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Prospective

Lab-on-a-Chip for Ovarian Cancer Monitoring

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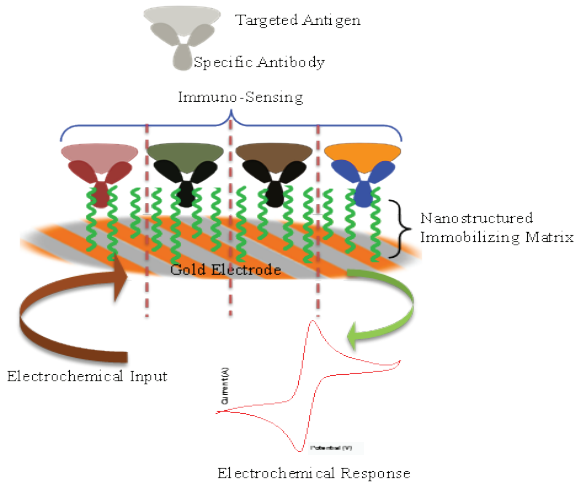
Ovarian cancer is the most deadly of the gynecological malignancies which kills 125,000 women worldwide each year and over 15,000 in USA alone. Studies reveal that early stage (I/II) of ovarian cancer patients has survival rates over 90%, while in advanced stage disease (III/IV), the 10 year survival rate is about 11%. Efforts to explore ovarian cancer-specific biomarkers for the early detection, to improve the dismal survival rate have not been successful.

Genomic and proteomic technologies are being used to identify genes, gene products, and proteins that may be potentially identified ovarian cancer biomarkers [1-3]. However, detection at an early stage is very limited due to the lack of highly sensitive advanced analytical detection tools. Electrochemical immunosensor technique shown promise in the early detection of cancer. However, such smart sensing system do not exist for the specific and rapid detection of ovarian cancer for diagnosis at clinics [4-8]. Potential ovarian cancer markers which are used for diagnosis of ovarian cancer are summarized in table 1. However, use of a single biomarker has not been clinically useful for screening and early detection of ovarian cancer. This represents an opportunity for researchers to develop efficient electrochemical immuno-sensing multiple arrays (Diagnosis-on-chip) [9,10]. These smart devices may be capable to detect multiple biomarkers to increase accuracy as a diagnostic and therapeutic tool. The introduction of nano-enabling sensors would also serve as a potential candidate to detect target analyte at picomolar (pM) to femtomolar (fM) level [11]. Multiple



Scheme 1: Proposed schematic of the electrochemical immunosensing arrays to detect ovarian cancer markers

Ovarian cancer markers	Properties	Remark & ref.
CA125 Cancer Antigen II 125	Diagnostic Expression; Very High Location; Serum Sensitivity; Low Specificity; Low	Highly studied marker for Ovarian Cancer, but lacks sufficient sensitivity/specificity [13]
CA 54/61 Mucin-type Glycoprotein Antigen	Diagnostic Expression; Very High Location; Serum Sensitivity; 50-75% Specificity; 91%	For mucinous cystadenocarcinoma sensitivity 65% (compared with 36% of CA 125) [14]
caGT Cancer Associated galactotransferase Antigen	Diagnostic Expression; Very High Location; Serum Sensitivity; 75% Specificity; 90%	8/9 in clear cell carcinoma [15]
IAP Immunosuppressive Protein	Diagnostic Expression; Very High Location; Serum Sensitivity; 89% Specificity; 91%	Early Detection of recurrence [16]
M-CSF Macrophage colony-stimulating factors	Diagnostic Expression; Very High Location; Serum Sensitivity; 61% Specificity; 92%	Serum level is useful in detecting ovarian cancer [17]
HE4 Human epididymis-specific protein 4 (HE4) encoded with WFDC2 gene	Diagnostic Tumor Marker for Ovarian Cancer Specific and selective	With CA 125, increases sensitivity of a single marker [18]

Table 1. Potential ovarian cancer markers selected for the diagnosis of ovarian cancer

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immuno-sensing electrochemical assays of high throughput should be useful to assess disease progression, drug response, quantification of biomarkers, and for understanding the efficacy and toxicity assessment of treatments [10,12].

The aim of this perspective is to develop an electrochemical immunosensing arrays, fabricated on a single chip i.e., Diagnostic-on-Chip (DoC, Scheme 1), functionalized with multiple ovarian cancer specific biomarkers (Table 1) using nanomaterials (Scheme 1) for screening and detection of ovarian cancer. The employment of nanomaterial will be of use to achieve a low detection limit (pM), a wide detection range, and a good sensitivity. The proposed DoC will be tested on real sample (blood, plasma, or serum) and performance of the sensing device will be validated using ELISA technique. Such DoC can be integrated with a fluidic system for the automation of samples and this sensing assay platform can be miniaturized for point-of-screening purpose and point-of-care (POC) for the monitoring of ovarian cancer progression. This information may be useful to predict clinical outcomes and simultaneously contribute to therapeutic decision-making processes. Such devices are expected to provide better care for patients with ovarian cancer in the future.

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References

1. Ramaswamy S, Tamayo P, Rifkin R, Mukherjee S, Yeang C-H, Angelo M, et al. Multiclass cancer diagnosis using tumor gene expression signatures. Proceedings of the National Academy of Sciences 2001; 98(26):15149-54.

2. Sorace JM, Zhan M. A data review and re-assessment of ovarian cancer serum proteomic profiling. BMC bioinformatics 2003; 4(1):24.

3. Sutphen R, Xu Y, Wilbanks GD, Fiorica J, Grendys EC, LaPolla JP, et al. Lysophospholipids are potential biomarkers of ovarian cancer. Cancer Epidemiology Biomarkers & Prevention 2004; 13(7):1185-91.

4. Mauk MG, Ziober BL, Chen Z, Thompson JA, Bau HH. Lab-on-a-Chip Technologies for Oral-Based Cancer Screening and Diagnostics. Annals of the New York Academy of Sciences 2007; 1098(1):467-75.

5. Soper SA, Brown K, Ellington A, Frazier B, Garcia-Manero G, Gau V, et al. Point-of-care biosensor systems for cancer diagnostics/prognostics. Biosensors and Bioelectronics 2006; 21(10):1932-42.

6. Wang J. Electrochemical biosensors: towards point-of-care cancer diagnostics. Biosensors and Bioelectronics 2006; 21(10):1887-92.

7. Ziober BL, Mauk MG, Falls EM, Chen Z, Ziober AF, Bau HH. Lab-on-a-chip for oral cancer screening and diagnosis. Head & neck 2008; 30(1):111-21.

8. Dixit CK, Kadimisetty K, Otieno BA, Tang C, Malla S, Krause CE, et al. Approaches to Low Cost, High Sensitivity, Automated, Multiplexed Protein Immunoassays for Cancer Diagnostics. Analyst 2015.

9. Cruz AFD, Norena N, Kaushik A, Bhansali S. A low-cost miniaturized potentiostat for point-of-care diagnosis. Biosensors and Bioelectronics 2014; 62:249-54.

10. Kaushik A, Yndart A, Jayant RD, Sagar V, Atluri V, Bhansali S, et al. Electrochemical sensing method for point-of-care cortisol detection in human immunodeficiency virus-infected patients. International Journal of Nanomedicine 2015; 10(10):677-85.

11. Kaushik A, Kumar R, Huey E, Bhansali S, Nair N, Nair M. Silica nanowires: Growth, integration, and sensing applications. Microchimica Acta 2014; 181(15-16):1759-80.

12. Shah P, Kaushik A, Zhu X, Zhang C, Li C-Z. Chip based single cell analysis for nanotoxicity assessment. Analyst 2014; 139(9):2088-98.

13. Jacobs I, Bast RC. The CA 125 tumour-associated antigen: a review of the literature. Human Reproduction 1989; 4(1):1-12.

14. Berek JS, Bast RC. Ovarian cancer screening. The use of serial complementary tumor markers to improve sensitivity and specificity for early detection. Cancer 1995; 76(S10):2092-96.

15. Nozawa S, Yajima M, Sakuma T, Udagawa Y, Kiguchi K, Sakayori M, et al. Cancer-associated galactosyltransferase as a new tumor marker for ovarian clear cell carcinoma. Cancer research 1990; 50(3):754-59.

16. Zou W. Immunosuppressive networks in the tumour environment and their therapeutic relevance. Nature Reviews Cancer 2005; 5(4):263-74.

17. Pollard JW. Tumour-educated macrophages promote tumour progression and metastasis. Nature Reviews Cancer 2004; 4(1):71-78.

18. Hellström I, Raycraft J, Hayden-Ledbetter M, Ledbetter JA, Schummer M, McIntosh M, et al. The HE4 (WFDC2) protein is a biomarker for ovarian carcinoma. Cancer research 2003; 63(13):3695-700.