PATHway Report Summary
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Periodic Reporting for period 3 - PATHway (PATHway: Technology enabled behavioural change as a pathway towards better self-management of CVD)

Reporting period: 2017-08-01 to 2018-09-30

Summary of the context and overall objectives of the project

Cardiovascular disease (CVD) is the leading cause of premature death and disability in Europe. While community-based phase 3 cardiac rehabilitation (CR) has been shown to be very effective, uptake is low, there is a requirement for a home-based solution.

PATHway is a radically novel approach to CR that empowers patients to more effectively self-manage their CVD. PATHway provides individualized rehabilitation programs that use regular, socially inclusive exercise sessions as the basis upon which to provide a personalized comprehensive lifestyle intervention program to enable patients to both better understand and deal with their own condition and to lead a healthier lifestyle in general. This is made possible by the provision of an Internet enabled sensor-based home exercise platform that allows remote participation in CR exercise programs at any time, by a small group of patients from the comfort of their own living room.

A 6 month usability trial found that PATHway is feasible and acceptable to patients and clinicians for Cardiac Rehabilitation, with very strong positive support for its key components. In addition, it shows preliminary clinical effectiveness for improving adherence to a physically active and healthy lifestyle, even over this short duration of use.

Work performed from the beginning of the project to the end of the period covered by the report and main results achieved so far

Management and oversight of the project (WP1) included: coordination of the Stakeholder Expert Panel, mechanisms for financial support and transfers, and data management and protection.

A comprehensive needs identification and analysis of end-users and stakeholders was completed (WP 2), along with obtaining ethical approval for studies, and development of Exercise and Behavioural Change content.

The key technology components were developed within WP3, including: ‘motion capturing’ and ‘exercise evaluation’, the decision support system, ExerClass and ExerGame interfaces, improved algorithms for recording vital signs signals, integration of a real-time Bluetooth enabled heart-rate system and an outdoor physical activity wrist-sensor, and development of an enjoyment level recognition system for each exercise.

The system architecture, Health Data Management System (HDMS) and main user interfaces (e.g. Patient progress feedback)
were developed and implemented in WP4. Successful validation tests were completed. During the final reporting period maintenance updates/fine-tuning actions were completed in order to support PATHway platform during randomized clinical trial (RCT).

The RCT was developed and successfully implemented within WP5, allowing for testing within Belgium and Ireland on 120 patients (60 PATHway users and 60 controls). All clinical assessments and intervention evaluation debriefs were conducted, providing extremely valuable insight into the acceptability of PATHway by users and evidence of improvements in adherence to a physically active and healthy lifestyle, even over the short 6 month duration of use.

Exploitation, per-commercialisation and dissemination were the focus of WP6. An in-depth analysis of the existing market solutions was completed through continuous industry monitoring of eHealth and tele-rehabilitation markets and technological trends were reviewed, along with reviews of competitors. In addition, an exploitation plan was developed, which included potential business models and associated financial modelling.

As part of WP6, we also examined the requirements for migration of PATHway into healthcare services. This included both (i) an analysis of health care system developments across Europe (as well as China and the USA) to increase impact creation, and (ii) and a survey of patients, clinicians, advocacy groups and hospital and healthcare regulators to understand what is required to encourage the healthcare sectors to ‘adopt’ and ‘recommend’ PATHway in their Cardiac Rehabilitation centres.

In terms of dissemination and exploitation, the project has resulted in: 32 scientific publications in peer-review journals and peer-review International Conferences, 4 workshops co-located at International Conferences; along with 21 press coverages, and over 10,000 visitors the to PATHway website. In addition, we have present at 18 clinical networks, 8 hospitals and 14 tradeshows, and delivered 8 clinical workshops. Finally, we have 3 invention disclosures and 8 re-use of software/technologies in other projects. To ensure further reusability of PATHway core technologies, appropriate channels for their distribution were identified and given components were published in the RAGE marketplace.

**Progress beyond the state of the art and expected potential impact (including the socio-economic impact and the wider societal implications of the project so far)**

PATHway is the first mHealth system designed specifically for unsupervised, socially inclusive cardiac rehabilitation that provides intensity and action specific exercises, through immersive class- and game-based experiences. The ongoing sensing of the user along with a specialised decision support system provided unique personalisation within the rehabilitation programme. It also provided a comprehensive lifestyle intervention programme based around goal-setting and the latest behavioural change theory. This unique approach allowed patients to better self-manage their own health. The design was driven by novel, extensive research of the users’ needs translated through a use-case based requirements specification process.

Many of the individual technical components that comprise PATHway also extend current state of the art. The motion analysis module provides advanced action detection, movement recognition and technique evaluation of cardiac rehabilitation specific exercises. ECG recording techniques were enhanced through miniaturisation and optimal placement of electrodes, along with improvements in filtering techniques specifically designed for vigorous exercise-based activities. The DSS allows for safe and tailored exercise programmes. The emotion recognition module improves the ability to automatically determine a patient’s enjoyment level of each exercise, which could allow the exercise intervention to be further tailored to the individual patient. 32 scientific publications in peer-review journals and peer-review International Conferences provide details of this progress beyond the state of the art.

The overall feedback on the usability of the system by the users and stakeholders was predominantly positive, with a mean satisfaction rating of 7/10. Despite the intervention only lasting 6-months, PATHway significantly increased the amount of
physical activity of patients in Cardiac Rehabilitation, which has the potential to significantly reduce all-cause mortality and provide considerable protection from cardiovascular risk factors and co-morbidities, leading to longer independent living in the long-term. While over the 6-month period PATHway did not reduce the risk of cardiovascular disease or statistically affect the quality adjusted life years (QALYs) and health costs, this is likely to be due to the short duration of the intervention and the fact that participants were already optimally medically managed at the start of the trial. The potential impact of PATHway will be best judged following a more long-term intervention when the benefits of the previous phase 2 cardiac rehabilitation are no longer evident and the comparison with usual-care is more valid. Under such conditions PATHway, if more effective than usual-care, will have the potential to improve health outcomes and reduce healthcare costs (e.g. medical care, hospitalizations).