Old Dominion University
College of Engineering and Technology
Department of Electrical and Computer Engineering

All lectures to be held at 3:00 pm on Fridays in Kaufman 224. For more information, contact Dr. Dimitrie Popescu at (757) 683-5414 or e-mail dpopescu@odu.edu. Refreshments provided after the seminar.

Friday, March 6, 2020 Seminar Topic:

EFFECT OF MUSCLE OXYGEN DELIVERY AND MICROVASCULAR VOLUME DISTRIBUTION ON Hb AND Mb CONTRIBUTION TO THE NIRS SIGNALS

by Bhabuk Koirala, Ph.D. Candidate in the Department of Biomedical Engineering at Old Dominion University

Abstract:

In vivo evaluation of skeletal muscle mitochondrial function can be obtained using near-infrared spectroscopy (NIRS). The non-invasive nature of this technology and the relative affordable price makes it a promising tool in translational medicine. NIRS can be used to evaluate the balance between muscle O2 delivery and utilization but uncertainties on quantitative information provided by the NIRS signal limits the physiological inferences. Although quantitative analysis of the temporal profile of muscle NIRS signal provides a valuable parameter characterizing the kinetics, inferences are limited by the unknown contribution of Hb and Mb to the NIRS kinetics. The linearity between venous oxygenation and NIRS signals is often interpreted as evidence of a predominant contribution of Hb to the NIRS signal.

We used a computational model of oxygen transport and metabolism to analyze muscle and venous oxygenation data obtained under different experimental conditions. The model quantifies the convection, diffusion, and cellular metabolism at rest and in contracting muscle. The model was validated by comparison between simulated and experimental data of O2 uptake, venous O2 content, oxygenated and deoxygenated NIRS signals under different O2 delivery conditions (blood flow, arterial O2 content) in presence or absence of muscle contraction. Model allows to simulate oxygenated (HbO2, MbO2) and deoxygenated (HHb, HMb) Hb and Mb contributions to the NIRS signals.

Under different O2 delivery conditions, model simulations indicate that the contribution of Hb to the oxygenated NIRS signal (HbMbO2) varies between 95-100% in absence of contraction and between 60-90% in contracting muscle. The contribution of Hb to the deoxygenated NIRS (HHbMb) signal was 80-90% in resting muscle and 45–85% in contracting muscle at different O2 delivery. Model simulations suggest that under certain conditions, the linearity between venous oxygenation and NIRS signal should not be interpreted as evidence for a main contribution of Hb to the NIRS signal because Mb contribution is also significant. During muscle contraction both Hb and Mb contributions to the NIRS signal are affecting simultaneously venous and tissue oxygenation changes detected by NIRS.

Bio:

Bhabuk Koirala is a Ph.D. candidate in SAMPE Lab of the department of Biomedical Engineering at the Old Dominion University. He received his Bachelor degree in Biotechnology from Kathmandu University, Nepal and MSc degree in Computational Systems Biology from Aalto University, Finland and Instituto Superior Tecnico, Portugal. His doctoral research is focused on the analysis of skeletal muscle oxygen transport and mitochondria fuel selection. Quantitative analysis is performed by physiologically and biochemically-based computational models to study regulatory mechanisms in health and disease states. His research interest includes mathematical modeling in systems biology, physiology, pharmacology, mass transport, metabolism and biochemistry; molecular biology, machine learning and bioinformatics.