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Dual-slope near-infrared spectroscopy for more accurate estimation of cerebral hemodynamics

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Inadequate oxygen delivery to the brain is a major cause of cerebral injury. Near-infrared spectroscopy (NIRS) is a portable and non-invasive technique that can detect brain injury by monitoring cerebral oxygenation. However, the use of NIRS for adult neuromonitoring has been stymied by significant signal contamination from their thick (˜10mm) extracerebral layers (ECL; scalp and skull). Sensitivity to the adult brain could be improved by combining NIRS with a dual-slope (DS) technique. DS NIRS involves the use of a symmetric optode configuration to obtain an average optical attenuation coefficient that is more sensitive to deeper-lying tissue such as the adult brain. Previous implementation of the DS technique involved combining continuous-wave NIRS (cwNIRS) with frequency-domain NIRS (fdNIRS); however, such approach is costly and complex. Therefore, our objective is to evaluate the accuracy of a purely CW method that applies the DS technique to *hyperspectral* cwNIRS. Simulations were conducted on a two-layer phantom that mimics the ECL and brain using a finite-element method software for modeling light transport in tissue. The blood oxygenation level of the phantom was varied within the range of low to high cerebral oxygenation and the ECL thickness was varied to mimic the range of ECL thicknesses from infants to adults. Using an in-house *hyperspectral* fitting algorithm, the DS-cwNIRS data were analysed to recover cerebral oxygenation and the light scattering parameters of the brain. Preliminary results show that the DS-cwNIRS and non-DS approaches estimated cerebral oxygenation with similar accuracy. However, DS-cwNIRS was more accurate in quantifying light scattering (error = 7±4%) than the non-DS technique (error = 17±16%), suggesting that the former is a superior method for estimating brain optical properties. This is important because large errors in the estimated brain optical properties will reduce the accuracy of the estimation of cerebral blood flow, which is critical in neuromonitoring.

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Biophotonics

Keyword-2

Neuromonitoring

Keyword-3

Brain oxygenation

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