Real-time Process Assessment during Cardiac Surgery: Relating NIRS, TCD, and Physiologic Monitoring to Surgical and Perfusion Techniques

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Authors: RC Groom, DS Likosky, CJ Eskey, JR Morton, CS Ross, J Belden, AJ Saykin, RS Kramer, YJ Kiang-Teck, C Clark, RJ Forest, GT O'Connor

Background: Recent studies have show that 1 – 5% of patients undergoing CABG surgery have clinical strokes, while 25-50% of patients have sub-clinical neurocognitive deficits. In previous work, we identified the principal mechanism of 388 patients having clinically apparent strokes secondary to isolated CABG surgery in northern New England from 1992 to 2000, and found that embolism was the dominant etiology (62%) while hypoperfusion accounted for 9%. Recent work also suggests that the same mechanism producing strokes may also produce these more frequent neurocognitive deficits. Improving neurological outcomes requires redesigning surgical care to reduce the frequency of these iatrogenic events. The aim of this study was to develop a system to identify processes of surgical care that expose patients to these neurological injuries.

Methods: A system has been developed to link routinely collected physiological data with measurements of cerebral desaturation and embolic activity (in the cardiopulmonary bypass circuit and cerebral arteries). Perfusion-related information included the following: temperatures, pressures, flow rate, and continuous blood gas and saturation measurement. Cerebral perfusion was assessed using continuous near- infrared spectroscopy. Cerebral blood flow and embolic activity were measured bilaterally in the middle cerebral arteries using transcranial Doppler (TCD). Embolic activity was also measured in the cardiopulmonary bypass circuit. Audio and video recordings of the surgical procedure were synchronized with the above parameters. A video was created which has the synchronized images of the cerebral and cardiopulmonary bypass TCD outputs as well as the image of the surgical site to facilitate the identification of associations between these measurements and surgical and perfusion techniques.

Conclusion: This novel approach allows real-time associations between processes of care and parameters of neurological injury. We believe that this approach will guide and facilitate the redesign of care surrounding neurological injury.