Early Cancer Diagnosis and Treatment through the Detection of Circulating Tumor Cells Using Drop-based Microfluidics

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This study employs the combination of a drop-based microfluidics platform and polymerase chain reaction (PCR) to create a breakthrough technology that enables the detection of circulating tumor cell (CTC) genes and the isolation of single CTCs from the blood. CTCs are shed from a primary tumor into the vasculature during metastasis, constituting seeds for growth of secondary tumors. CTCs have shown to represent molecular features of the original tumor, and analysis of genetic disruptions within CTCs can give oncologists insights into patients' cancer biogenesis and subsequent progression. Therefore, detection and characterization of CTCs remains the holy grail of early cancer diagnosis and treatment. The extreme rarity and heterogeneity of CTCs in the bloodstream has called for innovative methods to detect and characterize CTCs. Using a drop-based microfluidics platform coupled with PCR, this study allows (1) cDNA molecules from lysed CTCs to be amplified in microfluidic drops and quantitatively detected via fluorescence signal, and (2) intact single CTCs to be encapsulated and amplification-positive drops to be sorted from the remaining cells. To demonstrate the clinical utility of my technology, I analyzed KRAS gene mutations in colorectal cancer to study resistance to EGFR-based treatment as a test case. Thus, my methods present robust techniques for both the diagnosis and treatment of cancers, as well as for the obtainment of a pure CTC sample from billions of cells in the blood. By preserving full single-CTC genomes within each drop, sequencing and characterization results would allow drug therapies based on individual patients' cancer prognosis.

Awards Won:

First Award of $5,000