Nanoreactors for real time monitoring of the biomolecular markers in clinical diagnostics

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Basic vital parameters of the patient such as body temperature, pulse and respiratory rate, blood pressure can be continuously monitored at the patient's bedside. This is ensured by a series of physical sensors with an electronic readout. In contrast, real-time monitoring of the biomolecular markers still cannot be realized due to the lack of instrumentation that enables stable and continuous detection of biochemical processes with the sufficient time resolution. In acute and postoperative patients, the lack of real-time monitoring of biomarkers may delay adjustment of medical treatment in the event of complications and worsen prognosis.

We propose the system of nanoliter reactors fabricated using the droplet-based microfluidic approach as a tool to solve the aforementioned problem. The liquid can be divided into nanoliter compartments that contain the reagents for detecting different analytes in the sample, e.g. glucose, lactate or other protein-based species. Next, nanoliter compartments are transported towards detector and read-out one-by one, enabling time-resolved monitoring of the biomolecular markers. To enable real-time bedside examination of postoperative patients, we developed a portable, droplet-based fluid device. The clinical validation of the device is carried out using two models: the analysis of α-amylase levels in drainage secretions after abdominal surgery (1) and the lactate levels in blood and interstitial fluid in frames of animal studies (2). The presented droplet-based platform can be applied for analysis of different body fluids, diseases, and towards a broader range of biomarkers, including lipase, bilirubin, lactate, inflammation, or liquid biopsy markers, paving the way towards new standards in postoperative patient monitoring.

References

[1] Xinne Zhao, Fiona R. Kolbinger, Marius Distler, Jürgen Weitz, Denys Makarov, Michael Bachmann, Larysa Baraban, Biosensors and Bioelectronics, 250, (2024) [116034].
[2] Xinne Zhao, Tom A. Schröder, Lars Heubner, Paula Korn, Martin Mirus, Günter Lauer. Peter M. Spieth, Larysa Baraban, Journal.

Figures

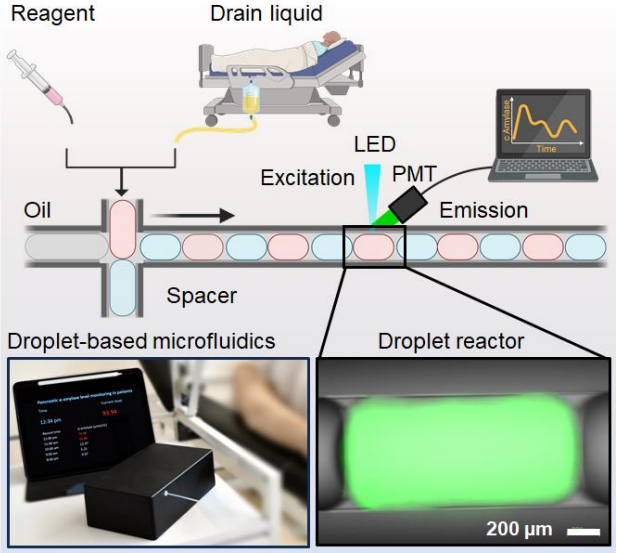

Figure 1. Detection concept: illustration of biomarker concentration detection using a droplet-based detector.