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Decreased Forebrain Cerebral Tissue Oxygen Saturation is Associated with Cognitive Decline after Cardiac Surgery

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Introduction: In this exploratory, non-interventional observational study, we examined the relationship of cerebral tissue oxygen saturation (SctO2) measured by the FORE-SIGHT® cerebral oximeter (CAS Medical Systems, Branford CT USA) to postoperative cognitive decline (POCD).

Methods: With IRB approval and informed consent, 60 subjects undergoing coronary bypass surgery (CABG) and/or valvular surgery (VS) were enrolled in the study. Exclusions were history of symptomatic cerebrovascular disease, uncontrolled hypertension, alcoholism, psychiatric illness, creatinine >2 mg/dL, <7th grade education, were pregnant, or baseline MMSE score <24. Bilateral sensors were placed on the subject's forehead from pre-induction to chest closure, with SctO2 recorded every two seconds. SctO2 minutes and area under the curve (AUC) below absolute thresholds 50, 55, 58, 60, & 65% were computed for L & R sensors. Subjects were examined with a battery of five cognitive tests a day before surgery and 6 weeks post surgery. The test battery consisted of the Short story module of the Randt Memory Test, Modified Visual Reproduction Test (WAIS-R), Digit Span subtest (WAIS-R), Digit Symbol subtest (WAIS-R), and Trail Making Test (Part B) which produced 10 scores. A factor analysis of the 10 test scores returned four independent cognitive domain scores: 1) verbal memory & language comprehension, 2) figural memory, 3) attention & concentration and 4) psychomotor & processing speed. These were averaged for an overall cognitive index, and domains 2, 3, and 4 were averaged as a separate summary score. The association between the various SctO2 measures and the 6-week change in cognitive scores was tested by Spearman rank correlation and by multivariable linear regression accounting for baseline cognitive score, age, gender, and years of education. Diabetes, crossclamp time, CPB time and CPB temperature were also tested as single covariates with SctO2 in separate regression models.

Results: 53 subjects completed all testing. Of these, 18% underwent CABG+VS, 32% were female, 87% were Caucasian, and 32% were diabetic. The pre-induction SctO2 was lower in patients undergoing valvular surgery (67.0% vs 72.1%; p=0.01). Declines in SctO2 below several thresholds were significantly associated with 6-week decline in the Domain 2, 3, & 4 average in unadjusted Spearman correlations (Table 1). After adjustment for baseline variables SctO2 minutes <60% remained significantly associated with this cognitive decline (p=.040, R-Squared=.09). Verbal memory (Domain 1), measured by the Randt test, was not associated with decreased SctO2.

Conclusion: Decreases in intraoperative SctO2 are associated with POCD. The lack of association with Domain 1 is explained by the fact that the Randt test is typically associated with temporal and parietal lobe function and thus not measured by a monitor of frontal lobe cerebral tissue oxygen saturation.

SctO2 Thresholds	Change in Cognitive score (Domains 2, 3, 4)	
	Correlation Coefficient	P-value
SctO2 < 65% (minutes)	-.328	.017
SctO2 < 60% (minutes)	-.326	.017
SctO2 < 58% (minutes)	-.357	.009
SctO2 < 55% (minutes)	-.382	.005
SctO2 < 50% (minutes)	-.318	.020
SctO2 < 65% (AUC)	-.357	.009
SctO2 < 60% (AUC)	-.346	.011
SctO2 < 58% (AUC)	-.363	.008
SctO2 < 55% (AUC)	-.358	.009
SctO2 < 50% (AUC)	-.316	.021