

Identification of biomarkers suitable for predicting cognitive decline in patients undergoing cardiac surgery

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Introduction: Postoperative cognitive decline (POCD) is a complication that remains significantly high in patients undergoing cardiac surgery^{1,2}. At time of discharge, 50-80% of patients exhibit POCD, persisting in 20-50% of patients 6 weeks after surgery³. Currently available cerebral oximeters that use near-infrared spectroscopy (NIRS) for patient monitoring are based on small-area, low-density arrays and utilize declines in cerebral hemoglobin saturation (Hbsat) to predict POCD, but these devices have demonstrated poor sensitivity⁴. We hypothesize that large, high-density arrays (HDA) of NIRS probes, used in combination with biomarkers based on cerebral autoregulation⁵, will provide better predictions of POCD.

Methods: 17 patients undergoing elective cardiac surgery were recruited. Each patient performed a series of neurocognitive tests before surgery and at time of discharge. Patients with >20% decrease in performance in at least 2 of the tests were considered to have acquired POCD as a result of the surgery. Intra-operatively, patients were monitored with a HDA consisting to 48 optical sources and 32 detectors, arranged into 104 overlapping source-detector pairs (channels), with an inter-optode distance of 4 cm. Several biomarkers derived from the NIRS data were tested using rank-sum tests to differentiate the deficit and no-deficit groups. The biomarkers that provided the best discrimination were used as input for binary logistic regression (BLR) analyses, with age and duration of surgery as covariates.

Results: 6 out of the 17 patients were unable to complete the neurocognitive testing. Of the 11 remaining patients, 5 met the criteria for POCD. Rank-sum tests showed that patients with POCD were significantly older than those without ($p < 0.02$), while duration of surgery was not significantly different. Several biomarkers, based on changes in Hbsat, total hemoglobin (Hbtot), or a marker for cerebral autoregulation (Hbsat correlated with mean arterial pressure (MAP)), were tested. The number of autoregulatory failures (defined as Hbsat/MAP correlation > 0.4) was significantly larger in patients with POCD ($p < 0.009$). In the BLR analyses, the autoregulation marker was selected as the single most strongly predictive variable, over age and duration of surgery.

Conclusion: A biomarker that is a surrogate for cerebral autoregulation accurately predicted postoperative cognitive decline in a small patient population. Larger studies using this marker are warranted.

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