Semi-automated Ultrasensitive Electrochemical Microfluidic Device for Multiplexed Detection of Cancer Protein Biomarkers

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Accurate, sensitive and multiplexed detection of biomarker proteins holds significant promise for early cancer diagnosis and therapy guidance. Herein, we report a semi-automated design of a simple, molded microfluidic system for on-line capture and detection of cancer protein biomarkers utilizing streptavidin magnetic beads with ~300,000 enzyme labels. The protein analyte is captured from serum or other biological samples, then magnetically separated and washed to remove non-specific binding (NSB) in a separate reaction chamber, with sample residual solutions being sent to waste. After the washing steps, a valve is switched to send the magnetic particles into an 8-electrode detection chamber. Compared to an off-line, manual capture protocol, the on-line capture system has most of the immunoassay steps including protein capture and washing incorporated in the microfluidic device. An 8-electrode screen printer carbon immunosensor coated with glutathione-gold nanoparticles (GSH-AuNP) was used in a microfluidic detection chamber to achieved high sensitivity within a relatively short assay time of 30 minutes. Unprecedented low detection limits of 5 fg mL^{-1} and 7 fg mL^{-1} were achieved for simultaneous detection of IL-6 and IL-8 in serum. Accuracy of this method was demonstrated by excellent correlation of the immunoarray levels of IL-6 and IL-8 in conditioned oral cancer cell media with the standard ELISA. This demonstrated that online capture of cancer protein biomarkers provide a potentially rapid, sensitive and effective tool for cancer diagnostics that can also be adapted to multiplexed detection of proteins.