Clinical Evidence Guide

BLOOD TRANSFUSION MANAGEMENT IN ADULT AND PEDIATRIC CARDIAC SURGERY PATIENTS

Monitoring cerebral perfusion with the INVOS™ cerebral/somatic oximeter

Each year, 15 million units of packed red blood cells (RBC) are transfused during surgery in the United States. Transfusions in cardiac surgery account for 10% to 15% of the total available blood supply. An analysis of the Society of Thoracic Surgeons Adult Cardiac Surgery Database reported that 54% of patients undergoing coronary artery bypass surgery received RBC. In 2010, the per-unit-RBC cost across four hospitals was reported to be between $522 and $1,183, including the direct and indirect costs of acquiring, processing, staffing, and consumables used.

Growing evidence suggests that the INVOS™ cerebral/somatic oximeter — both in general and as part of a decision algorithm — can help clinicians make transfusion decisions during adult and pediatric cardiac surgery. The 2015 American Society of Anesthesiologists Practice Guidelines for Perioperative Blood Management reported that 91% to 95% of surveyed consultants and members agree with using additional monitoring modalities, including cerebral oximetry, for transfusion management.

Studies included in this clinical evidence guide have shown that including cerebral oxygen saturation for transfusions decisions can result in:

- Fewer patients transfused
- Fewer units transfused per patient

Medtronic
Further, Together
Including INVOS™ monitoring technology in a transfusion decision algorithm during adult cardiac surgery is associated with fewer patients transfused and fewer units of RBC used.

Monitoring of brain oxygen saturation (INVOS) in a protocol to direct blood transfusions during cardiac surgery: a prospective randomized clinical trial


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<tr>
<th>Study design</th>
<th>Single-center, prospective randomized controlled trial (Greece)</th>
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</table>
| Arms        | GROUP A: blood transfusion need determined by hematocrit (Hct) alone  
GROUP B: blood transfusion need determined by both rSO₂ (OR only) and Hct |
| Objective   | Determine whether incorporation of INVOS™ monitoring technology into an intraoperative Hct-based transfusion algorithm reduces RBC use |
| N           | 150 |
| Population  | Cardiac surgery patients on CPB |
| Threshold for transfusion | GROUP A:  
· During aortic cross-clamp  
  – Hct ≤17%: 1 RBC unit transfused  
  – Hct 17% to 21%: transfusion at anesthesiologist’s discretion  
· After clamp removal, before weaning from CPB: Hct ≤21%  
· After CPB weaning and retransfusion of salvaged blood: Hct ≤24%  
· In the ICU: Hct ≤24%  
GROUP B (had to 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 transfusion 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 RBC units per patient transfused during surgery (1.27 vs. 1.75; p = 0.021) and overall (1.32 vs. 1.82; p = 0.024) |
| Conclusions | Incorporation of cerebral oximetry thresholds into a hematocrit-based transfusion algorithm was associated with a decrease in the number of patients transfused and number of RBC units transfused. |
Including INVOS™ technology to continuously monitor for changes in cerebral perfusion during cardiac surgery was associated with fewer units of RBC used.

A multidisciplinary perioperative strategy for attaining “more physiologic” cardiac surgery


<table>
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<tr>
<th>Study design</th>
<th>Single-center, retrospective analysis comparing results before and after a “more physiologic” anesthetic approach was implemented (Greece)</th>
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| Arms         | ROUTINE CARE CONTROL: cardiac surgery patients treated with routine anesthetic strategy  
PHYSIOLOGIC APPROACH: cardiac surgery patients treated according to a goal-directed strategy using cardiac index, SvO₂, (mixed venous saturation) DO₂,i (oxygen delivery), DO₂,i/ VCO₂,i (oxygen delivery indexed to carbon dioxide production ratio), and rSO₂, (using the INVOS™ monitor), in addition to using minimally invasive extracorporeal circulation  
Intervention included:  
1. Increasing hemoglobin levels to more than 8 g/dL  
2. Increasing cardiac output/circulatory flow to 120%  
3. Initiating inotropic/vasoactive support |
| Objective   | To use real-time monitoring to prevent malperfusion during surgery |
| N           | 120 |
| Population  | ROUTINE CARE: coronary artery bypass graft (CABG) patients only (n=60)  
PHYSIOLOGIC APPROACH: 24 CABG patients, 36 valve and complex procedure patients (n=60) |
| Threshold for intervention | <20% drop in rSO₂ from baseline |
| Results    | • There were no differences in the baseline characteristics of the two groups (except surgery type)  
• The physiologic approach group:  
  – Experienced fewer strokes (0% vs. 5%, p < 0.05)  
  – Demonstrated less acute kidney injury (AKI stage 2 and 3; 3.3% vs. 8.3%, p < 0.05)  
  – Required fewer RBC units intraoperatively (1 vs. 1.5 units, p < 0.05) |
| Conclusions | A strategy to continually monitor perfusion and immediately take action to maintain optimal perfusion throughout the perioperative period protects end-organ function and improves patient outcomes after cardiac surgery. |
Monitoring with INVOS™ technology and intervention in pediatric congenital heart surgery are associated with a higher hemoglobin transfusion trigger but lower total volume of RBCs used.

A retrospective study about cerebral near-infrared spectroscopy monitoring during paediatric cardiac surgery and intra-operative patient blood management


<table>
<thead>
<tr>
<th>Study design</th>
<th>Single-center, retrospective data analysis (France)</th>
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<tr>
<td>Arms</td>
<td>CONTROL: 20 months before implementing INVOS™ monitoring technology INTERVENTION: 22 months after INVOS™ monitoring technology was implemented and interventions were prescribed to maintain baseline rSO2 during surgery</td>
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<tr>
<td>Objective</td>
<td>Examine the association between the use of INVOS™ monitoring technology, blood transfusion practice, and patient outcomes</td>
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<tr>
<td>N</td>
<td>91</td>
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<td>Population</td>
<td>Pediatric (&lt;24 months of age) congenital heart surgery patients</td>
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<tr>
<td>Threshold for intervention</td>
<td>rSO2, &lt;80% of baseline or below 50%</td>
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<tr>
<td>Threshold for transfusion</td>
<td>At the discretion of the clinician</td>
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<tr>
<td>Results</td>
<td>• All but 3 children required transfusion • 56/91 patients (61.5%) were monitored with INVOS™ technology • In monitored patients: – Initial hemoglobin transfusion threshold was higher (9.8 vs. 8.7 g/dL, p &lt; 0.0001) – Volume of first RBC bolus used was lower (10 vs. 12.2 mL/kg, p = 0.0361) – Total intraoperative RBC volume used was lower (20 vs. 36 mL/kg, p = 0.0165) – ICU stay was shorter (5 vs. 7 days, p = 0.0084) • rSO2 monitoring was an independent predictor of: – Transfusion threshold &gt;9.5g/dL (OR = 5.665; p = 0.0014) – Total transfusion volume &lt;30 mL/kg (OR = 3.471; p = 0.0224) – ICU stay &lt;6 days (OR = 3.881; p = 0.0047)</td>
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<tr>
<td>Conclusions</td>
<td>Cerebral oximetry monitoring was associated with transfusion at a higher hemoglobin threshold but less blood was used.</td>
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A selection of clinical studies using INVOS™ technology for management of blood transfusion during cardiac surgery


References