A Biosensing Platform Based on Graphene-Gold Nanoparticles for the Rapid Sepsis Diagnosis

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Statement of Purpose: Every year more than 31 million people develop sepsis,[1] a life-threatening disease that causes major organs failure with a high rate of mortality in children and women.[2-3] Sepsis is caused by the dysregulated immune response during the fight against infection. The condition is considered expensive to treat resulting in 24 billion dollars/year for management. The clinical diagnosis of sepsis requires a blood culture in a clinical laboratory setting and may take up to 5 days[3]. Sepsis is a race to the death between the host immune response and the invading pathogen where every hour of delay in treating the affected patients decreases the chance of survival by ~8%[4]. While there are a few known experimental point-of-care (POC) diagnostic tests reported for sepsis, none of these systems can provide synchronous information on both the pathogen and the host innate response. Thus, there is a critical need to develop a fully integrated comprehensive test that can provide information about both the pathogen and the host response to help in the early diagnosis of this threatening condition. If successful, an inexpensive POC test can improve health access, reduce healthcare costs and improve the quality of healthcare treatment.

Results: To address this need we developed a novel approach for screening active infection and monitoring the immune response of patients using one integrated electrochemical biosensor in a multiplexed manner with a very short turnaround time of <10 min. The biosensor uses gold nanoparticles (AuNPs), capped with recognition probes targeting cytokines biomarkers and the causative pathogens. The sensing probes are immobilized on a graphene-based electrochemical platform where the data is recorded using a simple hand-held reader. Graphene has a large specific surface area, low electrical noise, and high charge carrier mobility, properties that enable the development of a sensitive platform for sepsis detection. This will help predict the formation of life-threatening organ dysfunction and may help with early intervention with specific anti-sepsis treatments. In addition, this research involves the clinical validation of the developed sensor using the gold standard tests to allow a smooth translation into clinical practice. The POC biosensor was designed and fabricated to allow the detection of the desired target using a small sample volume (~5 µL) without the need for any sophisticated equipment (*i.e.,* centrifuge. etc.) for sample processing. The biosensor has been validated using a spiked sample and found to have a wide linear range from 1fg/mL to 100 ng/mL with a limit of detection of 1fg/mL.

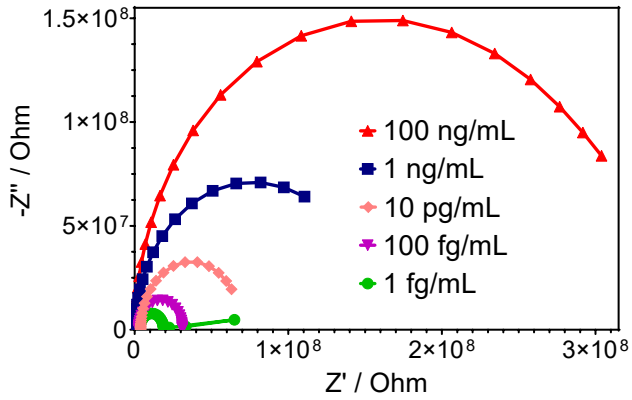

Figure 1. Electrochemical Impedance spectra of the developed sensor as a response to various concentrations of procalcitonin (PCT).

References:

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