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A Micro-optofluidic Approach Towards Individualization of Dialysis by Continuous Electrolyte Monitoring

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Study: Most outpatient centers use dialysate with fixed electrolyte concentrations. But pre-dialytic serum concentrations of the major electrolytes (Na+, K+ and Ca2+) differ widely between individual patients. This "one-size fits all approach" leads to the occurrence of acute and chronic cardiovascular complications. As the age and additional disorders of the dialysis patient increase in number, a patient specific dialysate is preferable. Electrochemical methods need frequent calibration and are prone to fouling. Optical sensors offer intrinsic electrical safety, miniaturization perspectives, biocompatibility, less fouling and simultaneous real-time measurement of multiple ions. The aim of this work is to develop a fluorescent micro-optofluidic sensor based on photo-induced electron transfer (PET).

Methods: The PET principle exploits the selective quenching of molecular fluorescence. Sensors contain a fluorophore, spacer and an ion-specific receptor. The intensity ratio between fluorescence and absorption gives specific ion concentration. As a first step, we have built the proof-of-concept setup for the validity of the optical excitation and collection system (without a PET sensor). A micro-optofluidic device in poly(dimethylsiloxane) is fabricated with integrated optical fibers. The device is used to observe the fluorescence of Rhodamine B solution.

Results: The typical results show that the fluorescence signal is dependent both on flow rate and temperature, but with an optimized design and an integrated temperature sensor this effect can be compensated. An embodiment with PET molecules integrated into the device for in-line monitoring of electrolytes is foreseen in the coming months.