THE HARD REALITY OF SCATTERED DATA TO PREDICT HEART RHYHTM DISORDERS

Carlijn M.A. Buck (1), Marloes A. de Winter (1), Anouk G.W. de Lepper (2), Marcel van 't Veer (1,2), Wouter Huberts (2,3), Frans N. van de Vosse (1), Lukas R.C. Dekker (1,2)

1. Department of Biomedical Engineering, University of Technology Eindhoven, the Netherlands; 2. Department of Cardiology, Catharina Hospital Eindhoven, the Netherlands; 3. Department of Biomedical Engineering, CARIM School for Cardiovascular Diseases, Maastricht University, the Netherland

Introduction

Survivors of myocardial infarction (MI) have an increased risk to develop scar-related ventricular tachycardia (VT) years later. A VT is a heart rhythm disorder which may lead to sudden cardiac death. Guidelines, based solely on symptoms and left ventricular function, insufficiently identify high-risk patients. We envision digital twins (DTs) as a solution. A DT is a virtual copy of your patient which can consider multiple, time-evolving aspects of the underlying pathophysiology by integrating evidence-based medicine, data-driven models and mechanistic models into one hybrid VT prediction model (Fig 1)[1]. We postulate that including time-evolving aspects of the pathophysiology and using hybrid models, possibly leads to better VT predictions.

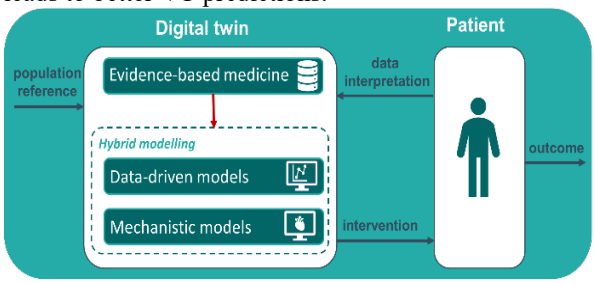

Figure 1: Schematic of a digital twin.

An interesting approach to develop such a DT can be the fast-scale-slow-scale model of Regazzoni et al. [2]. This model uses mechanistic models to simulate the current state of a patient (fast time scale, milliseconds to hours), whereas the change of parameters, i.e., the disease progression, was captured by a data-driven model (slow time scale, days to years) (Fig 2).

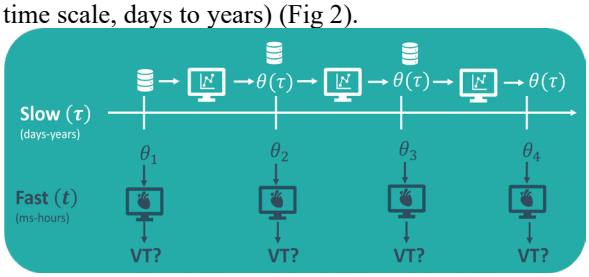

Figure 2: Schematic of the fast-scale-slow-scale model

To develop such a DT there is a need for time-evolving data that are representative for the patient's state over time. However, although an abundance of clinical data is available, they are multimodal, heterogeneous, unstructured and contain missing values. Therefore, before a hybrid model can be created, understanding of the available data is essential. This is the primary aim of this study. Additionally, coupling different multimodal data and analyzing their time-evolving trends might already unravel new useful insights.

Methods

We gathered existing multimodal data (between 1995-2022) of 10 VT and 36 matched MI patients without VT. Dashboards are created to visualize the data and perform exploratory analyses providing the main characteristics and insights in the presence and heterogeneity of the data including clinical context. Subsequently, statistical analysis suggests which data could be of interest as input for the hybrid model.

Results

Lab, ECG, and vital functions measurements are studied. Additionally, diagnosis, medication, and admission data provide context to the results (Fig 3).

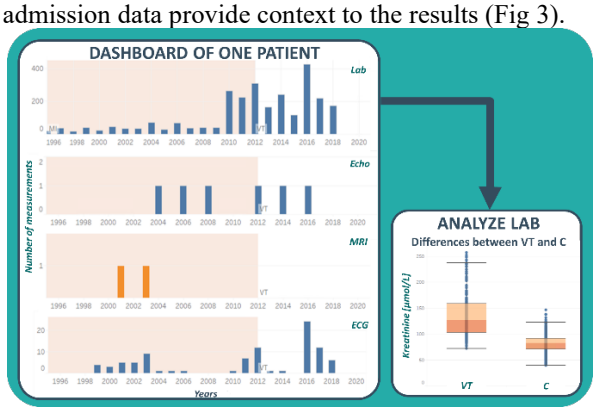

Figure 3: Example of a few dashboard figures.

Discussion

To optimize VT prediction, DTs are needed integrating patient-specific data in a hybrid way using data-driven and mechanistic models. Data is multimodal, heterogeneous, unstructured and contain missing values, making it important to critically select which data to include as model input. Dashboards and statistical analysis are of great usage for this.

References

1. de Lepper et al, J. R. Soc. Interfac, 19:20220317, 2022.
2. Regazzoni et al, Int. J. Numer. Method Biomed. Eng., 37:e3471, 2021.

Acknowledgements

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