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ABSOLUTE NEWS

ISSUE 4 SPRING 2013

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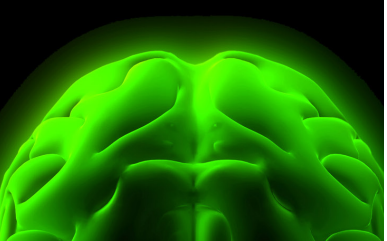

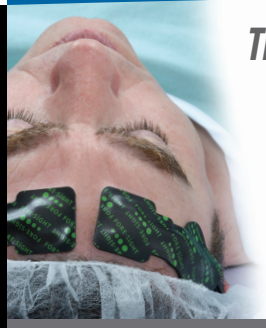

This issue:

FORE-SIGHT: Recently Published Articles:

FORE-SIGHT: First to Detect Cerebral Malperfusion During Peripheral Bypass

Jonathan D. Leff, M.D.

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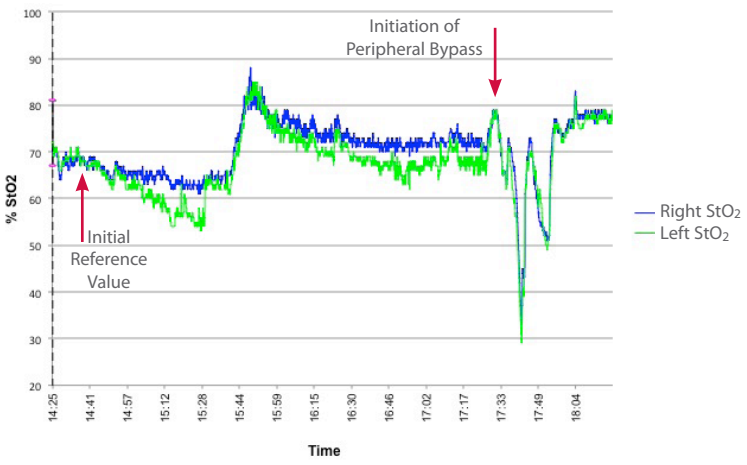
The use of cerebral oximetry to detect potentially devastating cerebral desaturation is well established. We describe a case in which the **FORE-SIGHT (CAS Medical Systems, Inc., Branford, CT) cerebral oximeter was the first monitor to detect cerebral malperfusion during peripheral bypass.** A 45 year-old female with a history of hypertension and morbid obesity (BMI of 41) had undergone multiple neck surgeries including thyroidectomy and a healed tracheostomy. Her otolaryngologist determined that her tracheal stenosis had worsened. Previous attempts to secure her airway with tracheostomy were unsuccessful secondary to distorted neck anatomy and difficult positioning because of dyspnea while supine. Fiberoptic bronchoscopy revealed tracheal narrowing that precluded general anesthesia with endotracheal intubation. Consensus was that femoral bypass would provide the safest approach for tracheostomy. In the operating room, the cardiothoracic surgeon secured a femoral venous and an arterial cannula via cut-down. The patient was monitored with standard ASA monitors, an arterial catheter, and the FORE-SIGHT cerebral oximeter. After induction of general anesthesia, a perfusionist initiated peripheral bypass with appropriate arterial flow and a mean arterial pressure of 80mmHg. The arterial oxygen saturation (SaO_2) registered at a 100% on the bypass machine. Three minutes after initiation of bypass, the cerebral oximeter precipitously dropped from the initial value of 72 to 30 on both the left and right cerebral channels (Figure 1). The team immediately verified our cannulation sites and pump flows. Approximately 2 minutes after cerebral desaturation appeared, the left digital pulse oximeter revealed desaturation from 100% to 50%. Face mask ventilation with 100% oxygen was initiated and both cerebral saturation and SpO_2 returned to acceptable values. The tracheostomy was successfully completed using facemask ventilation without the use of peripheral bypass.

This case highlights a potential complication that may occur during peripheral bypass. During femoral artery and vein cannulation, the upper body and cerebral circulation undergo retrograde perfusion. If the drainage through the venous femoral line is inadequate and cardiac output is high, antegrade (deoxygenated) flow competes with retrograde (oxygenated) flow. The perfusionist was measuring SaO_2 at a lower extremity cannulation site and was unaware that arterial desaturation was occurring in the upper body. The **FORE-SIGHT monitor allowed for rapid diagnosis of this problem, providing the team precious time needed to troubleshoot the system and to take appropriate action. The cerebral oximeter was the first monitor to detect an abnormality in cerebral oxygenation and should be used in every case where cerebral perfusion is potentially compromised.** Our patient underwent this high-risk procedure and recovered without neurologic deficit. In our practice, we believe that near infrared spectroscopy often provides the earliest indication of cerebral hypoperfusion and allows us to initiate analysis and intervention in a timely manner.

Figure 1



Northern State Medical University, Arkhangelsk, Russian Federation

Russian Federation

Absolute Tissue Oximetry in Valve Surgery: Is Normothermia better for Cerebral Oxygenation?[1]

By Andrey Lenkin, MD
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Cardiac surgery performed with cardiopulmonary bypass (CPB) is often associated with postoperative neurocognitive dysfunction. For a long time, hypothermia has been considered as an effective method for reducing potential brain damage during CPB. However, along with its beneficial effects, hypothermia has a negative impact on the autoregulation of cerebral blood flow that can promote neurological morbidity after surgery. Monitoring of cerebral blood flow and oxygenation allows us to evaluate the metabolic status of the brain in real-time. For these purposes, among different monitoring techniques used in cardiac surgery, cerebral oximetry can be especially useful. Cerebral tissue oxygen saturation ($SctO_2$) is calculated by determining the local ratio of oxygenated hemoglobin to total hemoglobin at the microvascular level (arterioles, venules and capillaries) in the region of interest. Several studies have shown that intraoperative use of cerebral oximetry, followed by goal-directed therapeutic interventions, is able to reduce the incidence of neurocognitive deficit and shorten the duration of postoperative respiratory support, time in intensive care and length of hospital stay. However, the influence of different temperature regimens on cerebral oxygenation during CPB has not yet been established. Moreover, the relationship between cerebral oxygenation and main determinants of oxygen transport in different clinical settings is still a subject for debates.

In a prospective, Ethics Committee approved study, we randomized 40 adult patients with combined valvular disorders requiring CPB for surgical correction of two or more valves into two groups: (1) a normothermic group (n = 20), in which the body core temperature was maintained at 36.6ºC during CPB and (2) a hypothermic group (n = 20), in which the body was cooled to a core temperature of 32ºC throughout the period of CPB. In addition to systemic oxygen transport variables, $SctO_2$ was assessed by means of a FORE-SIGHT cerebral oximeter.

The results of our study showed that central venous oxygen saturation was significantly higher in the hypothermic group, but $SctO_2$ was increased in the group receiving normothermic CPB (Table 1).[1] Throughout the study, there were positive correlations between the values of $SctO_2$ and cardiac index, central venous oxygen saturation and oxygen delivery index.[2]

These findings allowed us to conclude that during combined valve surgery, normothermic CPB provides lower central venous oxygen saturation, but increases cerebral tissue oxygenation as compared to the hypothermic regimen. In complex valve surgery and postoperatively, cerebral tissue oxygenation correlates with parameters of oxygen transport, thus it can reflect dysbalance between oxygen delivery and consumption during perioperative period and hypoperfusion during CPB. Independently from the regimen of CPB, cerebral oxygenation, as well as parameters of oxygen transport, may help guide early goal-directed therapy during cardiac surgery and in the early postoperative period. The influence of improved $SctO_2$ during normothermic CPB on cognitive function warrants further investigation.

References:

1. Lenkin A, Zaharov V, Lenkin P, Smetkin A, Bjertnaes L, Kirov M. Normothermic cardiopulmonary bypass increases cerebral tissue oxygenation during combined valve surgery: a single-centre, randomized trial. *Interactive CardioVascular and Thoracic Surgery* 2013: 1–7 doi:10.1093/icvts/ivt016.
2. Kirov M, Lenkin A, Zaharov V, Paromov K, Smetkin A. Relationship of cerebral oxygenation and oxygen transport in complex valve surgery. Presented at the 15th WFSA World Congress of Anaesthesiologists as paper #235.00. *BJA* 2012:108 (S2): ii114–ii115.

Data		Onset of CPB	30 min	60 min	90 min	120 min
$SctO_2$,%	Normothermic group	66 (63–70) *	71 (68–74) †	71 (69–75) *†	73 (69–75)* †	74 (69–77)* †
	Hypothermic group	63 (60–67)	69 (66–73) †	67 (62–73)	67 (62–72)	64 (60–67)

Data are presented as median (25^{th}–75^{th} percentiles). *$p < 0.05$ between the groups; †$p < 0.05$ compared with intragroup baseline.

Table 1: Cerebral oxygenation during cardiopulmonary bypass.

FORE-SIGHT: Recently Published Articles

Summaries by CASMED

Cerebral oxygen saturation: graded response to carbon dioxide with isoxia and graded response to oxygen with isocapnia.

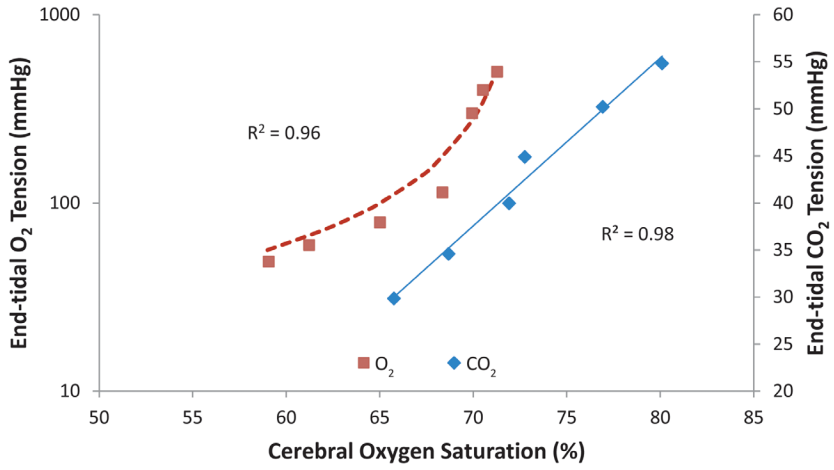
This study at the University Health Network of the University of Toronto observed how changes in carbon dioxide and oxygen affect cerebral oxygen saturation (StO_2). Each of 12 healthy volunteers breathed precisely-controlled gas mixtures of end tidal CO_2 and O_2 through a facemask for two stages: the first modified end-tidal CO_2 in sequential steps while maintaining O_2 and the second increased and decreased O_2 under isocapnia (i.e. constant, normal $PaCO_2$ levels).

The FORE-SIGHT monitor used in this study to measure StO_2 had very consistent output, showing a linear correlation with CO_2 and a log-linear correlation with changes in O_2 (Figure 2). Hypercapnia increased StO_2 more than hyperoxia (77 ± 3 vs 73 ±3%). The study suggests the potential for using modest hypercapnia to improve cerebral saturation while using patient monitors, including cerebral oximetry. There is potential for using FORE-SIGHT measurement to determine patient-specific O_2 and CO_2 curves in order to individualize the optimization of cerebral oxygen saturation.

Citation:

Mutch WA, Patel SR, Shahidi AM, Kulasekara SI, Fisher JA, Duffin J, Hudson C. *PLoS One.* 2013; 8(2):e57881.

Figure 2



Upcoming Conferences in 2013

For a full list of our upcoming conferences where FORE-SIGHT will be represented, please visit our website: www.casmed.com

April 6 Society of Cardiovascular Anesthesiologist (SCA) 35th Annual Meeting, Miami Beach, FL

- CASMED's Cerebral Oximetry Clinical Education Program: **"Cerebral Oximetry: Current Uses and Evolving Concepts in the Care of the Cardiac Patient"** Presenters: Hilary P. Grocott, MD and Alexander Mittnacht, MD

May 4 AUS NZ College of Anaesthetists (ANZCA), Melbourne, Australia

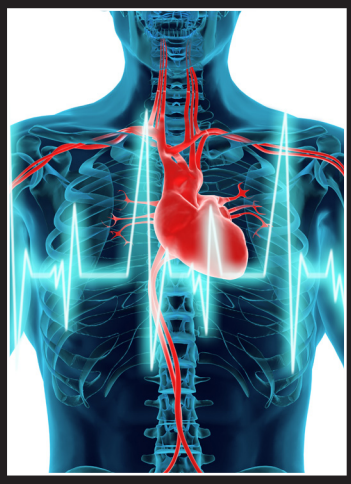
May 16 Mechanisms of Perfusion, Orlando, FL

June 1 Euroanesthesia 2013 (ESA), Barcelona, Spain

June 6 Annual European Association of Cardiothoracic Anesthesiologists (EACTA), Barcelona, Spain

June 7 Florida Society of Anesthesiologists, Palm Beach, FL

June 16 Duke 16th Annual Cardiothoracic Update and TEE Meeting, Hilton Head, SC



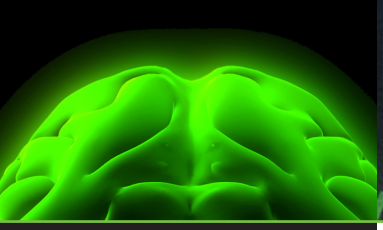
Excerpts from:

Percutaneous Hemodynamic Support With Impella 2.5 During Scar-Related Ventricular Tachycardia Ablation (PERMIT 1).

Miller MA, Dukkipati SR, Chinitz JS, Koruth JS, Mittnacht AJ, Napolitano C, d'Avila A, Reddy VY. *Circ Arrhythm Electrophysiol.* 2013; 6(1):151-9.

"When a cerebral oximetry desaturation threshold of 55% was used as an arbitrator of hemodynamic stability during percutaneous left ventricular assist device support, rather than the standard mean arterial pressure (MAP) criteria of <50 mm Hg, ventricular tachycardia (VT) was maintained for significantly longer periods of time."

"Cerebral oximetry is a complimentary monitoring modality during scar VT ablation, and avoidance of cerebral desaturations below a threshold of 55% may safely guide the duration of mapping during unstable VT."



FORE-SIGHT: Recently Published Articles

Summaries by CASMED

An accurate insight into brain oxygenation

"The current availability of reliable, absolute tissue oximetry makes this parameter a valuable addition to today's anesthesia practice. In caring for critically ill patients, it has become clear to me that this data can provide significant information to guide my clinical decision making, information that is not necessarily available via our routine monitoring regimen. As one who is trained in various neuro-monitoring techniques, I value having cerebral tissue oxygenation measurements to provide the added indication of brain tissue "environment", as opposed to conduction or EEG based techniques which indicate neural "function" in that environment. This "environmental" parameter does not always correlate with peripheral oxygen saturation so a pulse oximeter may not indicate neural compromise. As an indicator of absolute cerebral oxygen saturation, I have found the ***FORE-SIGHT tissue oximeter to be the most reliable tool for this purpose.****"*

Mark Mathews, MD

Scottsdale Healthcare Shea, Scottsdale, Arizona

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Visit us at **www.casmed.com**. Click on the "FORE-SIGHT Clinical Corner" for notes on recently published papers.

Cerebral desaturation events in the intensive care unit following cardiac surgery.

Many studies have found cerebral desaturation events (CDEs) intra-operatively, but no studies have attempted to quantify if these patients with hemodynamic instability leading to poor cerebral perfusion have continued CDEs in the intensive care unit. This observational study was undertaken to quantify the incidence of CDEs ($SctO_2$ <60% for greater than 60 seconds) in the immediate postoperative period following cardiac surgery.

On fifty-three moderate to high risk patients, continuous measurement of **bilateral $SctO_2$ was recorded with FORE-SIGHT (CAS Medical Systems, Inc) intra-operatively and for the first 6 hours of the postoperative period or until extubation. Cerebral desaturations were common in both the postoperative and intraoperative periods, occurring in 53% and 57% of patients, respectively.** The vast majority of patients (96%; Table 2) who had postoperative CDEs also had intraoperative CDEs (P <.0001) with 64% of these CDEs lasting longer than 1 hour. When grouping patients by presence (n=28) or absence of CDE (n=25), all patients who died or had postoperative nausea and vomiting (PONV) also had a CDE although this trend did not reach significance. Patients with low peripheral oxygen saturation (SpO_2) did not necessarily have low cerebral saturation.

No obvious correlation was found between physiologic parameters and CDEs, however 96% of patients in the CDE group also had at least 1 abnormality in readings for MAP, CI, or $ETCO_2$ while 92% of these patients had more than 2 abnormalities.

This study was the first to observe and find a high incidence of CDEs in the immediate postoperative period, while finding similar rates of intraoperative CDEs to previously published studies. This data suggests that moderate to high risk cardiac surgical patients are at continued risk for low cerebral perfusion after surgery, especially since most of the CDEs lasted longer than one hour. This observational study was inadequately powered to see statistically significant differences between groups, so additional larger studies are needed to understand if patients with CDEs have worse outcomes and would benefit from more monitoring.

Citation:
Greenberg SB, Murphy G, Alexander J, Fasanella R, Garcia A, Vender J. *J Crit Care.* 2012 Nov 14. [Epub ahead of print]

	CDE	No CDE	P
Percentage of Patients	53%	47%	
Intraoperative CDE	96%	12%	* <.0001
PONV	14%	0%	0.113
In-hospital Mortality	18%	0%	0.053
Low SpO_2 (80s)	18%	24%	0.737

Table 2: Moderate to high risk cardiac surgical patients separated into 2 groups corresponding to CDE or no CDE. *difference between groups reached significance

Relation between mixed venous oxygen saturation and cerebral oxygen saturation measured by absolute and relative near-infrared spectroscopy during off-pump coronary artery bypass grafting.

Mixed venous oxygen saturation ($SmvO_2$) is considered a reliable indicator of systemic oxygen delivery. Because of its invasive nature, $SmvO_2$ is not routinely monitored. Some prior studies showed that $SctO_2$ measured by NIRS showed poor correlation with $SmvO_2$. The authors hypothesized that this poor correlation could have been because of a) a lag time between changes in oxygen levels as measured by $SmvO_2$ at the pulmonary artery and by NIRS in the brain, or b) limitations related to the specific NIRS technology used in the earlier study.

On 42 OP-CABG (off-pump coronary artery bypass grafting) patients, continuous measurements of $SctO_2$ were recorded with both FORE-SIGHT (CAS Medical Systems, Inc.) and INVOS (Covidien) monitors along with $SmvO_2$ and MAP for a total of 8,338 collected data pairs (Figure 3).

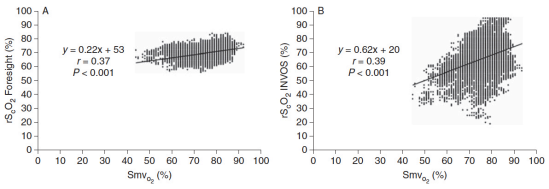

Figure 3: Correlation analysis of all collected data pairs (n=8338) demonstrating a correlation between mixed venous oxygen saturation ($SmvO_2$) and regional cerebral oxygen saturation ($rScO_2$) for FORE-SIGHT (A) and INVOS (B).

There was a time delay discovered, with $SmvO_2$ lagging behind $SctO_2$ by 19 seconds with FORE-SIGHT and 18 seconds with INVOS. Once this lag time was accounted for, there was a median correlation coefficient of r=0.73 for FORE-SIGHT and r=0.72 for INVOS for each subject. The correlations between MAP and $rScO_2$ were r=0.72 for FORE-SIGHT and r=0.77 for INVOS, with no time delay between the two measurements. Absolute values between the two devices differed significantly, with 4% lower mean values obtained with INVOS (66% vs. 70%) and spread over a greater range than FORE-SIGHT (28-95 vs. 58 to 89).

The data suggest that $SctO_2$ monitoring might be a reliable alternative to invasive mixed venous oxygen monitoring. NIRS cerebral measurements promptly respond to MAP variations in acute hemodynamic changes without the 18-19 second delay in $SmvO_2$ that may be due to the additional circulation time to the lower body. Both FORE-SIGHT and INVOS data exhibited similar correlations with $SmvO_2$and MAP, but the magnitude and spread of $SctO_2$ variations differed.

Citation:
Moerman A, Vandenplas G, Bové T, Wouters PF, De Hert SG. *Br J Anaesth.* 2013;110(2): 258-65.

NOTE: These summaries were created by CAS Medical Systems Inc. Any views expressed above are those of CASMED and do not necessarily reflect those of the authors or publications referenced.

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