering the variables *mean velocity index* (Mx) and *cerebral oximetry index* (COx), respectively. Consecutive, paired, 10-sec averaged values from 300-sec duration were used for each calculation, incorporating 30 data points for each index. When CBF is autoregulated, there is no correlation between CBF and MAP (i.e., Mx < 0.2 and COx < 0.3), but when pressure passive Mx and COx are positively correlated with MAP.

Results: There was a significant correlation ($r=0.55$, $p<0.0001$) between COx and Mx for the time-averaged data during CPB. Correlation between Mx and COx was significant for both INVOS™ ($R=0.52$, $p<0.0001$) and Foresight™ ($r=0.38$, $p< 0.0028$) devices. There was good agreement between Mx and COx (bias=0.082±0.18, 95% CI, -0.327 to 0.43). Coherence between slow waves (20 s to 2 min) from NIRS and TCD signals was high (0.74).

Conclusions: Our results suggest that CBF autoregulation can be reliably monitored continuously in adult patients undergoing cardiac surgery with CPB using NIRS. Since it is non-invasive, continuous, and requires little caregiver intervention, NIRS could be widely applied in a broad range of clinical settings and locations to monitor CBF autoregulation.

References: 1) J Thorac Cardiovasc Surg 2006;131:540; 2) Stroke 2007;38:2818.

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