

PRE- AND POSTOPERATIVE MONITORING IN ADULT CARDIAC SURGERY PATIENTS

With the INVOS™ cerebral/somatic oximeter

Emerging clinical evidence suggests that INVOS™ technology can help clinicians monitor and manage cardiac surgery patients throughout the entire perioperative period, not just in the OR.

Preoperative baseline measurement of cerebral oxygen saturation may provide an additional measure for risk stratification before cardiac surgery. These measurements of low rSO_2 are nearly as accurate as the EuroScore or Society of Thoracic Surgeons mortality risk score in predicting mortality.^{1,2}

Low rSO_2 has been associated with an increased risk of:

- Operative mortality^{1,2}
- Mortality at 30 days and 1 year³
- Major adverse events and complications³
- Longer time to extubation⁴
- Postoperative delirium^{5,6}

Cardiac surgery patients also are at risk of significant cerebral desaturation after surgery, with up to 73% of patients monitored with INVOS™ technology desaturating in the ICU.⁷

This clinical evidence guide explores the utility of preoperative rSO_2 values in predicting postoperative complications and of postoperative monitoring to identify continued cerebral desaturation in the ICU.

Low preoperative cerebral oxygen saturation is an independent predictor of operative mortality.

Mortality predicted by preinduction cerebral oxygen saturation after cardiac operation

Sun X, Ellis J, Corso PJ, et al.

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| Study design | Single-center, retrospective study (United States) |
| Arms | Single arm: INVOS™ monitoring technology |
| Objective | Determine the association between the manually calculated Society of Thoracic Surgeons (STS) mortality risk score and preoperative rSO ₂ for predicting mortality in Caucasian patients |
| N | 2,097 |
| Population | Cardiac surgery patients |
| Definition of low saturation | rSO ₂ <60% |
| Threshold for intervention | No interventions were made |
| Results | <ul style="list-style-type: none">▪ 28.6% (601/2,097) of patients had low preoperative rSO₂ levels▪ Operative mortality was lower in the rSO₂ ≥60% group (2.6% vs. 7.2%; p < 0.001)▪ After adjustment for confounders, higher preoperative rSO₂ remained significantly associated with reduced odds of operative mortality (OR = 0.97; p = 0.00)▪ Similar results were seen in a population of 1,186 African American patients published separately, despite a lower average baseline rSO₂ level²▪ Preoperative rSO₂ is slightly less accurate as a mortality predictor compared to the STS mortality risk score |
| Conclusions | Measuring preoperative rSO ₂ levels is less cumbersome and more objective than calculating the STS mortality risk score. It is only slightly less accurate in predicting operative mortality in Caucasian patients. |

Low preoperative cerebral oxygen saturation is associated with postoperative delirium and mortality at 30 days and 1 year after cardiac surgery.

Preoperative cerebral oxygen saturation and clinical outcomes in cardiac surgery

Heringlake M, Garbers C, Käbler JH, et al.

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| Study design | Single-center, prospective observational study (Germany) |
| Arms | Single arm: INVOS™ monitoring technology |
| Objective | Determine the association between preoperative cerebral saturation rSO ₂ , risk factors, and clinical outcomes |
| N | 1,178 |
| Population | Patients undergoing on-pump cardiac surgery |
| Threshold for intervention | No interventions were made based on preoperative rSO ₂ |
| Results | <ul style="list-style-type: none">▪ Outcome rates were as follows:<ul style="list-style-type: none">– 30-day mortality = 3.5% (41/1178)– 1-year mortality = 7.7% (91/1178)– Major morbidity (MaCS) = 13.3% (157/1178)†▪ 30-day mortality and MaCS were associated with lower rSO₂ on room air and on supplemental oxygen▪ Preoperative rSO₂ on supplemental oxygen was more accurate than the EuroScore in predicting 30-day mortality in high-risk patients (defined as EuroScore >10)▪ Patients with preoperative rSO₂ levels ≤50% on supplemental oxygen had a 2.5 times higher risk of 30-day and 1-year mortality▪ In a separate publication examining a subset of 256 patients from this study, preoperative rSO₂ on supplemental oxygen was an independent predictor of postoperative delirium⁵ |
| Conclusions | Preoperative rSO ₂ levels may reflect a patient's overall cardiopulmonary function and may provide clinicians with an additional factor for stratifying risk in patients before surgery. |

†Major adverse events and complications score (MaCS) was defined either as:

- At least two of the following complications — need for renal replacement, reintubation, stroke, low cardiac output syndrome
- The need for ICU plus intermediate care treatment for ≥10 days

Low preoperative cerebral oxygen saturation is associated with increased risk of postoperative delirium.

Cerebral oximetry and postoperative delirium after cardiac surgery: a randomised, controlled trial

Lei L, Katznelson R, Fedorko L, et al.

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| Study design | Single-center, randomized controlled trial (Canada) |
| Arms | CONTROL: perioperative blinded INVOS™ monitoring technology INTERVENTION: perioperative INVOS™ monitoring technology and use of an interventional protocol to restore rSO ₂ ; interventions to restore rSO ₂ were performed both in the OR and ICU For both groups, monitoring began intraoperatively and continued up to 24 hours in the ICU |
| Objective | Determine whether NIRS monitoring and intervention to restore rSO ₂ reduced the incidence of postoperative delirium (POD) after surgery |
| N | 250 |
| Population | Patients undergoing on-pump cardiac surgery, including deep hypothermic circulatory arrest |
| Threshold for intervention | 75% of baseline rSO ₂ for ≥1 minute |
| Results | <ul style="list-style-type: none">▪ The incidence of delirium (24.5% overall) was not affected by monitoring and intervention, presence of desaturation events, or success in restoring baseline rSO₂▪ The incidence of POD was higher in patients with baseline rSO₂ ≤50% (71% vs. 18%, p = 0.0001)▪ After adjusting for confounders, higher right-sided baseline rSO₂ was associated with reduced odds of POD (OR = 0.93, p < 0.0001) |
| Conclusions | Low preoperative rSO ₂ levels were associated with an increased risk of POD. |

Postoperative cerebral desaturation in the ICU is common in high-risk cardiac surgery patients, especially in those who experience intraoperative desaturation.

Reversal of decreases in cerebral saturation in high-risk cardiac surgery

Deschamps A, Lambert J, Couture P, et al.

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| Study design | Single-center, two-part trial (Canada) Reporting only Part 2: pilot randomized, controlled |
| Arms | CONTROL: perioperative blinded INVOS™ monitoring technology INTERVENTION: perioperative INVOS™ monitoring technology and use of an interventional protocol to restore rSO ₂ in the OR only (monitoring continued into the ICU but no interventions were performed) |
| Objective | Verify that interventions resulted in a reduction of the desaturation load during surgery |
| N | 48 |
| Population | Patients undergoing high-risk on-pump cardiac surgery |
| Definition of desaturation | <80% of baseline rSO ₂ for >15 seconds |
| Threshold for intervention | <80% of baseline rSO ₂ for >15 seconds (in OR only) |
| Results | <ul style="list-style-type: none"> ▪ Patients who did not experience cerebral desaturation in the OR did not subsequently desaturate in the ICU ▪ Of patients who desaturated in the OR, 73.7% (14/19) of the control group and 37.5% (6/16) of the intervention group also desaturated in the ICU (p < 0.0347) ▪ Intraoperative monitoring and intervention in the OR appeared to have a protective effect on desaturation in the ICU <ul style="list-style-type: none"> – Total mean desaturation load in the ICU was lower in the intervention group (324% vs. 856.6% · min; p = 0.030) |
| Conclusions | Postoperative cerebral desaturation was common in this high-risk cardiac surgery population. Intraoperative monitoring and intervention in the OR were associated with a reduction in the total postoperative cerebral desaturation load in the ICU. |

A selection of clinical studies using INVOS™ technology pre- and postoperatively in adult cardiac surgery

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