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Editorial

Nanotechnology for Biomarkers or Biomarkers for Nanotechnology in Medical Approaches: What Can We Anticipate?

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In recent years, there has been excitement about the ability to predict the future disease risk factor status. For this purpose, biomarkers have been used in pre-clinical research and clinical diagnosis. The National Institute of Health Biomarkers Definitions Working Group has defined a biomarker as a measurable indicator of some normal biological processes, pathogenic processes, or pharmacological responses and toxicological effects of a therapeutic intervention [1]. Biomarkers can be of various molecular origins, including nucleic acid (DNA or RNA), protein (enzymes or antibodies), or a substance introduced into the body to assess how an organ, tissue, or system is functioning.

Recent advances in nanotechnology have led to the development of high-sensitivity Nanobiosensors that can be used in prognostic and diagnostic applications and to determine drug effectiveness at various target sites. Nanomaterials (NM) possess unique chemical, physical, electrical, optical, and magnetic properties that enable their use as sensors [2]. Thus, the application of NM to the diagnosis refines molecular diagnostic approaches.

Diverse types of nanostructured materials, including carbon nanotubes, gold nanoparticles, silicon nanowires, and quantum dots, are being used in the fabrication of sensors [3]. When conjugated to a targeting ligand that can bind to a specific marker of interest, NM acts as a generator or a sensitive detector of a specific biological signal [4]. Compared to most conventional sensors, such Nanobiosensors show enhanced sensitivity and specificity. Nanobiosensors can be precisely engineered to detect emerging biomarkers of diseases such as cancer, autoimmune diseases, infectious diseases, and metabolic diseases and to assess the risk of transplant rejection [2-5]. This approach could potentially produce point-of-care diagnostic devices that could improve treatment effectiveness, reduce health care costs, and save lives [6].

Nanotechnology for biomarkers is a mainstream field in the area that deals with the development of powerful diagnostic methods. NM when combined with capture agents enables the sensitive detection of clinically relevant biomarkers. These advances in nanotechnology have revitalized the efforts aimed at finding new biomarkers with potential applications in medical and pharmacological sciences.

Despite their tremendous potential, little is known about the effects of NM on human health. So far, most of the studies on NM have focused on the medical applications of nanotechnology, often overlooking, during their design and fabrication, the toxic effects associated with their use. The unique chemical and physical properties, such as the small size, shape, and high reactivity, of NM that enable their applications in diverse areas of medicine might also render them potentially toxic to cells and tissues [7]. Results found in the literature often show discrepancies and variability depending on the cell type under investigation, surface functionalization, and NM size. Therefore, in-depth studies are needed to better understand the potential deleterious effects of NM on human health and to optimize the use of nanotechnology in the field of medicine.

The interactions of NM and cells will produce an array of different biomarkers that can be used to detect the damage caused by NM, including signaling, apoptosis, inflammation, intracellular compartmentalization, and transportation [8]. Therefore, changes in biomarkers can be used as indicators or predictors for nontoxicity. Our recent studies demonstrate that the expression of Heat shock protein 70.1 (HSP70.1), Peroxiredoxin 1 (PRDX1), B-cell leukemia (BCL-2), and BCL-2 associated X protein (BAX) genes are good biomarkers of cytotoxicity responses in cells exposed to NM [9].

Finally, nanotechnology approaches could be used to predict future diseases or to assess the toxic effects of NM use. New data about Nanobiosensors and Nanotoxicology are constantly being researched and presented. In this context, biomarkers offer an innovative and effective way to integrate and evaluate the safety issues associated with the application of nanotechnology in the field of medicine.

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