HEARTMAN

Personal Decision Support System for Heart Failure Management

MONITORING PHYSICAL AND PSYCHOLOGICAL STATE

INDEX

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In line with the project deliverables, a mobile application (app) for patients and informal caregivers has been developed. It acts as an interface between the users and the backend systems, thus allowing patients to easily interact with and benefit from the HeartMan system.

The app helps Heart Failure patients and informal caregivers manage their physical activity, nutritional needs, mental state, and medication. It does so by using the data collected from connected sensors, manual input, and the decision support system (DSS). Notifications will ask or remind patients to do certain tasks, such as a specific physical activity, play a mindfulness game, take their medication, or connect a sensor to measure a specific function (e.g. heart rate). The patients' progress and status are then displayed in a series of dashboards on their mobile phones. They are also able to manage doctors' appointments through the mobile application.

Informal caregivers can also use the application to view all the information needed. When the application is in 'caregiver mode', it shows all the information displayed in the dashboards, appointments, and notifications. Informal caregivers, however, can only see this information; they are not allowed to enter or edit any measurements or interact with the DSS.
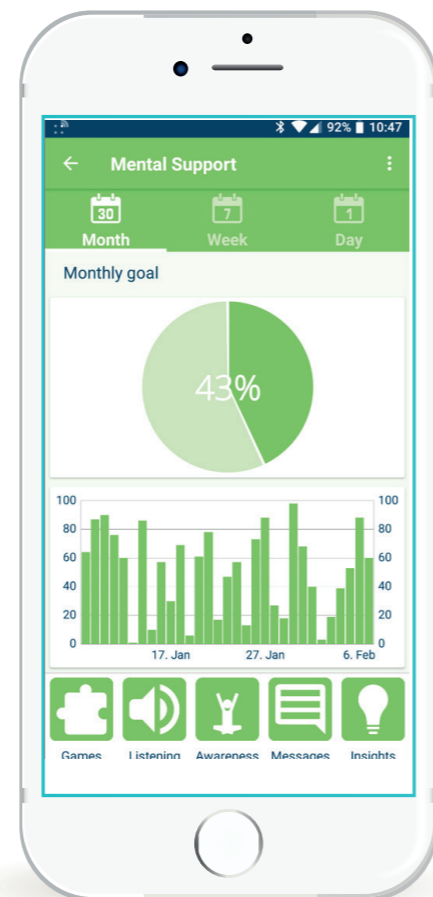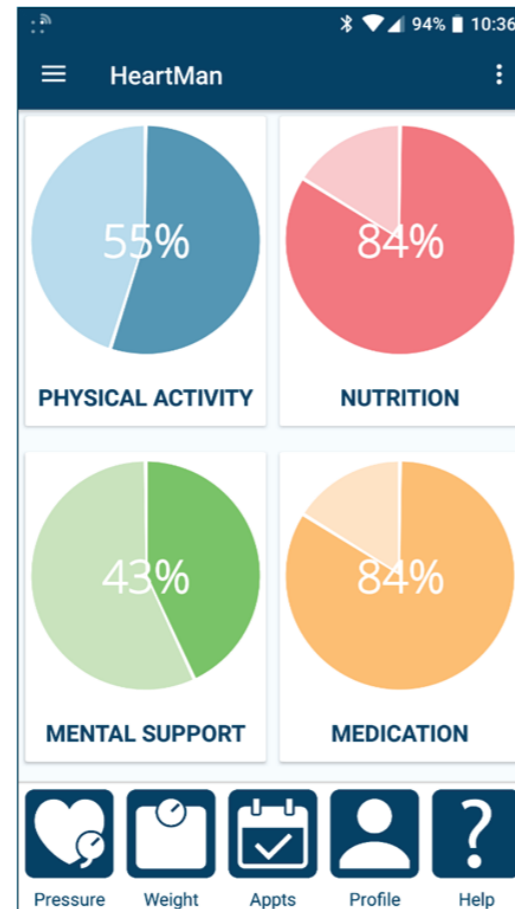
Healthcare professionals have a key role in the **HeartMan's Personal Health System (PHS)**. Therefore, a web portal has been designed to offer them the information they need to follow up on their patients.

Via this web portal, healthcare professionals can monitor the patients' data and response in the Decision Support System (DSS), namely patient health status, adherence to medication, nutrition or exercise plan, etc. The main challenge in the development of the web portal for the Personal Health System is how to deal with requirements' refinement and the flexible adoption of changes to meet the users' feedback. Continuous Integration and Delivery processes are being used to automatically implement and deploy the improvements and make them available in the stable interface that will be used in the pilot.

Through a user-friendly navigation in the web application, doctors can follow patients' evolution by examining the dashboard that combines patient data from HeartMan hard and software with existing health records from hospital systems. The communication with the Interoperability Layer, a standardised HL7 FHIR health data repository, solves the barrier of health information availability.

The PHS web portal for healthcare professionals has two clear objectives: to swiftly provide access to (multiple-sourced) patient data and simplify the interpretation of patient information to improve management of the disease

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As the clinical trials are about to start, the HeartMan consortium has recently concluded its human-centred design studies, optimising the user experience for both the mobile patient app and the healthcare professional portal. In this final stage of the human-centred design process, we made the transition from application mock-ups to the final, functional technology.

The results from the human-centered design enabled us to fine-tune the design of the technology, to best suit the users. As the design process began at the start of the project, user needs and preferences were systematically well-documented, and translated in the various iterations of the HeartMan technology. Prior user tests provided valuable lessons on, for instance,

the use of smartphone apps by an older patient population, and the interaction between patients and their partners in managing their condition.

The final user testing sessions allowed us to "dot the i's and cross the t's" on the functional technology. Similarly, the portal for healthcare professionals will be updated, offering the healthcare professionals a well-organised overview of the relevant patient data. The mobile patient app will be updated with additional navigation cues: this will ensure that the comprehensive information available in the app is still manageable for patients with limited smartphone experience.

In order to support the patients as best as possible, the HeartMan system aims to be aware of and respond to the patient's current situation. In particular, our objective is to have the system recognise when a patient begins to exercise and automatically – via the DSS – switch to exercise mode, thus advising the patient on the appropriate intensity and monitoring the heart rate for safety. In addition, we want the system to recognise eating and resting functions, because these activities are relevant to the cognitive behaviour therapy and mindfulness exercises integrated in the HeartMan system.

The activity monitoring relies on machine learning. This means that we had a number of people perform various activities – those that we aim to have recognised (e.g., eating) and others that appear similar (e.g., playing cards, since this also consists of moderate and frequent hand movements). During these activities, we recorded the data from the accelerometer built into the HeartMan wristband. We labelled each recording with the activity during which it was made and fed these data into a machine-learning algorithm, which learned to associate patterns of accelerometer data with activities. This model is now a part of the HeartMan system.

Predictive models in the DSS
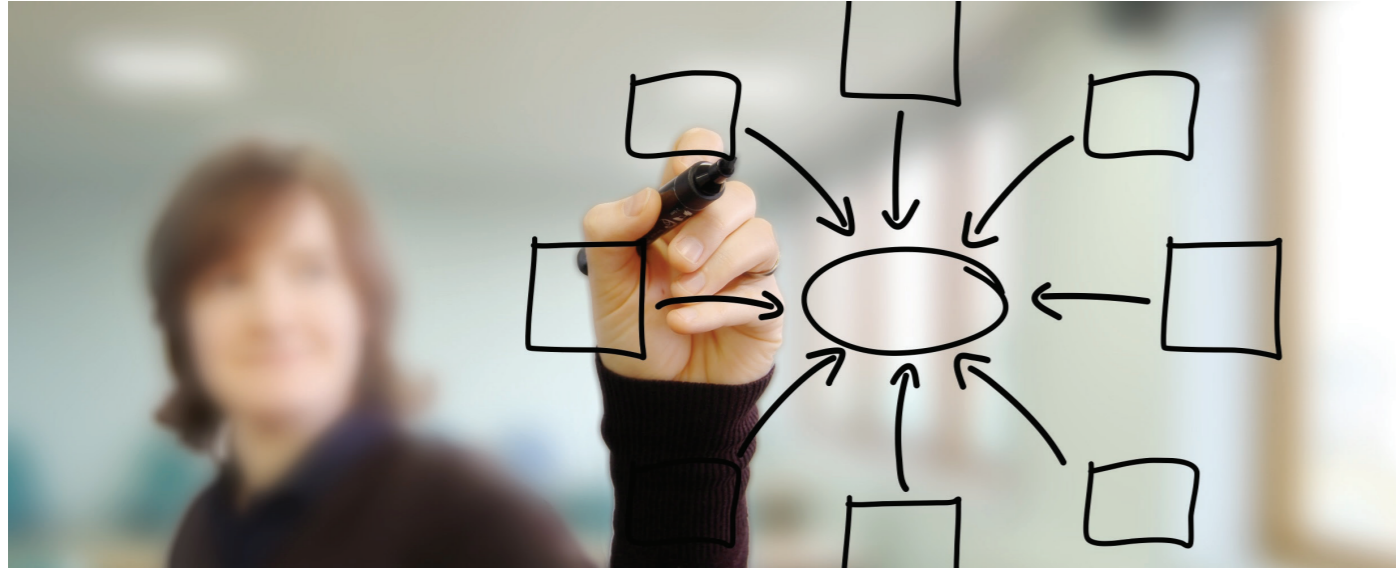
Predictive models are, in a way, similar to the models for activity recognition: in the health domain, they typically use some type of patient data to predict their health or wellbeing. The HeartMan system is no exception. The model was built from data collected in an earlier European project, Chiron, in which we tele-monitored heart failure patients. These patients were also asked about their perceived state of health on a daily basis. This enabled us to build a model that predicts the "feeling of health" from data such as heart rate, physical activity, ambient temperature and humidity.

Given enough data, a predictive model such as the one built from the Chiron data could predict patients' perceived state of

health very accurately. However, as the data currently available are not sufficient, the HeartMan system and advice will be based on the guidelines for self-management of heart failure. Although these are not as patient-specific as a custom-built predictive model could be, they fully rely on all available medical and scientific evidence. Despite these limitations, the HeartMan predictive model is still used to advise on ambient temperature and humidity, since we found this to significantly influence the patients' "feeling of health", even though there is relatively limited medical literature available on this issue. One of the key goals of the HeartMan trials will be to collect more data that can be used to build better predictive models in the future.

Ethical approval of the HeartMan project

The ethical issues that naturally arise from the HeartMan project are handled by those consortium partners who are responsible for the set-up of the trials in their home countries (Belgium and Italy).

Since HeartMan consists of a newly developed wristband, approval is not only required by ethical committees but also by the Federal Agency for Medicines and Health Products (FAMHP) in Belgium and the Ministry of Health in Italy to ensure that the product adheres to all safety regulations.

After an intensive preparation phase by all consortium partners, approval was obtained both by national ethical committees and by FAMHP in Belgium. Approval by the Italian Ministry of Health is expected soon.

The final steps have been taken for the HeartMan trials to start in Belgium in April 2018!

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