Application of optical methods for bedside monitoring of brain health and activity

The normal function of the brain is reliant on blood flow for a continuous supply of oxygen and nutrients. Therefore techniques for monitoring brain blood flow are extremely valuable, particularly for patients with major brain injuries such as stroke. Despite the existence of a number of advanced imaging methods like computed tomography and magnetic resonance, the biggest limitation which medical doctors have to deal with is the fact that these techniques do not allow for continuous, bedside measuring. To overcome this limitation, there is a great deal of interest in portable light-based technologies that potentially could enable physicians to perform brain monitoring in all types of patients. Despite its clinical potential and the fact that a number of commercial devices have even been developed, clinical acceptance has eluded optical technologies for brain monitoring. The originality of this approach centers on an alternative approach for tackling the main weakness, which is isolating the optical brain signal from the substantial signal coming from scalp and skull. The approach is based on the use of an optical contrast agent to provide greater signal contrast and the ability to measure brain blood flow and the integrity of blood vessels in the brain. The goal of our work is to demonstrate that our contrast-enhanced optical method can accurately measure these parameters in critically ill patients. We believe that the ability of this technology to detect impaired brain function at the bedside will help doctors improve the outcome for critical-care patients with serious brain injuries.

Brain-computer interfaces (BCIs) are devices that can be used to bridge the gap between thoughts and actions, allowing patients who cannot physically or verbally communicate the ability to establish rudimentary ‘mental communication’. Optical technologies such as functional near-infrared spectroscopy (fNIRS) are ideal for this purpose, since the systems are portable and inexpensive. Motor imagery (MI) is a commonly used BCI task that involves actively imagining coordinated movements in response to questions, and detecting the corresponding brain activity in motor planning regions. Our group used this approach in combination with time-resolved fNIRS to communicate with a locked-in patient under intensive care. Although promising, the accuracy of this approach should be assessed on a larger cohort, which is the purpose of the current study, if it is to be used a reliable BCI.