Cerebral tissue oxygen saturation (ScO2) is measured using cerebral oximetry. In cardiac surgery, pre-operative ScO2 levels have been associated with increased risk of mortality, morbidity, and post-operative delirium. Pre-operative ScO2 has been correlated with surrogates of cardiopulmonary function, and with maximal aerobic capacity and anaerobic threshold during cardiopulmonary exercise testing. This pilot study was designed with the aim to determine if pre-operative ScO2 levels identify patients with worse outcomes after major elective non-cardiac surgery. Patients were co-recruited when enrolled in the multicentre BALANCED depth of anaesthesia study at Liverpool Hospital, Sydney. The primary outcome was 30-day major adverse event (MAE; all cause mortality or major morbidity), and secondary outcome was 30-day new onset disability as measured using the World Health Organisation Disability Assessment Scale (WHODAS).

Methods and Statistical Analysis

Eligible patients were approached in the pre-admission clinic. Inclusion criteria was as for the BALANCED study: elderly (≥ 60yo), higher risk (ASA 3,4), elective major (≥2hrs duration, ≥2 days admission) non-cardiac surgery, planned to have general anaesthesia with or without regional anaesthesia. After informed consent, pre-operative data including co-morbidities and medication history were recorded.

Room air, baseline ScO2 was measured at rest and before medications. Supplemented ScO2 was measured after 5min of 6L.min⁻¹ oxygen via Hudson mask. 30-day MAE was defined as death, myocardial infarction, cardiac arrest, stroke, pulmonary embolism, sepsis, surgical site infection, and unplanned ICU admission. 30-day disability was defined as 24 point increase in WHODAS from pre-operative. No prior studies have been performed on pre-operative ScO2 and outcomes after non-cardiac surgery. A convenience sample size of 81 patients was recruited over 15 months. T-tests, Mann-Whitney U tests, and Fisher’s exact tests were used to compare pre-operative patient characteristics to the dichotomous MAE primary outcome and dichotomous WHODAS disability secondary outcome.

Baseline and supplemented ScO2 measurements were compared against each outcome using repeated measures mixed ANOVA, with Bonferroni correction for multiple pairwise comparisons. The five most highly correlated pre-operative characteristics after point-biserial bivariate analysis were entered into a binary logistic regression model. Receiver operating characteristic was performed for both baseline and supplemented ScO2 values against outcomes, and reported area under the curve. Statistical significance was by two-tailed analysis, p < 0.05.

Results

One patient withdrew from the study, leaving 80 patients for analysis. Pre- and post-operative patient characteristics are in Table 1. Eleven patients (13.6%) suffered death or morbidity, and 28 patients (34.6%) experienced new disability. There was no difference in outcomes based on randomisation to low or high depth of anaesthesia. Baseline ScO2 was significantly different between patients with MAE, 67% (95% CI 65 - 70) versus unaffected, 71% (95% CI 70 - 72; p = 0.04). No difference was found between patients for disability (range 70% - 74%; p = 0.73). This is shown in Table 2 and Figures 1 & 2.

Baseline ScO2 was a significant predictor of death or morbidity (odds ratio 1.36 (95% CI 1.03 - 1.79); p = 0.03). Baseline ScO2 levels ≤ 68% carried a positive likelihood ratio of 2.2 for death or morbidity, p = 0.04.

Discussion

In cardiac surgery, low pre-operative ScO2 has been associated with increased risk of complications (Fenton 2005; Schoen 2011; Heringlake 2011). This exploratory study demonstrates evidence for a similar association in major non-cardiac surgery. This patient population has high rates of mortality and disability. Pre-operative ScO2 measurements using cerebral oximetry may be used in the pre-anaesthesia clinic to supplement history and clinical examination, to stratify cardiorespiratory risk patients. Management options include optimisation, organising post-operative care, or discussing the appropriateness of surgery. Cerebral oximetry has advantages over cardiopulmonary exercise testing, including ease of use, rapid, lower staffing needs, and can be used on any patient. A definitive trial is required to confirm the results of this pilot study.

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Table 1. Pre-operative patient characteristics and outcomes

Table 2. Baseline and supplemented ScO2 values, and outcomes. Baseline ScO2 ≤ 68% has 64% sensitivity and 71% specificity for death/morbidity.