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A Structure-Switching Electrochemical Aptasensor for Rapid, Reagentless and Single-Step, Nanomolar Detection of C-Reactive Protein

Authors : William L. Whitehouse, Louisa H. Y. Lo, Andrew B. Kinghorn, Simon C. C. Shiu, Julian. A. Tanner

Abstract : C-reactive protein (CRP) is an acute-phase reactant and sensitive indicator for sepsis and other life-threatening pathologies, including systemic inflammatory response syndrome (SIRS). Currently, clinical turn-around times for established CRP detection methods take between 30 minutes to hours or even days from centralized laboratories. Here, we report the development of an electrochemical biosensor using redox probe-tagged DNA aptamers functionalized onto cheap, commercially available screen-printed electrodes. Binding-induced conformational switching of the CRP-targeting aptamer induces a specific and selective signal-ON event, which enables single-step and reagentless detection of CRP in as little as 1 minute. The aptasensor dynamic range spans 5-1000nM (R=0.97) or 5-500nM (R=0.99) in 50% diluted human serum, with a LOD of 3nM, corresponding to 2-orders of magnitude sensitivity under the clinically relevant cut-off for CRP. The sensor is stable for up to one week and can be reused numerous times, as judged from repeated real-time dosing and dose-response assays. By decoupling binding events from the signal induction mechanism, structure-switching electrochemical aptamer-based sensors (SS-EABs) provide considerable advantages over their adsorption-based counterparts. Our work expands on the retinue of such sensors reported in the literature and is the first instance of an SS-EAB for reagentless CRP detection. We hope this study can inspire further investigations into the suitability of SS-EABs for diagnostics, which will aid translational R&D toward fully realized devices aimed at point-of-care applications or for use more broadly by the public.

Keywords : structure-switching, C-reactive protein, electrochemical, biosensor, aptasensor.
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