Smart Microfluidics-based Impedance Aggregometry Biosensor for Detection of Platelet Hyperaggregation

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Cardiovascular disease (CVD) is the leading cause of death with over 2300 deaths daily and costs approximately $330 billion annually. Platelet hyperaggregation in CVD, especially with diabetes, is a useful indicator for disease diagnosis and prognosis. The objective of this study is to develop a smart microfluidics-based impedance aggregometry biosensor and test its efficiency in detection of platelet aggregation in a microfluidic Polydimethylsiloxane (PDMS) well. A factorial experimental design was used to evaluate two biosensor designs, one with Gold electrodes and the other with Indium Tin Oxide (ITO) electrodes. The two designs were compared by evaluating platelet aggregation in whole blood at frequencies of 4 kHz, 12 kHz, 280 kHz, and 2 MHz. Varying levels of platelet aggregation were induced using collagen agonist at 5µg/mL, 2.5µg/mL, 1.25µg/mL, and 0.625µg/mL concentrations at all frequencies. Continuous change in electrical impedance was observed in all testing conditions. Three trials were conducted for controls and each combination of factors. Statistical analysis of the results using ANOVA method showed that the biosensor design with ITO electrodes and 280 kHz was able to detect platelet aggregation by impedance change ($p < 0.05$). The biosensor was then used to develop an Arduino microcontroller based smart device. An Android app was developed to access results from the device. This study successfully developed a prototype of a smart, mobile, low-cost device, as a point-of-care solution for testing platelet hyperaggregation. This can help in lowering costs of early detection and monitoring of CVD, thereby decreasing its health and economic impact.

Awards Won:

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