Label-free Immunosensors for Early and Expeditious Diagnosis of Multi-Organ Failure

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Early diagnosis is of unequivocal importance to survive debilitating multiple organ failure (MOF), the leading cause of death in the intensive care unit (ICU). However, current lab-based methods of diagnosing individual organ dysfunctions are hampered by limited rapidity and accuracy, leading to late or misdiagnoses that greatly increase mortality. This work presents a novel impedance-based immunosensor design to rapidly detect early circulating biomarkers in physiological ranges for simultaneous, expeditious, and early detection of organ failures before their onset. EIS was employed for label-free qualitative and quantitative biomarker detection, through specific antigen-antibody interactions with cross-linked antibodies on DSP-functionalized gold microelectrode arrays. Results demonstrate exceptional selectivity against non-targets and serum interferents, with large 2- to 5-fold signal increases in the presence of targets even in high protein serum background. Further, an outstanding 50,000 times wider quantification range (0.03pg/ml – 1µg/ml) and 4,000 times lower limit of detection (R^2 = 0.879 to 0.999) were achieved without sample dilution, as compared to current detectable ranges by conventionally used ELISA even with 500,000 times dilution. These led to an impressive 10-fold increase in working efficiency which greatly expedites ELISA turn-around time of 5h to merely 0.5h. The proposed immunosensor and its point-of-care platform could potentially revolutionize MOF diagnosis to warrant timely clinical intervention, saving more lives in the ICU. More remarkably, with a simple change of the immobilized antibodies, utility of these immunosensors can be maximized to cover a wider spectrum of medical conditions for early, rapid, and more accurate medical diagnosis.

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