

## CEREBRAL OXIMETRY - REFERENCE LIST

### Cerebral Oximetry (Near Infrared Spectroscopy) Monitoring Improves Patient Outcomes

1. MacLeod DB, Ikeda K, Moretti E, Keifer JC, and Grocott H,

Department of Anesthesiology, Duke University Medical Center, Durham, NC, United States.

#### **Using the CAS Cerebral Oximeter to Estimate Cerebral Venous Oxygen Saturation**

Presented at the *ASA 2005*

- This study supports the feasibility of non-invasive NIRS S<sub>v</sub>O<sub>2</sub> as an estimate of cerebral tissue oxygenation during episodes of oxygen desaturation. There was a strong correlation with the global indices of tissue oxygen supply and demand, arterial and jugular bulb oxygen saturations respectively.

2. MacLeod DB, Ikeda K, Keifer JC, Moretti E, and Ames W,

Department of Anesthesiology, Duke University Medical Center, Durham, NC, United States.

#### **Validation of the CAS Adult Cerebral Oximeter during Hypoxia in Healthy Volunteers**

*Anesth Analg 2006*; 102:S162

“This study supports the feasibility of non-invasive NIRS S<sub>v</sub>O<sub>2</sub> as an estimate of cerebral tissue oxygenation during episodes of oxygen desaturation. There was a strong correlation with the global indices of tissue oxygen supply and demand, arterial and jugular bulb oxygen saturations respectively.”

3. Fischer GW, Reich D, Plestis KA, Griep RB

Departments of Anesthesiology and Cardiothoracic Surgery, Mount Sinai Medical Center, New York, NY, USA

#### **Results Utilizing Absolute Cerebral Oximetry Monitoring suggest the Need for Tailored Patient Management during Cardiac Surgery**

Presented at the *Outcomes 2006*: “The Key West Meeting”.

- The absolute cerebral oximeter (FORE-SIGHT™, CAS Medical Systems) could be used as a guide for patient management during cardiac surgery

4. Fischer GW, Reich D, Plestis KA, Griep RB

Departments of Anesthesiology and Cardiothoracic Surgery, Mount Sinai Medical Center, New York, NY, USA

#### **The Application of Absolute Cerebral Oximetry during Aortic Surgery**

Presented at the *ASA 2006*.

- “Cerebral oximetry provides continuous, real time monitoring brain oxygenation measurements during the absence of arterial pulsatility and cerebral perfusion, when other vital sign monitoring (i.e. pulse oximetry) cease to function. Our preliminary experience shows that absolute cerebral oximetry is useful in clinical settings to identify “catastrophic events” that may occur during the course of surgeries that would otherwise have been missed.”

5. Rais-Bahrami K, Rivera O, and Short BL

Department of Neonatology, Children's National Medical Center, Washington, DC, USA

#### **Validation of a noninvasive neonatal optical cerebral oximeter in veno-venous ECMO patients with a cephalad catheter**

- “We recommend the use of this noninvasive method (cerebral oximetry, FORE-SIGHT) as an alternative to blood draws for cerebral venous saturation measurements in neonates requiring extracorporeal life support.”

6. Casati A, Fanelli G, Pietropaoli P, Proietti R, Tufano R, Danelli G, Fierro G, De Cosmo G, Servillo G.

Department of Anesthesiology, Azienda Ospedaliera di Parma, Via Gramsci 14, 43100 Parma, Italy. [acasati@ao.pr.it](mailto:acasati@ao.pr.it)

**Continuous monitoring of cerebral oxygen saturation in elderly patients undergoing major abdominal surgery minimizes brain exposure to potential hypoxia**

*Anesth Analg.* 2005 Sep;101(3):740-7.

- Using cerebral oximetry monitoring to manage anesthesia in elderly patients undergoing major abdominal surgery reduces the potential exposure of the brain to hypoxia. This leads to shorter time to postanesthesia care unit (PACU) discharge and shorter hospital stay.
7. Orihashi K, Sueda T, Okada K, Imai K. *Eur J Cardiothorac Surg.* 2004 Nov;26(5):907-11.

Division of Cardiovascular Surgery, Hiroshima University Hospital, Kasumi 1-2-3, Minami-ku, Hiroshima, 734-8551 Japan. [orichan@hiroshima-u.ac.jp](mailto:orichan@hiroshima-u.ac.jp)

**Near-infrared spectroscopy for monitoring cerebral ischemia during selective cerebral perfusion.**

- “diffuse malperfusion can be avoided only by early detection of malperfusion, followed by immediate restoration of adequate perfusion before irreversible damage develops. Thus, for this purpose, sensitive, real-time monitoring of brain ischemia is needed.”
- “A sustained drop in rSO<sub>2</sub> during aortic surgery is closely related to the occurrence of neurological events following surgery. We recommend that recovery of drop in rSO<sub>2</sub> below 55% should be addressed without delay.”

8. Murkin JM.

University of Western Ontario, London, Ontario, Canada. [jmurkin@uwo.ca](mailto:jmurkin@uwo.ca)

**Applied neuromonitoring and improving CNS outcomes**

*Semin Cardiothorac Vasc Anesth.* 2005 Jun;9(2):139-42.

- “Cerebral hypoperfusion from unrecognized cerebral venous obstruction, inadequate mean arterial pressure, or from hypocapnic cerebral alkalosis can be identified by multimodality neuromonitoring using regional cerebral oxygen saturation and transcranial Doppler. Overall patient outcomes can be improved, and hospital length of stay shortened, by applied neuromonitoring techniques.”
9. Murkin JM, Iglesias I, Bainbridge D, Adams S, Schaefer B, Irwin B, Fox S, Novick RJ;

University of Western Ontario, London, Ontario, Canada

**Brain Oxygenation In Diabetic Patients During Coronary Surgery: A Randomized Prospective Blinded Study**

Presented at the *Outcomes 2005*: “The Key West Meeting”.

- “We demonstrated that avoidance of cerebral oxygen desaturation in actively rSO<sub>2</sub> monitored diabetic patients is associated with significantly improved length of stay outcomes and speculate that by avoiding cerebral desaturation overall tissue oxygenation and function is enhanced in diabetic patients undergoing CAB surgery.”
10. Baker RA, Kuring J, Hallsworth L, Knight JL.
- Department of Cardiac and Thoracic Surgery, Flinders Medical Centre and Flinders University, Bedford Park, Adelaide, South Australia, AUSTRALIA
- Prospective randomized evaluation of cerebral oximetry in adult cardiac surgical patients: clinical and oximetry outcomes.**
- Presented at the *Outcomes 2005*: “The Key West Meeting”.
- “These results support previous data suggesting a benefit associated for CABG surgery patients with cerebral oximetry.”

11. Goldman S, Sutter F, Ferdinand F, Trace C.

**Optimizing intraoperative cerebral oxygen delivery using noninvasive cerebral oximetry decreases the incidence of stroke for cardiac surgical patients.**

*Heart Surg Forum.* 2004;7(5):E376-81.

- “The treatment group, which underwent all cardiac surgeries with optimized cerebral oxygen delivery using cerebral oximetry monitoring, demonstrated a significantly lower incidence of permanent stroke.”

12. Edmonds HL Jr, Ganzel BL, Austin EH 3rd.

Department of Anesthesiology and Perioperative Medicine, University of Louisville School of Medicine, Louisville, Kentucky 40202-3619, USA. LHARVO@louisville.edu

**Protective Effect of Neuromonitoring during Cardiac Surgery**

*Ann. N.Y. Acad. Sci.* 2005;053: 12–19.

“In the absence of neuromonitoring, the expected incidence of serious brain injury is 6.1%. With neuromonitoring, the actual observed incidence was 3.0% (P = 0.03). The apparent improvement can be attributed primarily to a reduction in the number of nonembolic diffuse injuries.”

13. Hoffman GM,

Department of Anesthesiology and Critical Care Medicine, Children's Hospital of Wisconsin, Medical College of Wisconsin, Milwaukee, Wisconsin 53226, USA. [ghoffman@mcw.edu](mailto:ghoffman@mcw.edu)

**Neurologic monitoring on cardiopulmonary bypass: What are we obligated to do?**

*Ann Thorac Surg* 2006; 81:S2373-80.

- “Specific neurologic monitoring techniques that can be used during cardiopulmonary bypass include near-infrared spectroscopy, transcranial Doppler ultrasonography, and electroencephalographic techniques. Of these, only near-infrared spectroscopy provides a continuous quantitative signal of the physiologic variable most related to injury and most amenable to intervention.”

14. Sakamoto T, Duebener LF, Laussen PC, Jonas RA.

Department of Cardiac Surgery, Children's Hospital, Harvard Medical School, Boston, MA, USA.

**Cerebral ischemia caused by obstructed superior vena cava cannula is detected by near-infrared spectroscopy.**

*J Cardiothorac Vasc Anesth.* 2004 Jun;18(3):293-303.

- “SVC cannula obstruction causes cerebral ischemia with no change in blood pressure or venous oxygen saturation. In view of the difficulties and risks of CVP monitoring in babies, it is recommended to use other monitoring modalities such as NIRS to assess adequacy of cerebral perfusion if bicaval cannulation is used in neonates and infants.”

15. SH Han, CS Kim, C Lim, WH Kim

Department of Anesthesiology and Thoracic Surgery, Seoul National University Hospital, Seoul, Korea

**Obstruction of the Superior Vena Cava Cannula Detected by Desaturation of the Cerebral Oximeter**

*J Cardiothorac Vasc Anesth*, 2005

- “cerebral ischemia caused by SVC cannula obstruction could be detected with NIRS in our case. Without NIRS, the obstruction of the SVC could have been overlooked. In this regard, NIRS can be recommended as a routine monitor in pediatric cardiac anesthesia.”

16. Olsson C, Thelin S.

Uppsala University Hospital, Department of Surgical Sciences, Division of Cardiothoracic Surgery, Uppsala, Sweden.  
[christian.olsson@surgsci.uu.se](mailto:christian.olsson@surgsci.uu.se)

**Regional cerebral saturation monitoring with near-infrared spectroscopy during selective antegrade cerebral perfusion: diagnostic performance and relationship to postoperative stroke.**

*J Thorac Cardiovasc Surg.* 2006 Feb;131(2):371-9. Epub 2006 Jan 18.

- “Monitoring of regional cerebral tissue oxygen saturation by using near-infrared spectroscopy during selective antegrade cerebral perfusion allows detection of clinically important cerebral desaturation. It can help predict perioperative neurologic sequelae. Its performance as a diagnostic instrument is satisfying and supports its use as a noninvasive trend monitor of cerebral saturation.”

17. Murkin JM, Adams SJ, Novick RJ, Quantz M, Bainbridge D, Iglesias I, Cleland A, Schaefer B, Irwin B, Fox S

**Monitoring brain oxygen saturation during coronary bypass surgery: a randomized, prospective study.**

*Anesth Analg.* 2007 Jan;104(1):51-8.

Department of Anesthesiology and Perioperative Medicine, University Hospital-LHSC, University of Western Ontario, London, Ontario, Canada. jmurkin@uwo.ca

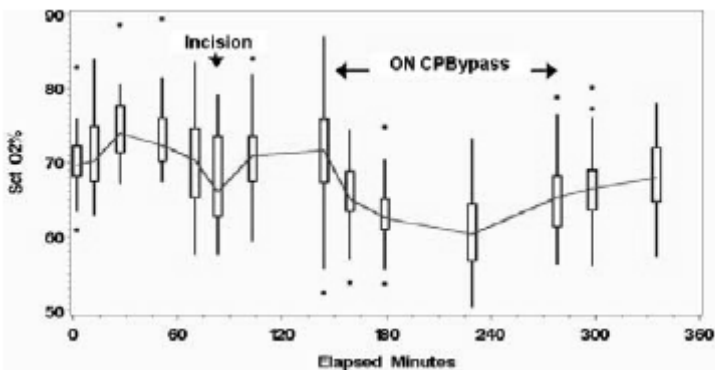
- **CONCLUSION: Monitoring cerebral rSO<sub>2</sub> in coronary artery bypass patients avoids profound cerebral desaturation and is associated with significantly fewer incidences of major organ dysfunction.**

18. **D. B. MacLeod, K. Ikeda, W. White, J. C. Keifer, E. Moretti;**  
**PILOT STUDY OF FORE-SIGHT CEREBRAL OXIMETER IN CARDIAC PATIENTS**

Duke University Medical Center, Durham, NC

*Anesth Analg* 2007; 104: S-129

- In this study, the median SctO<sub>2</sub> value of awake patients was 70%. **Awake SctO<sub>2</sub> variability was small (SD 3.9%) independent of age, skin color and gender.** The pre-CPB median SctO<sub>2</sub> 72% dropped to 60% during CPB before returning to 68% at chest closure. VS patients showed longer periods below all 3 thresholds of SctO<sub>2</sub> values.
- 33 patients



19. **Benni, P., Chen, B., Fenik, J. et.al.,**

**Cerebral and Pulse Oximetry Monitoring of Newborns – Clinical Observations**

CAS Medical Systems, Inc., Children’s National Medical Center, Washington, DC

*Abstract of a Poster Presented at the International Symposium on Innovations and Advancements in Monitoring Oxygenation and Ventilation (ISLAMOV 2007)*

- The FORE-SIGHT™ Cerebral Oximeter was used to monitor neonates undergoing veno-venous or veno-arterial ECMO.
- 30 subjects were studied with a total of >1200 hours of cerebral and pulse oximetry data collected.
- Conclusion: Pulse oximetry is often unreliable as an indicator of arterial blood oxygenation during low or zero perfusion events, especially during circulatory arrest due to diminished or non-existent pulsatile arterial blood flow. Pulse oximetry is not a direct indicator of cerebral tissue oxygen saturation. Cerebral oximetry offers a direct method to measure cerebral tissue oxygen saturation and potentially predicts brain injury caused by an impaired balance between cerebral oxygen supply and demand. These results demonstrate the value of cerebral oximetry to monitor the effectiveness of CPR in situations in which pulse oximetry is unreliable. Cerebral oximetry is a promising modality for bedside monitoring in the NICU and is complementary to pulse oximetry.