Innovative Biosensors for New Point-of-Care Devices

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Abstract

There is a general need in healthcare systems all around the world to reduce costs in terms of time and money without compromising patient outcome. Point-of-Care (POC) testing is currently being used in some applications (e.g. coagulation devices) as an alternative to already established standard central laboratory tests to overcome sample transportation and long turnaround times. The main objective of this investigation is to develop innovative technologies for their integration into POC platforms.

In this research, a model protein biomarker was selected as an excuse to prove the potential of the biosensors developed. Tumour Necrosis Factor-alpha (TNF-α) was chosen because it was considered a challenging goal due to its extremely low presence in blood/serum/plasma samples. In addition, assaying of this biomarker is interesting for many immunological studies. For instance, the binding inhibition of circulating TNF-α to its receptors by biological drugs has been seen to alleviate the symptoms of certain diseases such as rheumatoid arthritis or Crohn's disease. With the above-mentioned framework in mind, three different technologies were investigated:

Firstly, an electrochemical immunoassay for the detection of proteins in human serum based on the combination of amperometric measurements, magnetic microbeads (MBs) and disposable screen-printed carbon electrodes (SPCEs) has been developed. The specifically modified microbeads were magnetically captured onto the working electrode surface and the electrodic and enzymatic reactions of the H_2O_2-hydroquinone mediated reduction was amperometrically monitored [1].

Secondly, a novel solid-phase assay based on a magnetic bead-mediated proximity ligation assay (PLA) has been developed in which one of the assay proximity probes was directly immobilized onto streptavidin-coated magnetic beads. The portable device was based on a disposable and single-use cyclo olefin polymer (COP) microfluidic chip interfaced with a quantitative real-time polymerase chain reaction (qPCR) device [2].

Finally, a simple method for the detection of biomarkers in human serum with great sensitivity has been developed using a surface plasmon resonance (SPR) biosensor. Signal amplification based on a sandwich immunoassay including gold nanoparticles was used. Detection in serum proved to be challenging due to high undesirable non-specific binding to the sensor surface stemming from the matrix nature of the sample [3].

The simplicity, robustness and the clinically interesting LODs obtained with the three methods presented here proved them as good contenders for real clinical application. The knowledge acquired could be horizontally applied to the other interesting protein or DNA biomarkers. The POC platforms envisioned in this project could potentially help in increasing the quality of patient care by reducing turnaround times and improving clinical decision making. It should also be emphasized the possibility of integrating high-throughput, multiplex detection and automatization into the platforms. These advantages may have a significant positive impact on cost in terms of time and money on governmental health service budgets.

References

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