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Electrochemical Immunoassay-based Sensors Towards Point-Of-Care Diagnostics: Recent Progress and Challenges in Multiple Biomarkers Detection

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Summary

Specific biomarkers detected in body fluids and tissues are crucial elements for disease diagnosis, prediction of its progression, and evaluation of personalised treatment effectiveness. Although the detection of a single specific biomarker is sufficient, the simultaneous detection of multiple disease-associated biomarkers (cancer biomarkers, inflammatory proteins, etc.) significantly improves the diagnostic power of biomarkers in terms of specificity and sensitivity from the Receiver operating characteristic curve (ROC) [1].

Electrochemical biosensors meet the criteria of Point-of-Care (POCT) devices and represent the alternative to a commonly used instrumentally and time-consuming laborious diagnostic methods (ELISA, immunohistochemistry, PCR). Biosensors are a group of cheap, portable, sensitive, quick-responsive and accurate devices enabling complete automation. Among electrochemical biosensors, immunosensors, which are based on the principle of highly specific affinity interactions between antigens and two corresponding antibodies identical with ELISA method, are therefore of interest in clinical diagnosis. Recently, the most common enzyme-based immunosensors have been replaced by nanomaterials-based sensors to overcome the shortcomings of enzymes. From electroactive nanoparticles, gold nanoparticles (AuNPs), silver nanoparticles (AgNPs), quantum dots (QDs), carbon nanotubes (CNTs), graphene, and carbon quantum dots (CQDs) are the most commonly used. Moreover, these nanomaterials enable the simultaneous detection of multiple biomarkers since they provide separate, non-interfering and mutually unaffected electrochemical signals.

Here, we present two examples of the development of electrochemical magneto-immunoassay-based sensors for simultaneous stripping voltammetric detection of ovarian cancer biomarkers, namely proteins HE4, CA125, AFP [2,3], and pro-inflammatory biomarkers PTX3 and CALR, as potential predictive markers of preterm labour. Silica nanoparticles (SiNPs) combined with electroactive QDs (CdTe, PbS) were used for site-directed labelling of detection antibodies and providing non-interfering signals. Disposable screen-printed carbon electrodes were used for measurements, enabling the droplet analysis. Cut-off limits gained for detected biomarkers meet the criteria for clinical importance.

References

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