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Use of the Wavelength Differential Method to Eliminate Baseline Drift in the Assessment of Cerebral Function Using NIRS

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Abstract The estimation of oxy-and deoxy-hemoglobin (HbO_2 and Hb) concentration change in cerebral blood flow by near infrared spectroscopy (NIRS) has been being used for the assessment of cerebral function in recent years. However, some oscillating artifacts in the estimation seen even when subjects are in the resting state have made practical application difficult. This paper focuses on a method to eliminate the artifacts and level the baseline in the estimation. At first, we examined the appropriateness of the two-component model generally used in NIRS estimation, in which it is believed that HbO_2 and Hb alone cause the changes in absorbance. Several estimations based on observations at different wavelength couples were carried out. If the two-component model is appropriate, these estimations should be identical. However, they significantly differed from each other. In order to avoid this problem, we introduced a wavelength-independent component into the model. This component represents factors such as light scattering, transmittance change in optics, and absorbance change caused by other matter, which are not considered in the two-component model. The wavelength-independent artifact was eliminated by using the differences in absorbance at the point of wavelength coupling. The Wiener filter was used to stabilize the estimation. Compared with the two-component model, the proposed three-component model was able to level the baseline in the estimation of concentration change well. The power spectra of the concentration changes estimated by the two models were also compared. A peak at about 1.2 Hz correlating with the heartbeat was observed in the case of the two-component model ; however, it disappeared when the three-component model was used. This method is useful to eliminate artifacts in the estimation of

concentration change in HbO_2 and Hb since it does not require any modification when used with multi-wavelength-type NIRS hardware.

Keywords: NIRS, absorbance difference by wavelength, Wiener filter, cerebral oxygenation, cerebral function

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