The reported benefits are related to detection of perioperative events that can impact cerebral oxygenation and perfusion. Early recognition of events allows for quicker assessment and earlier interventions to improve cerebral oxygen that can lead to a reduction in postoperative complications. The benefits are seen in reductions in the following areas:

- Major organ morbidity or mortality
- Stroke
- Postoperative cognitive decline
- Respiratory failure/vent time
- Adverse surgical events
- Coma
- ICU length of stay (LOS)
- Hospital LOS

Clinical Vignette
The patient is a 73-year-old female who underwent on-pump coronary artery bypass grafting and has been diagnosed with morbid obesity, hypertension, obstructive sleep apnea, diabetes type 2, renal insufficiency, coronary artery disease, and peripheral vascular insufficiency. Baseline rSO2 values were set upon entering the Operating Room with the patient on room air for 1 minute, as is my usual practice. There was an initial rise in rSO2, bilaterally resulting from the administration of oxygen and was followed by a brief decline during induction. Once the patient was intubated and stabilized on mechanical ventilation, bilateral cerebral oxygen saturations were greater than 75%.
Additional improvement in cerebral saturation coincided with patient optimization, which included paralysis and mechanical ventilation on 100% oxygen, increased arterial CO₂ through adjustment of ventilation, and maintaining blood pressure within 20% of baseline.

Approximately 45 minutes after the procedure had started, there was a precipitous drop that coincided with initiation of cardiopulmonary bypass. While it is not uncommon to see a temporary dip when initiating cardiopulmonary bypass due in part to hemodilution from the priming solution of the perfusion circuit, it should not be sustained as it was in this case. Multiple strategies were implemented to improve the cerebral rSO₂ values that eventually became critical. I increased the pump flow to maximal values, increased the CO₂ values, checked cannula positions, decreased the temperature, and sent an initial set of electrolytes. The values were all within normal ranges, except elevated potassium (5.1mmol/L) and a hematocrit of 21%, which was down from 30%, preoperatively.

When the rSO₂ values decreased below 50%, I transfused a unit of blood when the rSO₂ values finally decreased below 50%, which resulted in a relatively immediate improvement in our values. We have strict protocols limiting transfusions and one of the criteria we use is the inability to maintain cerebral oximetry values greater than 50%, despite other optimization.

The values steadily improved after the transfusion, but we did not see a return to baseline values until we separated the patient from cardiopulmonary bypass. A slow return to baseline following separation from cardiopulmonary bypass can be attributed to rapid rewarming and the initiation of mechanical ventilation. In this case, I resumed the same protection strategies, including increased CO₂, 100% oxygen, slow rewarming, and continued vigilance for electrolyte and hematologic abnormalities. The values remained better than baseline and no further strategies were needed.

The patient was weaned from norepinephrine and milrinone within the first hour and was extubated less than 2 hours postoperatively. The patient was following commands within the first hour upon arrival to the ICU and progressed well with good cognitive outcomes. The patient was discharged on postoperative day 4.
Potential cost impact

Studies have documented the association of using cerebral oximetry during cardiac surgery with quantifiable decreases in ventilator time, ICU LOS, and hospital LOS. Aside from clinical and patient safety benefits, use of the INVOS™ system may also have favorable downstream cost impacts related to these factors. The adjacent figure uses published data sources on decreases in ventilator time (11.4 hours vs 14.7 hours)¹, ICU LOS (1.25 days vs 1.87 days)¹, and hospital LOS (6.81 days vs 8.79 days)⁸ associated with using cerebral oximetry during cardiac surgery (vs not using cerebral oximetry). Published data on the costs associated with each parameter were used to estimate potential cost savings.

Conclusions

The INVOS™ system is a valuable tool that facilitates timely intraoperative intervention to maintain adequate cerebral oxygen saturation and improve clinical outcomes. As demonstrated in the referenced publications, improvements in clinical outcomes result in decreased ICU and hospital lengths of stay, ultimately improving operational efficiency and allowing patients to resume normal, productive lifestyles sooner.