A TESTING TOOL FOR THE CEREBRAL AUTOREGULATION COTRENDING ALGORITHM

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Introduction: Cerebral blood flow is regulated over a range of systemic blood pressures through the Cerebral Autoregulation (CA) control mechanism [1]. Blood pressure outside the intact range of CA is associated with adverse patient outcomes. We have developed a real-time algorithm for the measurement of CA status based on the cotrending of mean arterial pressure (MAP) and regional oxygen saturation (rSO_2) signals, previously demonstrating its performance on a cohort of CVOR patients [2]. Here we describe a novel testing tool to synthesize MAP and rSO_2 to augment our clinical data and allow for robust testing of the algorithm over a wide operating range.

Method: The tool's parameters and operating ranges are provided in the table. The tool allows for the input of a test MAP signal which is matched with a synthetic rSO_2 signal. The two signals can be made to trend together to indicate an impaired autoregulation status or, alternatively, they can be decoupled to indicate an intact status (where systemic blood pressure is not driving flow).

Parameter	Range	Steps
Initial MAP	20-150 mmHg	15 mmHg
Initial rSO_2	15-95 %	10 %
LLA	40-90 mmHg	10 mmHg

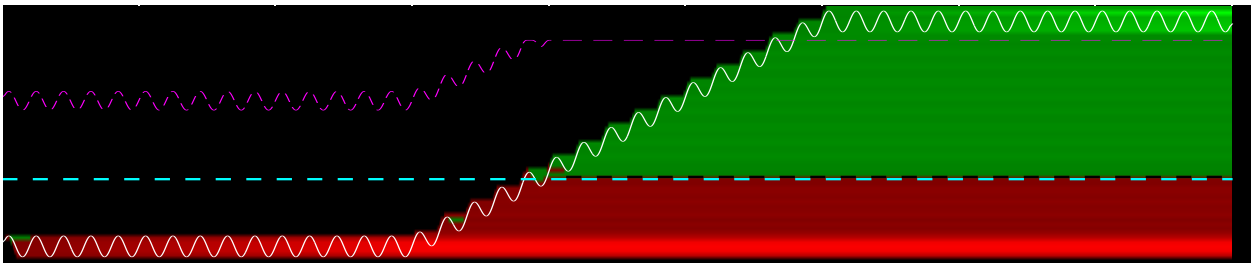

Figure 1

Results: Figure 1 shows a typical cotrending algorithm plot using for input synthetic MAP and rSO_2 signals (white and magenta traces, respectively). The LLA determined by the cotrending algorithm is indicated as the change from red to green shading. It shows excellent agreement with the inputted LLA (horizontal dashed line in the plot) and also indicated by the modulation in the input rSO_2 signal being switched off. We ran a range of parametrized synthetic inputs for a total of 272 algorithm runs and benchmarked the algorithm's accuracy using the Root Mean Square Differences (RMSD) between the input LLA and the algorithm output LLA. The mean of the RMSD for all synthetic datasets was 0.29 ± 0.41 mmHg.

Conclusions: A synthetic model has been presented to test our cotrending algorithm over a wide range of parameters. The results of this parametric study have been presented and demonstrate that the algorithm performs well within our target accuracy of 5 mmHg. We believe this to be a most useful tool for the development of a robust algorithm. Future work may include adding noise to the generated data to further test the robustness of the algorithm.

References:

[1] M. J. H. Aries, J. W. Elting, J. De Keyser, B. P. H. Kremer, and P. C. A. J. Vroomen, (2010) "Cerebral autoregulation in stroke: A review of transcranial doppler studies," *Stroke*, 41(11), 2697–2704.
[2] D. Montgomery, C. Brown, C. W. Hogue, K. Brady, M. Nakano, Y. Nomura, A. Antunes, P.S. Addison, (2020). Real-time intraoperative determination and reporting of cerebral autoregulation state using near-infrared spectroscopy. *Anesthesia and Analgesia*, 131(5), 1520.