# Methods and tools for exploring vascular calcification mediators in kidney failure and monitoring their removal during dialysis in patients with end-stage renal disease

## Summary

*The overall goal of the project is to explore the optical properties of vascular calcification mediators, mainly the inhibitors of vascular calcification in chronic kidney disease. The extent and dynamics of vascular calcification in kidney failure shall be reviewed, main contributors shall be detected, vascular calcification inhibitor levels and removal shall be studied and optical removal estimation possibilities shall be detected.*

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| Research field: | Biomedicine and health technology |
| Supervisors: | Prof. Dr. Ivo Fridolin<br>Dr. Jana Holmar |
| Availability: | This position is available. |
| Offered by: | School of Information Technologies<br>Department of Health Technologies |
| Application deadline: | Applications are accepted between October 01, 2022 00:00 and October 23, 2022 23:59 (Europe/Zurich) |

## Description

Around 13% of the adult population suffers some form of kidney damage, and the death rate of complications related to chronic kidney disease (CKD) is very high. The primary cause of death in CKD patients is cardiovascular disease. Vascular calcification (VC), one of the cardiovascular complications, is prevailing in CKD. One of the causes of VC in CKD is the disbalance between VC inhibitors and inducers due to failed kidney function. During the dialysis therapy for end-stage renal disease (ESRD) patients, inducers and also inhibitors are removed from the patients' blood. The aim of the research is to explore and develop methods to monitor the levels and removal of VC inhibitors in dialysis patients. The results have potential to improve the life quality and survival of ESRD patients by monitoring disturbances in VC inhibitor balance and in vasculature allowing timely interventions.

The thesis should address the following questions: 1) What are the contributors to highly prevalent vascular calcification in CKD? 2) How many inhibitors are removed during dialysis therapy? 3) How could the removal be monitored?

**Supervisors:**

Main supervisor: Dr. Jana Holmar
Co-supervisor: Prof. Dr. Ivo Fridolin

**Responsibilities and (foreseen) tasks**

- Explore and evaluate the state-of-the-art literature about the contributors of vascular calcification in CKD
- Study possible methods and tools for exploring contribution and removal dynamics of the main vascular calcification inhibitors in the spent dialysate in dialysis patients.
- Perform analyses (Absorbance spectra, Fluorescence spectra, HPLC spectra, MS spectra) of the vascular calcification mediators in biofluids, participation in clinical studies at hospital experimenting with the hemodialysis optical monitoring technology. Setup and run computational vascular calcification mediators removal kinetics models, evaluating data quality. Statistical data analysis and development of algorithms for interpretation of optical signals of spent dialysate. Writing high-level journal publications, attending and presenting the work at leading national and international conferences.

**Applicants should fulfil the following requirements:**

- A clear interest in the topic of the position

- MSc in the field of medicine, biomedical engineering, medical physics, or similar discipline
- Good communication and writing skills in English
- Previous experience in at least one of the following: biofluid optics, metabolomics, biochemistry, signal interpretation, optical design, programming (MATLAB)
- Capacity to work both as an independent researcher and as part of an international team

The candidate should submit a research plan for the topic, including the overall research and data collection strategy. The candidate can expand on the listed research questions and tasks, and propose theoretical approaches to be used.

**We offer:**

- 4-year PhD position in supportive and international research team
- The chance to do high-level research in the area of health technologies and potentially improve the life quality and survival of ESRD patients
- Opportunities for conference visits, research stays and networking with globally leading universities and research centers in the fields of health technologies

**About the department**

The Department of Health Technologies in Tallinn University of Technology combines biomedical engineering and digital health (E-health) competencies, performs innovative research and development activities in the named areas, and offers education at the master and PhD-level. The core competencies of the department lie within:

1. **Biomedical engineering.** The development of flexible and novel sensor technologies and algorithms in biomedical engineering applications.

More specifically:

(1) development of new optical methods and technologies for early diagnosis of atherosclerosis, and digital decision support systems and communication tools for personalised medicine for diagnostics and treatment of cardiovascular diseases;

(2) to develop the applications incorporated into a smart wearable multi-sensor fusion system for generating valuable data about the persons' location, locomotion, physical activity, energy consumption, wellbeing, and physiological status;

(3) development of an optical sensor technology to estimate dialysis adequacy and quality, securing end stage renal disease (ESRD) patients' care quality; optical sensors for liquids analysis;

(4) to detect and interpret the features in the brain electroencephalography (EEG) signal characteristic for mental disorder (e.g., depression), occupational and/or environmental stressors comprising the advanced methods of signal analysis and the knowledge about brain neuronal;

(5) studies and expertise in radiation safety.

1. **E-Health.**

(1) Supporting the development of IT solutions for digitalisation of healthcare and examining interoperability factors (strategies, standards, IT architecture, data sets, databases) needed for the implementation of digital health solutions;

(2) evaluation of digital health technologies and developing the necessary framework for deployment; (3) testing and development of solutions related to personalized medicine.

**Additional information**

For further information, please contact senior research scientist Jana Holmar, jana.holmar@taltech.ee and prof. Ivo Fridolin ivo.fridolin@taltech.ee or visit https://taltech.ee/en/department-health-technologies

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