*Public summary of PhD-thesis of Manoj Kumar Sharma*
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## New measurement tool to individualize dialysis and alleviate side-effects

**Dialysis, for patients with kidney failure, currently has a one-size-fits-all approach as there is no good tool yet for live monitoring of the relevant electrolytes during dialysis. We developed a microfluidic device that opens the door to individualized treatment via live monitoring and adjusting dialysis dose. This can eventually take away some of the serious side-effects of the current one-size-fits-all approach.**

Our kidneys are vital organs that remove excess fluid and toxic nitrogenous waste products from our body. They also maintain the balance of salts (electrolytes) such as sodium, potassium and calcium. These functions of kidneys result in a stable composition of the blood and normal functioning of our body. Persons with kidney failure often undergo regular dialysis treatment. Their blood is cleaned and brought to the right composition by leading it outside the body, and letting it flow along a semi-permeable membrane with 'dialysate' flowing on the other side of the membrane.

Current dialysis practices are based on a 'one-size-fits-all' model in which standard salt concentrations in the dialysate are used for all patients. However, optimal concentrations in blood plasma differ from one patient to another. The 'one-size-fits-all' model oftentimes leads to adverse side effects such as, change in blood pressure, heart rhythm disturbances and renal bone disease. Therefore, live monitoring of the vital salts during dialysis plays a significant role in personalizing the dialysis treatment and thus, mitigating the health complications. Yet, there is a lack of an affordable and a reliable ion-selective electrolyte monitoring method.

In this PhD study, we developed a microfluidic sensor system for live electrolyte monitoring in a fluid. It contains a microchannel (for fluid flow), which is covered with sensor molecules that are fluorescent only when a specific salt is present in the flowing fluid. A small laser lights the microchannel intermittently, to activate the fluorescence. Finally, our device has integrated optical fibers which guide the emitted light to a spectrometer for analysis. Our experimental results clearly show a linear dependence between fluorescence intensity and concentrations of sodium, the most relevant electrolyte. These results are not influenced by the presence of competing ions such as potassium and calcium.

The fluorescent materials are photo-induced electron transfer (PET) sensor molecules. We attached the corresponding PET molecules to the microchannel walls of the device such that the attached molecules do not contaminate the solution.

With this proof-of-concept device, we have demonstrated the technical feasibility of monitoring salt concentration in real time using optical methods. The benefits of this device include low cost, disposability, good stability, high sensitivity among others. The device can be extended to measure other ions such as potassium and calcium by using other PET sensor molecules. The size of the current device is 5x5 cm, but this can be reduced to 1x1 cm for integration in dialysis machines.

The novel and compact sensor system that we have developed in this PhD project is a first step towards individualizing dialysis treatments. It has a great potential to be integrated into the existing dialysis machines. Furthermore, such a sensor system may aid in the development of a portable artificial kidney.

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*Title of PhD-thesis: Development of a micro-optofluidic sensor for in-line electrolyte monitoring: Towards individualized dialysis treatment.*

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