Scientific report on the implementation of the project
PN-III-P2-2.1-PED-2019-5446 (contract no. 429PED/2020) entitled
"Smart health system based on artificial intelligence as a predictor for chronic kidney disease development – ArtiPred", Phase 2 - 2021

Related delivered activities:

- *Study of algorithms for ECG signal processing;*
- *Central database for data analysis and web data interface;*
- *Development and optimization of CKD animal models;*
- *Mechanisms of disease generation and progression compared with controls;*
- *Laboratory parameters in CKD and control animals;*
- *Electrocardiogram test;*
- *Validation of data acquisition system.*

Over the years, several new methods were proposed and tested to improve CKD predictability. In 2014, Zachariah et al.[1] found that found that ECG of any patient undergoing CKD, shows some significant changes which can be traced back to CKD. Although there are a number of dynamic changes that occur in CKD, but not all the patients suffer through all the changes therefore more studies are needed to highlight the major changes that can be observed in the majority of kidney patients.

The idea of detecting the presence of kidney disease through machine learning based classification modelling, by processing the patient's ECG signal was presented recently at the International Conference on Robotics, Electrical and Signal Processing Techniques (ICREST).[2] For this model, digitized ECG data was collected from open access databases such as PTB (for kidney patients) and Fantasia (for healthy people) from Physionet Database (www.physionet.org) and the model was later validated using different data from the same online database. The validation process gave satisfactory results, as the model could successfully classify the users from being healthy or a kidney patient. In this study, the authors found an accuracy level of 97.6% which was the highest using both features QT and RR interval, in comparison to the accuracy that was found when either one of the features was used.

The proposed architecture for implementing the ArtiPred system involves the use of a sensor to capture ECG signals (Figure 1A) that will be further processed amongst with other clinical data acquired with medical equipment (Figure 1B). The goal is to establish a clinical framework that will be the basis of the CKD models development. In order to capture the clinical data we will deploy a web interface, which will allow registering and storing the clinical observation of the medical personnel, based on imagistics and biochemistry trials. After establishing the clinical framework and achieve the CKD data models, we will study and experiment specific AI solutions in order to identify the correlations between the ECG data sets and the disease evolution. The main goal is to develop and validate, at laboratory level, an artificial intelligence tool that will allow early diagnosis of the CKD.

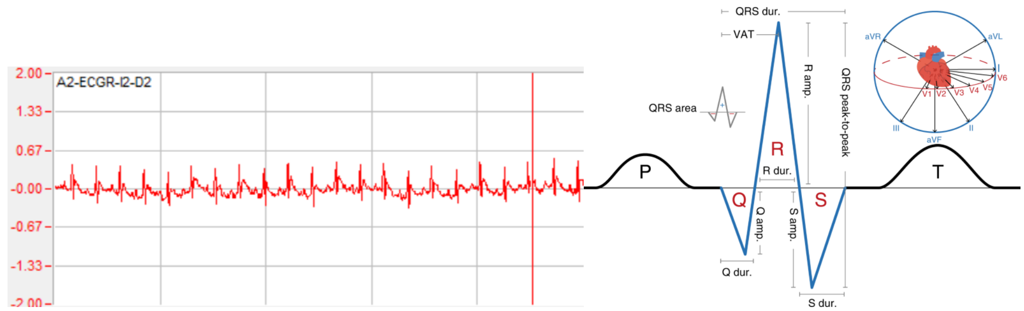

Figure 1. A.ECG data set and B. signal analysis[3]

Conclusion

The deliverables associated with the activities of phase 2:

- *Study of ECG signal data processing algorithms;*
- *Central database deployment and web interface;*
- *Optimized procedure of CKD models;*
- *Biochemical and imagistic database on CKD monitorization and progression;*
- *ECG data sets;*
- *2 posters at national conferences:*
  - IEEE E-HEALTH AND BIOENGINEERING CONFERENCE - EHB 2021, 9th Edition, Iași, Romania, 18-19 November 2021: Electrocardiogram assessment in experimental animals for early detection of kidney disease through artificial intelligence, Ioannis Gardikiotis, Florina D. Cojocaru, Anca Diaconu, Adrian Pasat, George V. Iordache, George Suciu, Ciprian Rezus, Gianina Dodi;
  - Congresul Universității de Medicină și Farmacie "Carol Davila", București, Romania, 25- 27 November 2021: ArtIPred- A Smart health system based on artificial intelligence as a predictor for chronic kidney disease development, Adrian Pasat, George Suciu, I. Pop, Ioana Suciu, Gianina Dodi, Ciprian Rezus.

References

[1] D. Zachariah, P. Kalra and P. Roberts, Journal of Nephrology, 2014, 28: 133-141.

[2] T.M. Rahman, et al., 2019 International Conference on Robotics,Electrical and Signal Processing Techniques. National Kidney Foundation (NKF), About Chronic Kidney Disease, https://www.kidney.org/atoz/content/about-chronic-kidney-disease (accessed on 2nd of October 2019).

[3] K. Norland, G. Sveinbjornsson, R.B. Thorolfsdottir, et al. Sequence variants with large effects on cardiac electrophysiology and disease. Nat Commun 10, 4803 (2019). https://doi.org/10.1038/s41467-019-12682-9