Research project setting (physical sites, online forums and alternatives)

The project will take place in the Hunter Medical Research Institute (HMRI), the location of the NIRS device and the Clinical Nutrition Research Centre at the University of Newcastle's Callaghan campus on a separate occasion for TCD imaging.

Methodological approach

Each participant will undergo two imaging sessions over two days. On both days the participant will be requested to refrain from caffeine prior to the imaging session.

In the first imaging session, all subjects will undergo 60 minutes of NIRS imaging. The NIRS data will be recorded using the HMRI ISS Imagent device with 4 detectors and 32 sources (16 at 690nm and 16 at 830nm). These 128 channels will be attached to a head strap on subject's head. The NIRS data will be collected during 10 minutes of resting state of sitting position. During NIRS recordings subjects will wear a non-invasive chest strap containing an EquivitalTM EQ02 LifeMonitor to monitor respiration, heartbeat. Respiration and heart beat will be later used for noise removal, motion correction and also aligning the waveform timing of the ventricular contractions. Compliance will be calculated as explained in [1].

After the NIRS session, subjects will be asked to answer a questionnaire about their daily activity and their height and weight will be measured to assess their cardiorespiratory fitness based on [2]. This index was used as the reference of subjects' health in the original NIRS-compliance study [3]. The questionnaire is a non-exercise estimation of cardiorespiratory fitness (CRF) based on self-response to the level of daily activities, asking participants to choose one activity category that best describes their usual pattern of daily physical activities. Their answer along with the measure of body mass index will be used to assess their cardiorespiratory fitness level. The method is adopted from [2] and have been used by [3] to correlate the compliance index extracted from optical data.

In the first imaging session participants will also undergo T1-weighted and phase contrast MRI imaging. These images will not be used in the comparison of NiR and TCD compliance in this study but will be used later to develop new distributed cerebral vascular compliance models.

In the second imaging session, the transcranial doppler device will be used to measure blood flow in middle cerebral arteries. Participants will be fitted with a headpiece supporting a transcranial Doppler (TCD) ultrasound probe on each temporal region. An investigator will adjust the probes until a measurable blood flow signal is obtained in each middle cerebral artery. An appropriately sized blood pressure cuff will also be placed firmly around the upper-left arm of the participant, centered over the left brachial artery to assess seated blood pressure. Once a steady-state cerebral blood flow velocity is achieved, a 60-s beat-to-beat recording will be obtained to determine the basal blood flow velocity (peak systolic, end-diastolic and mean) in a seated position with eyes opened. A blood pressure reading will be obtained at the end of the 60-s recording. This procedure will be repeated five times. Compliance will be calculated directly from the formula [4], which involves assumptions about vessel diameters being constant during cardiac pulses and volume change during cardiac cycles representing the change between arterial inflow and outflow.

References:

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[4] E. Carrera, D.-J. Kim, G. Castellani, C. Zweifel, P. Smielewski, J. D. Pickard, P. J. Kirkpatrick, and M. Czosnyka, "Cerebral arterial compliance in patients with internal carotid artery disease," European Journal of Neurology, vol. 18, no. 5, pp. 711–718, 2011. [Online]. Available: http://dx.doi.org/10.1111/j.1468-1331.2010.03247.