Abstract

Cardiovascular diseases (CVD) are the leading cause of death in the Western world. Several modifiable risk factors contribute to the pathogenesis of CVD which are all addressed during cardiac rehabilitation (CR). CR is conducted in three phases: I: acute care hospital, II: subsequent in- or outpatient CR, and III: outpatient CR with focus on lifelong prevention. Despite its proven merits, the adherence to healthy lifestyle changes following completion of CR phase II is challenging. This gap is addressed in recent recommendations, suggesting that clinicians should help patients to set personal goals to i) achieve and maintain the benefits of physical activity, ii) include physical activity into their daily routine and iii) overcome barriers to exercise, to achieve behavior change more effectively and more sustainably. We have developed tele-rehabilitation services to support patients during home-based exercise training in CR phase III. Our services provide a link between CR experts and patients by means of individualized exercise prescription supported by different kinds of wearables for measuring e.g. physical activity volume. The effectiveness of such services and other supportive measures regarding adherence to home training plans and changes in exercise capacity during CR phase III CR is currently evaluated in a study.

1. Introduction

Cardiovascular diseases (CVD) are the leading cause of death in the Western world with substantial micro- as well as macro-economic burden [1-3]. Several modifiable risk factors contribute to the pathogenesis of CVD which can be addressed during cardiac rehabilitation (CR). CR is a comprehensive multi-phased secondary prevention framework which has proven to reduce mortality in CVD patients [4] as well as lower its economic burden [5].

Increasing physical activity and exercise capacity are one of the main goals during CR because they have favorable effects on multiple cardiovascular risk factors [6] and have shown to be strongly associated with lower mortality in CVD patients [7, 8].

CR is conducted in three phases: I: acute care hospital, II: subsequent in-clinic or out-patient CR, and III: outpatient CR with focus on lifelong prevention. Enrollment in CR phase II should take place as soon as possible once a patient meets one of the well-established indications [9]. CR phase II can be carried out in an inpatient (IN-II) or outpatient (OUT-II) CR facility. Notably, in the Austrian health care system, IN-II is standard, which stands in contrast to other European countries [10].

Following phase II, an outpatient phase III (OUT-III) enrollment is offered with weekly visits at the outpatient CR facility. In general, international secondary prevention guidelines advocate physical activity recommendations, i.e. ≥ 150 min of moderate intensity or ≥ 60 to 75 min of vigorous exercise each week [11]. But it is well established that additional benefits without adverse effects occur with even more physical activity [12] and thus should be personalized and if indicated, gradually increased. Notably, the greatest benefits to health are likely to be achieved by increases in physical activity in subjects with more advanced disease and sedentary persons [7].

Despite its proven merits, the adherence to regular physical activity following completion of CR phase II seems challenging and the long-term preservation of recommended physical activity volume and exercise capacity is disappointing [13, 14]. This gap is addressed in recent recommendations [11], suggesting that clinicians should help patients to set personal goals to i) achieve and maintain the benefits of physical activity, ii) include physical activity into their daily routine and iii) overcome...
barriers to exercise in order to achieve behavior change more effectively and more sustainably.

The rapid growth and availability of mobile health (mHealth) technology, such as wearable-trackers and smartphone-based application programs (mobile apps), provide a novel opportunity to address these recommendations. Notably, the proliferation of mobile technology reached even individuals 65 years or older with already four-in-ten seniors being smartphone owners and continuously increasing availability in these individuals. Different aspects of behavioral change, which pave the road to increase physical activity and exercise capacity, may be addressed by mHealth interventions: patient education, modelling, environmental restructuring and enablement as well as incentivisation and coercion [15, 16]. Additional opportunities of mHealth in CR are tailoring care to individual requirements and to get access to groups which are otherwise hard to reach.

The present paper describes the implementation and evaluation of telehealth services which support home-based rehabilitation for cardiac patients, with the aim to increase long-term adherence to physical activity and improve the outcome of CR.

2. Methods

2.1. Telehealth Services

Two tele-rehabilitation services to support patients during home-based exercise training in CR phase III were developed. The services provide a link between CR experts and patients by means of individualized exercise prescription supported by different kinds of wearables for measuring e.g. physical activity volume. Details of both services are described in the following.

2.2. heartfish app

The heartfish app is a certified medical product designed to improve adherence to therapeutic and medical treatments in cardiometabolic prevention and rehabilitation. The core of the product are digital biomarkers, i.e. consumer-generated physiological and behavioral measures collected with digital tools. These data are used to continuously measure adherence to therapeutic and medical recommendations and to monitor the user’s current cardiometabolic risk. Based on these digital biomarkers, the integrated dual coaching system enables service providers to intervene immediately and tailored to the individual needs of the patient. A screenshot of the app’s activity screen is shown in Fig. 1.
2.4. Evaluation

The effectiveness of such services and other supportive measures regarding adherence to home training plans and changes in exercise capacity during CR phase III is currently evaluated in the EPICURE (Evaluation of multimodal supportive actions in outpatient cardiac rehabilitation in subjects with cardiovascular disease) study. The study protocol was approved by a local ethics committee and registered at ClinicalTrials.gov (NCT04458727). An overview of cardiac rehabilitation phase III and the EPICURE study is provided in Fig. 3.

3. Results

3.1. heartfish app

The medical concept on which heartfish is based reflects the requirements for outpatient CR and fits seamlessly into existing structures and processes. heartfish offers a customizable training program, individual recommendations, progress visualization, a multi-level adherence warning system and a dual coaching system to support both patients and service providers, especially during home-based training phases.

3.2. KIT telehealth service

For tele-rehabilitation, a specific disease plugin was developed. In addition to recording of various vital parameters (blood pressure, heart rate, body weight, subjective wellbeing, etc.), this plugin also supported a) tele-training with different kinds of activity trackers and smart watches and b) different training profiles (e.g. interval training, etc.).

3.3. EPICURE study

The EPICURE study started in autumn 2019 in five CR centers in Austria. At the moment (August 2020), 48 patients have finished the trial.

Out of five rehabilitation centers participating in the study, two centers used the heartfish app, two centers used the KIT telehealth service, and one center did not use a specific telehealth service to support their patient during home-based training.

Since – due to the CoVID-19 lockdown – recruitment was delayed especially in March to June 2020, we are currently prolonging the study period.

4. Discussion

Since the EPICURE study is still ongoing, details concerning the study results can only be analyzed and published after the end of the study.

During the CoVID-19 lockdown from March until June 2020, no CV at rehabilitation centers was allowed. However, home training as supported by our solution was possible. Therefore, patients already included in the study before the lockdown could continue their rehabilitation. Still, since no new patients could be recruited during the lockdown, the overall study duration had to be prolonged. However, the past months have shown that telehealth solutions might be a valuable alternative to training in the rehabilitation centers, especially while CoVID-19 is not completely under control.

5. Conclusion

Telehealth services for home-based rehabilitation of cardiac patients have the potential to improve long-term
adherence to physical activity, even in situations when no training in rehabilitation centers is possible.

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References


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