

Droplet-Based Microfluidics for Point-of-Care Monitoring of Biomarker Levels in Clinical Diagnostics

Biomarkers play an important role in early detection and prognosis; evaluating and monitoring their levels can indicate various clinical conditions of diseases (e.g., cancer and metabolic disorders).¹ However, the traditional diagnostic methods often involve time-consuming laboratory assays, delaying clinical decisions. In recent years, there has been a growing interest in developing portable point-of-care diagnostic tools for rapid and accurate detecting of biomarkers.² However, these biomolecular tests mainly focus on detecting biomolecules intermittently, lacking real-time and continuous monitoring. In our group, we present a novel portable droplet-based microfluidic system, combined with optical sensors, for the real-time continuous and long-term monitoring of biomarker (amylase or lactate) levels. Based on encapsulating samples within discrete droplets, our platform integrates sample acquisition, enzymatic assays, and optical detection, enabling real-time monitoring of biomarker concentrations with minimal sample volumes, reagent dose, and processing time. Moreover, our approach can analyze diverse clinical samples, including blood, interstitial fluids, and drain liquid with high sensitivity, selectivity, and accuracy. In previous work, we have achieved real-time sensing of drain α -amylase activity of patients undergoing pancreatic surgery with a bedside portable droplet-based microfluidic device.³ Among 32 patient samples, 97 % of the results matched the clinical data. This strategy significantly improves the determination time (3 min), the detection limit of 7 nmol/s·L, and minimal material requirement (ca. 10 μ L) and wastes. In the latest work, the portable droplet-based strategy performed well in accurately tracking lactate levels in the blood and interstitial liquid during animal trials, which aims to locally monitor lactate levels to indicate tissue blood perfusions during skin graft surgery. In summary, the droplet-based platform used in biomarkers monitoring brings a big potential in medical diagnosis, disease monitoring, peri-, and postoperative monitoring, and metabolism tracking during exercise.

References

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