Translational, multiplexing and multiomics (nano)bioelectroanalytical tools: Taking on gigantic challenges towards precision medicine

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Aware of human diseases evolution involves a highly dynamic and interactive system of multiple layers of molecular markers (e.g. genetics, epigenetics, mRNA transcripts, proteins and metabolites), precision medicine aims to provide a detailed characterization of each disease to customize healthcare. On the other hand, it is now fully accepted that the simultaneous analysis of multiple layers of molecular markers leads to novel strategies for early detection or predisposition to suffer from prevalent and high mortality diseases such as cancer and neurological conditions, thus improving their prevention and treatment. In this sense, features such as versatility to profile multiple biomarkers at different omics levels, simplicity, affordable cost, remarkably shorter analysis time and the smaller sample amount required for the analyses compared to conventional or latest generation methodologies, make electrochemical bioplatforms particularly promising alternatives for this purpose [1].

Bearing this in mind, this lecture will discuss bioelectroanalytical tools recently developed in our research group, implemented both using magnetic microbeads and integrated formats at disposable electrodes, by exploiting advantages of quite current HaloTag and diazonium salt chemistries, new developments and uses of hybrid nanomaterials, latest generation bioreceptors, smart bioassay formats and multiplexed amperometric transduction, for assisting mostly in proteomics and epigenomics. In particular, the most relevant aspects of electroanalytical bioplatforms potentially transferable to the clinic due to their simplicity, cost, testing time, versatility, multiplexing capability and decentralized character, which have shown pioneering applications to decisively assist in personalized early diagnosis of neurological and cancer diseases by targeting dysregulated proteins and autoantibodies, and methylation events in nucleic acids, will be discussed.

The giant strides in the forefront in electrochemical biosensing, of which those to be discussed in this Keynote are a good example, make us expect the birth of new simple, versatile, affordable, and applicable devices even in ambulatory or domestic environments, that will play a leading role both in clinical routine and in our daily life. These biodevices are proved to be ready to validate candidate biomarkers, to manage human diseases, or to face unexpected global health challenges in record time, as occurred with the current coronavirus pandemic, in a personalized and early way. This will entail unprecedented advantages in minimizing the spread of infections, improving both the statistics and the patients' quality of life, also alleviating the cost associated with their treatment by the health systems and the emotional burden on families.

References

[1] S. Campuzano, R. Barderas, P. Yánez-Sedeño, J.M. Pingarrón. Curr. Opin. Electrochem. 28 (2021) 100703. https://doi.org/10.1016/j.coelec.2021.100703.