Cerebral desaturation during cardiac surgery can be identified and reversed based on the information provided by the INVOS™ Cerebral/Somatic Oximeter. A recent publication involving over 300 high-risk cardiac surgical patients suggests that monitoring with INVOS™ technology and intervening to minimize cerebral desaturation events often resulted in successful resaturation of the brain and can reduce the desaturation load during surgery.\(^1\)

Implementation of INVOS™ monitoring technology has also been shown to improve patient outcomes and use of hospital resources. A single-center retrospective database analysis compared clinical outcomes in cardiac surgery patients before and after implementation of INVOS monitoring.\(^2\) The analysis concluded that patients monitored with INVOS and where the clinician intervened based on the departure from baseline cerebral oxygen values during surgery presented a reduced incidence of permanent stroke, the need for prolonged postoperative ventilation, and length of hospital stay compared to an historical unmonitored control group. Additionally, a randomized controlled trial demonstrated that fewer patients randomized to a blood conservation protocol incorporating INVOS™-guided cerebral oxygenation thresholds received transfusions and received fewer units of blood than control patients.\(^3\)
Cerebral desaturation during high-risk cardiac surgery is common and can be successfully identified using INVOS™ monitoring technology and reversed, reducing desaturation load during surgery.


| Study design | Single center trial (Canada):  
|             | • Part 1: Prospective, observational  
|             | • Part 2: Pilot randomized, controlled |
| Arms | Part 1: Single arm: INVOS™ monitoring and use of an interventional protocol to restore cerebral saturation levels (rSO₂)  
|      | Part 2: Control: blinded INVOS™ monitoring  
|      | Intervention: INVOS™ monitoring and use of an interventional protocol to restore rSO₂ |
| Objective | Part 1: Test of the efficacy of an interventional algorithm to restore decreases in rSO₂  
|          | Part 2: Verify that interventions resulted in a reduction of the desaturation load during surgery |
| N | Part 1: 279  
|   | Part 2: 48 |
| Population | High-risk cardiac surgery on cardiopulmonary bypass (CPB) |
| Definition of desaturation | <80% of baseline rSO₂ for >15 seconds |
| Threshold for intervention | <80% of baseline rSO₂ for >15 seconds |
| Results | Part 1:  
|         | • Desaturation occurred in 136 patients (48.8%)  
|         | • Reversal was successful in 120/136 patients (88.2%)  
| Part 2: | • Incidence of desaturation was not statistically different between the intervention (69.9%) and control groups (76%)  
|         | • Total mean desaturation load during surgery was lower in the intervention group (154.3 vs 729.7 %•min; P=0.041) |
| Conclusions | Cerebral desaturation was common in this high-risk cardiac surgery population and was successfully reversed in the majority of patients by employing an interventional protocol. Monitoring and intervention was associated with a reduction in the total cerebral desaturation load during surgery. |
Monitoring with INVOS™ technology and intervention is associated with reduced permanent stroke rates, need for mechanical ventilation, and length of hospital stay


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<tr>
<th>Study design</th>
<th>Single center, retrospective data analysis (US)</th>
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| Arms        | **Control**: 18 months prior to implementing INVOS™ monitoring technology  
**Intervention**: 18 months after INVOS™ monitoring technology was implemented and interventions were prescribed to maintain baseline rSO₂ |
| Objective   | Demonstrate that monitoring with INVOS™ technology and intervening to optimize cerebral oxygen delivery variables could reduce the incidence of stroke |
| N           | 2,279 (including 1,245 controls) |
| Population  | All cardiac surgery |
| Threshold for intervention | Any rSO₂ decrease from baseline |
| Results     | • Intervention group had a higher incidence of baseline cardiovascular risk factors, including more New York Heart Association (NYHA) class III and IV patients  
• Monitoring and intervention was associated with:  
  – Lower rate of permanent stroke (0.97% vs 2.01%; P<0.044) in NYHA class I through III patients  
  – Shorter time on ventilation (4 vs 5 hours; P<0.0016)  
  – Fewer patients requiring prolonged ventilation (6.8 vs 10.6%; P<0.0112)  
  – Reduction in hospital length of stay by between 0.2 days and 2.3 days, depending on NYHA class (P<0.046)  
• In a subsequent publication, the authors estimate that they had avoided 12 cerebrovascular incidents in the intervention group, with a potential avoidance of US$254,214 in direct costs and $US425,000 in total costs⁴ |
| Conclusions | Despite that patients in the intervention group were sicker and had more comorbidity, they had a lower incidence of permanent stroke, less need for prolonged ventilation, and a shorter hospital stay. |
Inclusion of INVOS™ monitoring technology into a blood conservation protocol is associated with fewer blood transfusions and fewer units of blood transfused


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<tr>
<th>Study design</th>
<th>Single-center randomized controlled trial (Greece)</th>
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| Arms         | **Control:** blood transfusion need determined by hematocrit (Hct)  
**Intervention:** blood transfusion need determined by rSO₂ and Hct |
| Objective    | Determine whether incorporation of INVOS™ monitoring technology into an intraoperative Hct-based blood conservation algorithm reduces blood use |
| N            | 150 |
| Population   | Cardiac surgery on CPB |
| Threshold for intervention | **Control:**  
- During aortic cross-clamp: Hct ≤ 17%  
- After clamp removal, before weaning from CPB: Hct ≤ 21%  
- After CPB weaning and re-transfusion of salvaged blood: Hct ≤ 24%  
- In the intensive care unit (ICU): Hct ≤ 24%  
**Intervention (must meet both criteria):**  
- rSO₂ < 60% or <20% decrease from mean value during pulmonary arterial catheter insertion, AND  
- Fulfills Hct-based threshold for transfusion as listed above |
| Results      | Based on a “per-protocol” analysis (protocol violations were identified in 8.7% of patients and were not included in the final analysis), incorporation of an rSO₂ threshold into a blood conservation algorithm was associated with:  
- Fewer patients receiving transfusions during surgery (15.7 vs 29.8%; P=0.048) and during their hospital stay (65.7 vs 82.1%; P=0.029)  
- Fewer units per patient transfused in the OR (P=0.021) |
| Conclusions  | INVOS™ monitoring technology could be incorporated into a blood conservation strategy with hematocrit levels to guide blood transfusions during cardiac surgery. |
Inclusion of INVOS™ monitoring technology into a blood conservation protocol is associated with fewer blood transfusions and fewer units of blood transfused.

Monitoring with INVOS™ technology and intervention is associated with reduced permanent stroke rates, need for mechanical ventilation, and length of hospital stay.

A selection of clinical studies using INVOS™ technology intraoperatively in broad cardiac surgery patient populations:


Now That You’ve Read the Evidence

**Cerebral desaturation during high-risk cardiac surgery is common and can be successfully identified using INVOS™ monitoring technology and reversed, reducing desaturation load during surgery.**

**Monitoring with INVOS™ technology and intervention is associated with reduced permanent stroke rates, need for mechanical ventilation, and length of hospital stay.**

**Inclusion of INVOS™ monitoring technology into a blood conservation protocol is associated with fewer blood transfusions and fewer units of blood transfused.**

**A selection of clinical studies using INVOS™ technology intraoperatively in broad cardiac surgery patient populations.**

Consider using INVOS™ monitoring with all adult cardiac surgery cases.

For more information, contact your Covidien representative or visit covidien.com/rms/products/cerebral-somatic-oximetry

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