Tissue Oximetry for Skeletal Muscles - Barth Syndrome Focus

Washington University’s School of Medicine - St. Louis, MO

W. Todd Cade, PT, PhD of Washington University’s School of Medicine in St. Louis, MO is working on improving the lives of individuals affected with Barth Syndrome: a rare, genetic disorder of metabolism primarily affecting males. Some characteristics of the condition are growth delay, severe mitochondrial dysfunction, and impaired ability to extract and use oxygen needed by both skeletal and cardiac muscle, causing severe exercise intolerance. Based on preliminary data collected in 2008, Dr. Cade developed a theory that supervised aerobic exercise training might improve muscle function and quality of life. He is currently enrolling patients in a study to investigate this idea, thanks to a $40,000 grant from the Barth Syndrome Foundation.

Initial biologic measurements were taken on affected adolescents and young men during cycling, including FORE-SIGHT Tissue Oximeter measurements on both the brain and quadriceps skeletal muscle. These values were compared with values from their brothers, who were used as healthy controls (Figure 1). Although the Barth-affected individuals were not able to exercise as long due to fatigue, the brain saturations were similar in both groups, showing a slight decrease at peak exercise followed by a slight increase during rest. The skeletal muscle saturation showed a marked difference. The healthy subjects showed a decrease in saturation as demand for oxygen increased. However the Barth patients displayed an increase in StO2 during exercise. This response is possibly due to an increase in blood flow to the area due to arterial vasodilation, combined with the inability to efficiently extract and utilize oxygen. These NIRS muscle measurements confirmed Barth Syndrome’s characteristic exercise intolerance.

After preliminary data were collected, adolescents and young men enrolled in the study trained for 20-45 minutes, 3 times a week, for 12 continuous weeks at a physical therapy facility near the patients’ homes. So far, three patients have been enrolled in the study with promising results. Post-training testing shows an improvement in patients’ FORE-SIGHT derived skeletal muscle oxygen extraction as well as an increase in exercise tolerance. The information learned from this study may benefit others by helping to understand other mitochondrial muscle diseases and adult heart failure. Dr. Cade plans to enroll one more subject in this pilot study and use this encouraging data to apply for a larger grant.

Citation:

Figure 1: Subjects (both Barth Syndrome and controls) exercised on a cycle ergometer with increasing work rate until deliberate exhaustion. Barth Syndrome subjects were not able to exercise as long as the controls did as shown with the gap in data at 100W.
**Q & A**

**FORE-SIGHT at Memorial Regional Hospital**

Dr. Robert Brooker is Chief of Cardiac Anesthesia at Memorial Regional Hospital in Hollywood, FL.

Robert F. Brooker, MD

**Q: How was FORE-SIGHT (FS) Absolute Tissue Oximetry implemented in your facility?**

A: The cerebral oximetry monitoring system we were using was not working well and our group was looking for a more accurate monitor for assessing cerebral perfusion. I had read about the development of the technology employed in the CASMED system. It is a significant improvement over our old monitor.

**Q: Is FS an essential part of your intervention protocols?**

A: Yes. Cerebral oximetry is an important component of our monitoring system to ensure adequate cerebral blood flow. As such, it is used to aid in decisions regarding perfusion pressure, perfusion flows, and when transfusion of blood maybe appropriate. During carotid endarterectomy it is used selectively by some surgeons to stratify the need for carotid shunting.

**Q: Would you recommend the FS Technology to your peers? What would you say to them?**

A: I certainly would recommend this technology to my peers. The cerebral oximeter has played an important role in our surgical team’s efforts to reduce neurologic injury and unnecessary transfusion of blood during cardiac surgery. We have come to rely on the monitor for any procedure in which the adequacy of cerebral blood flow is uncertain. The key is that the FORE-SIGHT Tissue Oximeter provides reliable data.

**Recently Published Abstract - Debut at ASA 2011**

**Performance of 5 Cerebral Oximeters During Hypoxia in Healthy Volunteers**

*Summary by CASMED*

<table>
<thead>
<tr>
<th>FORE-SIGHT</th>
<th>INVOS</th>
<th>NIRO-200NX</th>
<th>EQUANOX Classic</th>
<th>EQUANOX Advance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prec (±1SD)</td>
<td>3.90</td>
<td>9.72</td>
<td>9.64</td>
<td>8.12</td>
</tr>
<tr>
<td>Bias</td>
<td>-1.73</td>
<td>-0.05</td>
<td>1.23</td>
<td>-2.48</td>
</tr>
<tr>
<td>A rms</td>
<td>4.26</td>
<td>9.69</td>
<td>9.68</td>
<td>8.47</td>
</tr>
</tbody>
</table>

Table 1: Precision, Bias, and A rms of FORE-SIGHT compared to competitive technologies. Bias is presented as [Reference CX - Measured Value].

In the first independent study of its kind, the authors looked at simultaneous measurements from five near-infrared spectroscopy (NIRS) cerebral oximeters: FORE-SIGHT™ (CAS Medical Systems, Branford, CT, USA), INVOS® 5100C (Covidien, Boulder, CO, USA), EQUANOX™ Model 7600 (Nonin Medical, Plymouth, MN, USA) with both EQUANOX Advance™ and EQUANOX Classic™ sensors, and NIRO-200NX (Hamamatsu Photonics, Hamamatsu City, Japan) on adult volunteers. The device readings were directly compared against the commonly used invasive standard of weighted CO-oximetry jugular bulb and arterial oxygen saturation values during episodes of deliberate oxygen desaturation. All of these monitors have FDA clearance with the exception of the NIRO-200NX which has CE Marking. The results demonstrate that the FORE-SIGHT monitor has the greatest precision (3.90) for measuring absolute changes in cerebral tissue oxygen saturation. This result is consistent with two previously published validation studies which showed precisions of 3.70 and 3.12.

**Citation:**

I was in Amsterdam a few months ago for the ESA and EuroSIVA annual meetings, when, during a dinner, I tried to guess how much oxygen was circulating in the brain of the other guests after a delicious sauvignon blanc with a grilled hake fillet. Hard task if we had to use a non-absolute brain oximeter (i.e., not a FORE-SIGHT)! During prior years, those who wanted to non-invasively monitor brain oxygenation had to establish a baseline and manage therapy accordingly. That extra analysis was clearly a limitation for ICU patients and during surgery, especially when sudden events occur. Recently, we compared readings from two different FORE-SIGHT monitors on the same patient undergoing spine surgery. With the first FORE-SIGHT, we started to monitor before induction of intravenous anesthesia (propofol and remifentanil!) while the patient breathed room air. The second FORE-SIGHT was started after stable anesthesia with controlled ventilation and breathing 100% oxygen. The readings were similar and are proof of the consistent accuracy and reproducibility of FORE-SIGHT values. In my mainly neuroanesthesia clinical practice, FORE-SIGHT has been essential for detecting and responding to cerebral ischemic events. Brain trauma and Neuro ICU care, temporary clipping of cerebral arterial circulation, "controlled" hyperventilation, carotid surgery and spine surgery during positioning in prone or "Jack-Knife" positions, are examples of procedures or events with high risk of brain ischemia. These procedures can be associated with poor outcomes if early detection and prompt interventions are not taken. I highly recommend the use of FORE-SIGHT to provide a window over the at-risk brain. In summary, either for research or patient management, my practice definitely improved after use of FORE-SIGHT, with clearly improved outcomes for my patients.

The Need for and Routine Use of Absolute Tissue Oximetry

Although Jöbsis introduced the first transcranial near infrared spectroscopy (NIRS) nearly 35 years ago, it was only recently that NIRS became a standard for monitoring brain metabolism. In 1999, we brought NIRS into clinical practice at the Maastricht University Medical Centre. During the ensuing years, the acceptance of NIRS has evolved from complete scepticism of the first-generation devices to full enthusiasm with the FORE-SIGHT Absolute Tissue Oximeter.

Murkin et al. performed an elegant randomized, prospective study in coronary artery bypass surgery. They showed that by using cerebral rSO2, to avoid profound cerebral desaturations, there were significantly fewer incidences of major organ dysfunction. Yao et al. performed a prospective observational study in a similar patient population and concluded that cerebral oxygen desaturation is associated with early postoperative neuropsychological dysfunction. Next, Heringlake et al., in a prospective study of 1,178 patients, found that a preoperative cerebral SctO2 ≤ 50% is an independent predictor of short- and long-term mortality in patients undergoing on-pump cardiac surgery. Finally, and owing to the improved NIRS accuracy of the FORE-SIGHT Absolute Tissue Oximeter, Fischer et al. demonstrated specific lower threshold values in combination with exposure time that were associated with severe outcomes. Commenting on the advancements found in FORE-SIGHT, Dr. Fischer concluded, “A potential advantage of absolute brain tissue oxygenation is that threshold values may be more strongly associated with adverse outcomes than trends.”

Maastricht University Medical Centre was the first hospital in the Netherlands to use FORE-SIGHT Absolute Cerebral Oximetry for routine monitoring of all cardiac surgical patients (>1000/year). Today, thanks to recent developments and studies of NIRS, perfusionists finally have a powerful monitor to optimize intraoperative cerebral protection.

Citations:

The Netherlands

Accuracy & Reproducibility

by Francisco A. Lobo, MD
Anesthesiology Department, Division of Neuroanesthesia
Pharmaeria - Research Center, Hospital Geral de Santo António, Porto – Portugal

In my clinical practice, the number of patients at high-risk for postoperative neurologic injuries has increased dramatically over the past 10 years. The FORE-SIGHT cerebral oximeter provides the clinician with immediate access to absolute measurements of cerebral oxygenation. Early detection of cerebral desaturation events allows for prompt interventions, which may enhance recovery and reduce adverse postoperative events. We use the FORE-SIGHT device in patients undergoing beach chair position surgery. Many patients have cerebral desaturation events that occur in the absence of other hemodynamic changes; such events would otherwise be undetected without FORE-SIGHT monitoring. We believe that early detection and treatment of cerebral desaturation events may reduce the risk of neurocognitive dysfunction after surgery, and may also decrease the occurrence of rarer catastrophic neurologic injuries like stroke.

Glenn S. Murphy, MD
Director of Cardiac Anesthesia and Clinical Research
Clinical Associate Professor
NorthShore University HealthSystem
University of Chicago
Pritzker School of Medicine
Evanston, IL

Standard of Care at NorthShore University HealthSystem
Upcoming Conferences in 2011 - 2012

For a full list of our upcoming conferences, please visit our website www.casmed.com

Oct 14 - 16  Pennsylvania State Perfusion Society, King of Prussia, PA, USA
Oct 14 - 19  American Society of Anesthesiologists (ASA), Chicago, IL, USA
Dec 10 - 12  65th PostGraduate Assembly in Anesthesiology (PGA), New York, NY, USA
  • Dr. Steven Greenberg will be presenting “The Perioperative Use of Cerebral Oximetry”
Dec 11 - 14  Update on Neuromonitoring, Rome, Italy
  • Dr. Mike Hartley will be presenting “NIRS in Surgical Patients”
Jan 15 - 20  30th Annual Symposium: Clinical Update in Anesthesiology, Surgery and Perioperative Medicine, Rio Grande, Puerto Rico
Jan 18 - 20  Society for Technology in Anesthesia (STA), Palm Beach, FL, USA
Jan 24 - 28  7th International Conference on Brain Monitoring and Neuroprotection in the Newborn, Clearwater Beach, FL, USA
Jan 29 - 31  The Society for Thoracic Surgeons, Fort Lauderdale, FL, USA
Feb 12 - 15  41st Annual Meeting of the German Society for Thoracic and Cardiovascular Surgery (GSTCVS), Freiburg, Germany
Feb 16 - 18  Sanibel Symposium, Fort Myers, FL, USA
Feb 16 - 18  7th International Update on Interdisciplinary Neuroscience - EURO-NEURO Meeting, Vienna, Austria
Feb 17 - 19  The 7th Annual Canadian Winter Cardiac Team Meeting, Quebec, Canada
Feb 18 - 21  12th Annual International Symposium on Congenital Heart Disease, St. Petersburg, FL, USA
Feb 23 - 26  Society for Pediatric Anesthesia Winter Meeting, Tampa, FL, USA
Feb 29 - Mar 4  32nd Annual Cardiothoracic Surgery Symposium (CREF), San Diego, CA, USA
Mar 11 - 16  SCA 17th Annual Update on Cardiopulmonary Bypass, Aspen/Snowmass Village, CO, USA
Mar 25 - 30  15th World Federation of Societies of Anesthesiologists (WFSA)/World Congress of Anesthesiologists, Buenos Aires, Argentina
Mar 28 - 31  AmSECT International Conference, Orlando, FL, USA

We had a great response to our first “Absolute News” earlier this year, and hope that you found the articles here in our second issue helpful to your practice.

If you have a suggestion or idea or if you would like to be considered for an article submission in CASMED’s Absolute News, please call 203.315.6953 or email us at fore-sight@casmed.com