Continuous Cerebral Oximetry Patient Monitoring During Post-Operative Transport Identifies Desaturation

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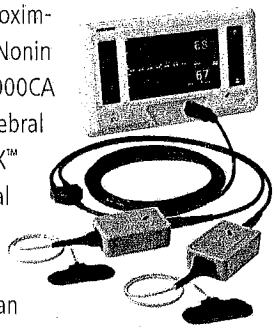
Anamnesis. A male patient, age 73 years, presented to the hospital following angina pectoris and was admitted. Cardiac examination indicated that a coronary artery bypass graft (CABG) was required. Pertinent medical history included hypertension. Routine pre-operative duplex and transcranial Doppler ultrasound examination revealed complete blockage of the left internal carotid artery but patent intracranial collaterals. The patient was deemed to be of significant risk of cerebro-vascular incidence and subsequent neurocognitive dysfunction. Cerebral oximetry monitoring was ordered for the peri-operative and post-operative period through extubation.

Cerebral Oximetry Monitoring. Cerebral oximetry monitoring was conducted using the Nonin Model 7600 NIRS regional oximetry with 8000CA sensor. The latest advancement in cerebral oximetry, this system is based on EQUANOX™ dual-emitter architecture, enhanced signal processing and computational algorithms, which deliver quicker, and more consistent and accurate measurements than traditional cerebral oximetry products.



Pre-operative. The EQUANOX cerebral sensors were placed prior to anesthetic interventions after cleaning and drying the skin. Sensors were placed bilaterally, lateral to the sagittal sinus. Baseline cerebral oxygenation levels were established and noted to be slightly lower on the left hemisphere (65%) which had the complete ICA blockage as compared to the right (70%). *(Table 1)*

Prior to the start of surgery, thresholds for intervention were defined by the attending anesthesiologist as 55% for the left and 60% for the right, representing a change from baseline of 10 points. The intervention threshold was made by the anesthesiologist based on prior NIRS oximetry experience and published literature on patient outcomes.[1] The baseline reference values and alarm limits were entered into the Model 7600 system to assure audible and visual warning if the thresholds were crossed during monitoring.

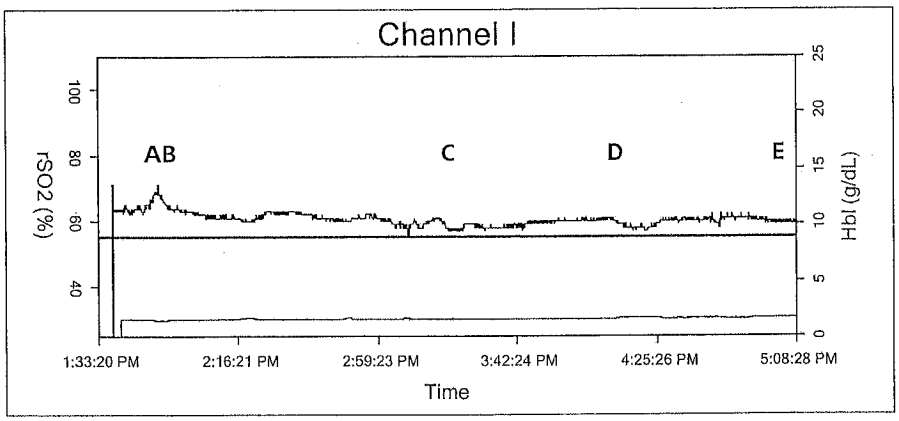
Table 1

	Hemisphere	Baseline (Pre-intervention)	Threshold for Intervention
Channel I	Left	65	55
Channel II	Right	70	60

Peri-operative. In the operative suite, the Model 7600 was installed adjacent to the anesthesia monitoring screen to allow simultaneous visual observation throughout the case. The patient was transferred to the operating table and prepped for intubation. The patient was administered 100% oxygen and intubation was achieved at 13:48. An initial increase in cerebral oxygenation was observed *(Figure 1, B)*.

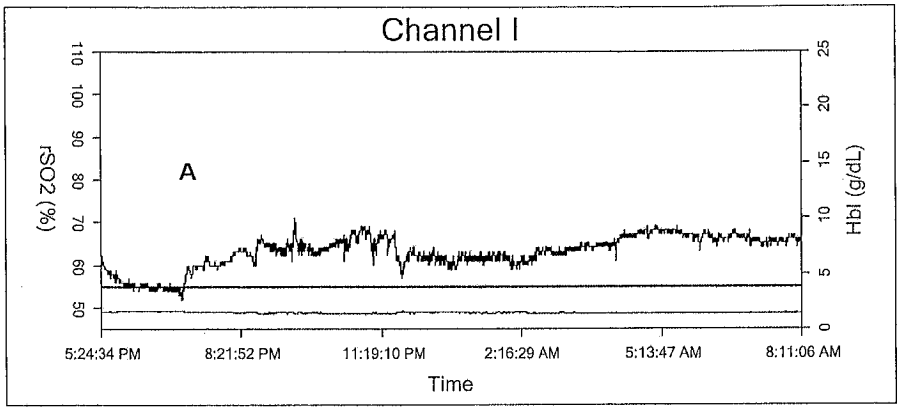
The surgical case was without incident. The patient was on cardiopulmonary bypass for 56 minutes. Throughout the surgery cerebral oxygenation was stable with no significant desaturation events in either hemisphere. Closure was completed at 17:08 (3 hours, 16 minutes from intubation through closure).

Figure 1: Peri-Operative Monitoring of Left Hemisphere



A: Pre-induction baseline
B: Intubation with 100% O_2
C: Cardiopulmonary bypass initiated
D: End of cardiopulmonary bypass
E: Closure complete

Figure 2: Post-Operative Monitoring of Left Hemisphere



A: Desaturation, O_2 increased

Post-operative. Continuous cerebral monitoring through post-operative recovery was ordered due to the high risk of cerebral vascular incidence as a result of the carotid disease. The cerebral sensors remained in place and monitoring was not interrupted post-operatively. The Model 7600 monitor was positioned on the patient bed during transport, providing continuous monitoring during the critical time of transfer to the ICU. During this transfer into the ICU, the cerebral oxygenation in the left hemisphere decreased to 55% resulting in device alarms. Based on the cerebral oximetry findings, the ICU nurse intervened with an increase in O_2, as sanctioned by both the attending intensivist and cardiothoracic anesthesiologist. The cerebral oxygen level of the left side responded and returned to baseline values. *(Figure 2, A)*

Cerebral oximetry monitoring was maintained throughout the post-operative period until extubation at 08:11 post-operative Day 1, 15 hours post-operatively. The total monitoring time was 18 hours, 44 minutes. Following extubation, the patient remained stable and showed no clinical signs of neurocognitive defects. The patient was discharged from the hospital on post-operative Day 6.

Discussion. Continuous cerebral oximetry throughout the post-operative course, including transport from the operating suite to recovery or ICU, can be critical in high risk patients. This case report describes the observation of a clinically relevant desaturation occurring during this critical time. The ability to maintain monitoring during transportation and transfer resulted in identification of an event and appropriate intervention to maintain adequate oxygenation at the baseline levels. Without such monitoring, the event would have either gone unnoticed or identification would have been delayed.

Neurocognitive dysfunction following CABG has been reported to be as high as 75%.[2] Recent clinical studies have shown a relationship between post-operative neurocognitive dysfunction and inter-operative cerebral oxygenation.[3,4] The contribution of post-operative cerebral oxygen desaturation to neurocognitive sequella has not been reported on to date. We contend that these unidentified or "silent" desaturation events that occur postoperatively can contribute to the negative outcomes of cardiac surgery patients. By providing a means to continuously monitor the patient, appropriate interventions can be undertaken to minimize the impact of these events. During transport and the initial hours in the ICU, exceptional physiologic alterations continue for the cardiac surgical patient. The Model 7600 cerebral oximetry system provides two key features that facilitate continuous monitoring throughout this critical period: portability and repeatability of sensor application.

From a neurological point of view, it is important to mention that the CABG can be a completely safe procedure for patients with unilateral occluded internal carotid arteries if cerebral hemodynamics are checked pre-operatively and cerebral oximetry is performed during and after surgery. Doppler ultrasound and cerebral oximetry seem to be complementary in the prevention of cerebral ischemia during CABG.

Portability: At a weight of one kilogram (2.2 pounds), the device can easily be placed on the patient bed or carried alongside during transport. The compact size (approximately 12 inches by 5.4 inches footprint) and optional pole mount application provides convenient alternatives for placement in the crowded ICU room.

Sensor repeatability: The unique topography of the EQUANOX sensor provides consistency in readings when the sensor is removed or replaced.[5] This can be critical for extended monitoring when sensors may need to be moved. By providing a consistent reading between applications, a new baseline is not necessary allowing for consistent thresholds for intervention throughout the monitoring period.

Conclusions. Cerebral oximetry is used extensively interoperatively in cardiac surgery. This case report illustrates the importance of continued uninterrupted monitoring beyond the operating suite during transport and throughout extubation for identification of cerebrovascular events during this critical time period.

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