

Cerebral and Pulse Oximetry Monitoring of Newborns – Clinical Observations

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Introduction

Cerebral oximetry, which is based on near-infrared spectroscopy (NIRS) technology, is a non-invasive optical technique that offers continuous real-time monitoring of cerebral tissue oxygen saturation (SctO₂). SctO₂ represents the blood oxygen saturation in the microvasculature of brain tissue, which contains a mixture of arterial and venous blood, and reflects the balance between cerebral oxygen supply and demand. A cerebral oximeter (FORE-SIGHT™, CAS Medical Systems, Branford, CT USA) has been previously validated on neonatal patients during Extracorporeal Membrane Oxygenation (ECMO) (1,2). From the data collected in the validation study, we observed the relationship between cerebral oximetry and pulse oximetry measurements.

Methods

After obtaining informed consent, we used the FORE-SIGHT cerebral oximeter to monitor neonates undergoing veno-venous or veno-arterial ECMO. A specially designed neonatal sensor was attached to the subject's left or right forehead. Arterial oxygen saturation (SpO₂) data was collected from a Nellcor N-395 (Tyco/Nellcor, Pleasanton, CA USA) pulse oximeter with the sensor placed on the neonate's foot. For the study, cerebral oximetry and pulse oximetry data was collected every 3 seconds. Pre-ECMO surgical event markers were also recorded.

Results

30 subjects were studied with a total of >1200 hours of cerebral and pulse oximetry data collected. For the most part, cerebral oximeter SctO₂ and pulse oximeter SpO₂ closely correlated with each other. Typical SctO₂ observed values were 65 to 90% during clinically stable conditions, with observed typical SpO₂ values of 88 to 100%. SctO₂ values tended to be 20 -30% lower than SpO₂ because cerebral oximetry interrogates mostly venous blood in the microvasculature of the brain. During certain clinical situations, pulse oximetry was either less sensitive to brain oxygenation changes compared to SctO₂, or did not function reliably during low perfusion conditions such as circulatory arrest leading to the application of cardiopulmonary resuscitation (CPR). The case study shown in the figure below is one example where pulse oximetry was intermittently functional, while cerebral oximetry continued to be reliable during CPR. Other cases show that during hyperemia or increased FiO₂, cerebral oximetry SctO₂ was sensitive to brain oxygenation changes while pulse oximetry was not able to measure changes because arterial oxygen saturation was at 100%.

Conclusion

Current use of real-time non-invasive pulse oximetry to monitor arterial blood oxygenation is often unreliable during low perfusion events, especially during circulatory arrest because of diminished or cessation of pulsatile blood flow. Also, pulse oximetry is not a direct indicator of brain oxygenation. Cerebral oximetry offers a direct method to measure cerebral saturation and potentially predict 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 where pulse oximetry is unreliable. Cerebral oximetry is a promising modality for bedside monitoring in the NICU and is complementary to pulse oximetry.

References

Rais-Bahrami K, Rivera O, and Short BL, Journal of Perinatology 2006; 26: 628-635.
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