**Construction of a bedside monitor with a hybrid optical system**

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**Introduction:** The possibility to assess microvascular physiology of deep tissue over long periods of time at the bedside is a real clinical demand that should lead to more individualized – therefore more efficient – treatments. Diffuse optical techniques can greatly improve the current scenario and take an opportunity in this niche by offering direct, noninvasive and portable instrumentation to monitor tissue physiology at the patient’s bedside. Recently, we have validated Diffuse Optical Spectroscopy (DOS, also known as Near Infrared Spectroscopy, NIRS) as a reliable tissue oxygenation marker. In particular, we have shown that Frequency-Domain (FD) DOS is capable of measuring absolute oxy and deoxy-hemoglobin concentrations, conveying information about tissue oxygenation with great accuracy if the correct model is employed [1,2]. We have also developed a homemade Diffuse Correlation Spectroscopy (DCS) system that was shown to assess microvascular tissue blood flow [3,4,5]. In this work, we developed a hybrid optical system by integrating both DOS and DCS. The developed system leverages the capability of DOS to measure tissue oxygenation and the DCS ability of measuring microvascular blood flow. In addition, the concurrent measurements of DOS and DCS allows for the unique bedside estimative of the metabolic rate of oxygen consumption (MRO2).

**Materials and Methods:** To develop the hybrid optical system we combined a DCS system previously developed in our lab and a commercial DOS system (Imagent, Iss Inc, Illinois). The homemade DCS instrument employs 16 detectors and one continuous-wave (CW) laser source at 785 nm (~100 mW). The commercial DOS system employs 4 detectors and 32 diode laser sources at 4 different wavelengths (690, 705, 750, 840 nm; ~10 mW each). To integrate both systems we built a homemade trigger capable of controlling the state of DOS/DCS, preventing them to interfere and damage each other. To control the trigger, we modified our DCS’s control software, programming it to also control an Arduino board inside the trigger box, which allowed the communication of both systems. After making sure that the switching lasers were working, we moved the hybrid instrument to the hospital and proceeded with system characterization.

**Results and Discussion:** The hybrid instrument is extremely stable, with laser power varying less than 2% over 21 hours. Despite the long period of monitoring, the system temperature was also kept constant at 29.0 ± 0.5 oC. Regarding temporal resolution, the whole cycle (DCS+DOS) takes approximately 3 s, which is excellent for long-term monitoring at the patient’s bedside. Overall, the results of the system performance demonstrate the viability of the integration of a commercial DOS system with our homemade DCS system, allowing the monitoring of patients at the bedside during long periods of time. Our pilot results in the clinical phase are ongoing.

**Conclusion:** On a series of previous studies our lab has shown the utility of DCS and DOS for measurements of microvascular blood flow and absolute tissue oxygenation, respectively. In this work we combined both techniques to develop a portable hybrid optical system capable of measuring deep tissue physiology. The main advantages of this system are that it allows the continuous monitoring of patients at the bedside for long periods, providing the clinician with noninvasive and direct measurements of tissue physiology, such as tissue oxygenation, blood flow and oxygen metabolism. We are currently on the first steps of implementing the system inside the clinic, with the main goal of monitoring stroke patients.

**References:** [1] *R. C. Rodriguez*, MSc Dissertation, UNICAMP (2014); [2] *R. C. Rodriguez*, XVIII CBFM (2013); [3] *R. M. Forti*, MSc Dissertation, UNICAMP (2015); [4] *R.M. Forti et al.,* 1st Congress CEPID BRAINN (2014); [5] *R M. Forti et al.,* 2nd Congress CEPID BRAINN (2015).