Karlsruhe Institute of Technology

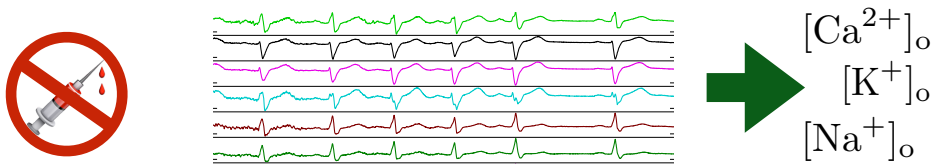
Institute of Biomedical Engineering (IBT)

Student Research Project

Influence of Ionic Concentrations on the ECG Evaluated with a Computer Model of the Heart

Motivation

Chronic kidney disease (CKD) affects more than 30 million patients in the European Union and is characterized by a failure of the renal system to control the electrolyte concentrations in the blood and the whole body within the physiological limits. The altered electrolyte levels (e.g. potassium, calcium, sodium) have massive effects on the affected patients. Often, these effects cause severe consequences such as sudden cardiac death (SCD), which is the most frequent cause of death in the CKD population. SCD is defined as a natural, rapid, and unexpected cardiac death within an hour of symptom onset. Indeed, end-stage CKD patients have a 100-fold increased risk to die from SCD compared to the general population. More than 100,000 CKD patients die from SCD each year. These deaths might be in direct relation with the changes of ionic concentrations. However, up to now, it is very hard to investigate this since there is no device for continuous monitoring. As the electrocardiogram (ECG) changes with different ionic concentrations, the analysis of these signals can help to investigate the connection between changed ionic concentrations and the increased frequency of death.



Tasks

In this project, the effects of different extracellular ionic concentrations on the ECG will be evaluated. Therefore, the Himeno et al. model, which was recently implemented in our multiscale simulation environment, will be used to systematically evaluate the influence of changed ionic concentrations on the ECG. Existing features describing these changes will be evaluated and new ones will be proposed and implemented. These features will be used to investigate the capability of the ECG as a monitoring device. Adequate methods for the reconstruction will be chosen and their performance will be evaluated. Lastly, the simulation study will be extended to other patient models and the results will be compared to estimate the inter-patient variability of the proposed features. Alternatively, the connection between a concentration dependent heart rate and the features can be evaluated. The results will be compared with data from experiments if these data are available or with data known from literature.

Requirements

- Fundamentals of modeling and simulation
- Good fundamentals in signal processing and statistics
- Programming skills in MATLAB and C++

Areas

Modeling & Simulation
Signal processing
Software programming
Machine Learning

Field of Studies

Engineering
Computer science

Earliest Starting Date

January/February 2018

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