Detecting Hypoxia Through the Non-Invasive Monitoring of Sweat Lactate and Tissue Oxygenation

Cheng, Cindy (School: Laurel Heights Secondary School)

Hypoxia is the state of insufficient tissue oxygenation to support homeostasis that, if untreated in time, can lead to tissue damage and organ failure. However, there is a lack of accurate and timely methods for detecting hypoxia, even in hospitals. To address this critical need, a wearable integrated device for the non-invasive and simultaneous detection of sweat lactate and tissue oxygenation levels was developed. The integrated device consists of two main functional components: a chemical lactate biosensor that exhibits colourimetric change in response to sweat lactate and optical electronics that quantitatively read out tissue oxygenation and the colourimetric change. Prototype devices were first evaluated on an optical phantom using artificial and real sweat samples. The response of the lactate sensor to various concentrations of lactate was successfully measured while the tissue oxygenation (StO2) and blood volume index (BVI) of the phantom were monitored accurately and stably. An increase in lactate concentration of 36 mM was identified in the sweat sample collected after anaerobic exercise compared to that after aerobic exercise. Furthermore, the device was demonstrated to be capable of real-time “on-body” simultaneous monitoring of sweat lactate spikes and tissue oxygenation drops (StO2 and BVI), which showed strong correlation during a hypoxia protocol. The novel device can potentially be applied in broad clinical and non-clinical settings, such as post-operative care, detecting sepsis, and measuring endurance in athletes. It also has the potential to facilitate cost-effective and sustainable healthcare solutions accessible to under-resourced regions and populations.

Awards Won:
Fourth Award of $500