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Nano-biosensors: Point of Care Devices for Personalized Cancer Diagnosis

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Editorial

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Point-of-care technologies (POCT) are transforming the healthcare landscape. As per the definition given by College of American Pathologists (COA) "POCT is the testing performed near or at the site of a patient with the result leading to a possible change in the care of the patient." With the tremendous growth in this segment and technological advancements, we can imagine the future where patients themselves will be able to diagnose the disease based on the bio-marker corresponding to that disease by a simple and handy diagnostic kit; a step towards personalized medicine that will help the clinicians to design appropriate therapy for patients [1,2].

In recent year, we have witnessed vast technological innovations in healthcare sector, including biosensors, lab-on-a chip and smart-phone based apps that collectively contributed to the growth of POC technologies and owing to the convenience, timeliness, and potential to improve patient outcomes, point of care devices have attained lots of interest in recent years. It is a rapidly expanding field and is expected to reach $23 billion market by 2020. Although glucometers, pregnancy testing kits have become part of routine life, still diagnostic kits for complex diseases like cancer is far behind reality [3].

According to the National Cancer Institute, "Cancer is not just one disease but many diseases." and cancers are curable if diagnosed early as at later stages, survival statistics are far less favourable. Usually cancer exhibits insignificant early symptoms and lack of efficient diagnostic systems are the major hurdle in cancer therapy. In this regard, it is a need of hour to develop point of care devices for early cancer detection having potential to address the diagnostic challenges of this fatal disease.

Biosensors have diversified applications in various areas from healthcare to agriculture and have been technically enriched with the advancement is different scientific fields of material sciences, nanotechnology and micro/nanoelectronics. "Nano-biosensor" is a new wave with a promising future to revolutionize the current scenario of point of care diagnosis. There can be two aspects of defining this field:

i. Nano empowered non-invasive portable sensing devices

ii. Implantable nano-sensors for internal monitoring

In recent years, many fields have been benefit by the 'Midas touch' of nanotechnology intervention and biosensors also gained from nanotechnology in terms of better precision and sensitivity. In this era of interdisciplinary sciences, nano-biosensors based on different detection principles have been developed to detect cancer biomarkers (proteomic and genetic markers) and cells [4,5]. Although new sensing platforms for cancer biomarkers have been emerging, the prime challenges of cancer diagnosis are still same; cancer is a complex disease therefore accuracy and sensitivity of diagnosis and portability of the detection system that could be applied in remote area is utmost important. The fruitful association of nanotechnology with biosensing has resulted in few miniaturized point of care devices for cancer detection. Gronewold et al. put forth their concept of detecting circulating tumor cells on gold nanospots modified with antibodies and have reported high sensitivity of detecting less than 10 CTC in a single run [6]. Recently, Rayappan et al. have reported a nano-interface biosensor for cancer cell proliferation basedon blend of carbon

nanotubes-graphene [7]. In another report by Abdolahad et al., silicon nanowires were explored as electrode modifiers to analyse drug metabolism against breast cancer [8]. These are just few examples demonstrating how nanotechnology can change the face of cancer diagnosis and the best impact of nanotechnology in biosensing is yet to come!

We started our discussion with POC devices for cancer prediction. For a complex disease like cancer, to effectively design such systems is not an easy task but with rapid technological advancements and growth in MEMS/ NEMS and microfabrication techniques indicates a bright future. POC for cancer diagnosis is a fast growing field with significant market share also. As a broad classification, POC for cancer have diversified utilization from identifying biomarkers to monitor the chemotherapy response in patient and reoccurrence of cancer. To date now very few commercial diagnostic kits are available; AMOS test from oncolab, PSA based prostate cancer kit and cervical cancer kits are just a few and still a scope for lot more is there. A new trend in POC for cancer is heading towards miniaturized electrochemical detection platforms due to better sensitivity and ease of fabrication and nanobased electrochemical biosensors is a booming area for designing robust cost effective POC for cancer prediction and screening [9,10].

Another important futuristic approach based on nano-biosensors is fabrication of tiny nanorobots with specific functions that could provide data from inside human body and serve as a tool for real time monitoring of chemotherapy response, presence of cancer specific cells and even drug delivery in a programmable manner. This concept on nano sized robotic biosensors is inspired by a movie “The Fantastic Voyage” in 1966, research is going on all over world to materialize this concept into reality as these tiny devices can change the face of cancer diagnosis and will be a giant leap towards personalized medicine. Recently Douglas et al. devised a DNA based nanorobot tested on a species each of lymphoma and leukaemia [11]. In an improvised version, Rudchenko et al proposed multiple simple molecules chained to form a robot. These were designed to identify a specific set of blood cells and tag them. In principle, this property could be explored for treatment and killing of specific cells [12]. It is just a beginning and this research arena has immense potential and utility in medical science and healthcare segment.

Nano-biosensors as POC devices for cancer hold great promise in routine analysis as well as cancer screening in remote areas. In the resource poor countries, such systems are a boon because cancer is a major cause of deaths in these regions and early diagnosis can save lives. We may expect that next decade will bring a new realm of precision and efficiency and with nanotechnology involvement we can expect miracles. Science is getting enriched day by day and this wave of nano-biosensors or nano-based POC devices showed a promising future for cancer diagnosis still a lot more is needed to achieve, that requires synergy between public resources and private investments, joint efforts of health care providers and clinicians and awareness among common people to combat cancer.

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