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STEMI-CR: Solution for Patients with Acute Myocardial Infarction at Home-Based Cardiac Rehabilitation Program

Pinheiro Candjondjo[a,b,*], Elisabete Vaz[a], Sara Marques[a], José Moreira[a,c]

aNational School of Public Health, Universidade NOVA de Lisboa, Avenida Padre Cruz, Lisbon 1600-560, Portugal
bHospital de São Bernardo, Centro Hospitalar de Setúbal, Rua Camilo Castelo Branco, Setúbal 175, 2910-549, Portugal
cPortuguese Oncology Institute of Lisbon, Rua Professor Lima Basto, Lisbon 1099-023, Portugal

Abstract

STEMI - CR (ST Elevation Myocardial Infarction - Cardiac Rehabilitation) is a program based on a model of home monitoring through digital tools (mobile application and website) in patients who have suffered acute myocardial infarction. This solution found in information technology will be used to address the delivery of services with remote operation between patients and health professionals and allows the delivery of home services through a cardiac recovery program in post-myocardial infarction patients through the automation of PROM's (Patient Reported Outcomes Measures) and biometric/electrocardiographic data monitored in real time, which can be incorporated into the hospital clinical record. The platform brings together several resources, such as exercise prescription, diet and medication, monitoring exercise plan, prescription history and recording the symptom. It will also be possible to have an avatar, gamification challenges and a communication area (social network), so that patients included in the program can enhance interaction and share their experiences about the various recommended activities and their impact on quality of life. It is based on this conception that any pharmacological and non-pharmacological guidelines can be based, with the expectation of greater patient adherence to CR programs and a significantly impact on the respective prognosis.

Keywords: Cardiac Rehabilitation; Acute Myocardial Infarction.

* Corresponding author. Tel.: +351 937 413 507.
E-mail address: apc.candjondjo@ensp.unl.pt

1. Introduction

At a global level, in 2019, seven of the top ten causes of death were due to noncommunicable diseases, with ischemic heart disease accounting 16% of total deaths. Since the year 2000 it is a disease with the highest increase in deaths, rising about 2 million to 8.9 million deaths in 2019 (1). These deaths occurred mainly in individual's adulthood and in the active. Therefore, these events have a high economic and social impact on the countries. In Portugal, intervening in prevention is also a priority for health policies. Since 1964, WHO defined Cardiac Rehabilitation (CR) as a premise for the successful treatment of patients with heart disease. Half a century later, Portugal still has a long way to go when it comes a implementing these programs. CR care may start in the inpatient hospital setting, but its most significant component takes place over the long term in the outpatient setting as an integrated program. CR is a key element of phase II for patients after acute coronary events, bypass surgery, percutaneous coronary intervention, valvular surgery, heart transplantation, stable coronary disease and heart failure.

The geographical dispersion and lack of these centres are two of the factors that contribute to the low adherence of patients to rehabilitation treatment. The high costs (economic and personal/family costs) due to travel, as well as the difficulties experienced not only by patients but also by professionals in maintaining high levels of motivation, are also causes pointed out below adherence to programs. In addition to these factors, the pandemic situation due to the SARS Covid2 virus has aggravated the situation (2).

Nowadays, CR programs, in addition to promoting functional capacity, also seek to be levers for the adoption of healthy lifestyles for patients and their families.

It was in this context that the STEMI-CR project emerged. A digital platform created for healthcare professionals to monitor several variables related to CR programs in patients after percutaneous intervention (phase II, post-AMS), and to issue individualized exercise prescriptions adapted to the evolution of each patient's program. Besides this monitoring, it also allows a constant and continuous contact between professionals and patients in an interactive social network on the platform, with the purpose of improving the quality of life in its various aspects and has the added value of the presence of Avatar with gamification challenges. We then have an alliance between the smartphone, smartwatches and the web, inseparable tools of our daily lives.

The article will be divided into 5 phases. The background, where the problem will be characterized and where the needs that gave rise to the project will be explained according to the literature review; The Home-based solutions based on technology for rehabilitation of patients with myocardial infarction. In this phase we will characterize the STEMI-CR rehabilitation program, eligible people, etc. And we will also specify the requirements/functionalities of the STEMI-CR app, how the quality assurance and quality control were structured; The Benchmarking, where we will perform a comparative analysis of the STEMI-CR app with other solutions on the market, showing the competitive advantage. We shall end our article with a conclusion, where, in a synthetic way, we will identify the challenges that we faced during the development of the project and which future work will be carried out, so that the application can be put into production. The bibliographic references that served to support the article will also be made available.

2. Background

Ischemic heart disease, with a declining in Europe, cause 862,000 deaths/year (19% of all deaths) among men and 877 000 deaths at women each year (3). The incidence related to STEMI is decreasing at the United States of America (USA) and European level, may be related to advances in pharmacotherapy, greater accessibility of primary intervention and development of clinical guidelines (3). However, each year in USA there are approximately 258 000 STEMI presentations to the emergency department, with an incidence rate of 7.3 per 10 000 (4).

When hospitalized, early discharge (48-72hours) should be considered in low-risk patients, with targeted follow-up and early CR, at a level of recommendation and evidence IIa-A (5).

The main interventions after acute myocardial infarction involve changing lifestyles, such as smoking cessation, blood pressure control, suitable weight, balanced diet and incentive to physical activity. During hospitalization, time is limited to consolidate knowledge to secondary prevention and a multidisciplinary intervention is essential (5).

In order to changing lifestyles, control and optimize the prognosis of coronary heart disease, the implementation of a CR programs is important. CR program can start in hospitalization (phase I), but it most significant component happen in the long-term at outpatient setting (phase II), an integrated program, after acute myocardial event. Over the years, CR programs have evolved and make relevance due to their effectiveness in the physical, social and mental components of the patients who participate in them (6).

The CR at a level of recommendation and evidence I-A by the European Society of Cardiology, with benefits well described the literature, in cardiac patients, namely those with coronary ischemic disease. The implementation of CR is being carried out at a slowly, although its benefits are well recognized. In Portugal, only 8% of patients discharged after AMI are included in CR programs, a clear underutilization of the needs verified. In Europe, the percentage of admission to these programs is on average 30%, while in the USA it is between 20-30% (7).

Assuming that current clinical practices are maintained, the prevalence of heart failure in mainland Portugal will increase by 30% in 2035 and 33% in 2060, compared to 2011, resulting in 479 921 and 494 191 affected individuals, respectively (8).

Since CR programs are very scarce across the entire national territory, there is an urgent need to define strategies to improve their population coverage. Several causes have been pointed out for the delay in implementing these programs: asymmetry in the geographical distribution of cardiology centers, the high costs carried out by the patient to transport to CR centers, absenteeism by caregivers, not be structures in the community that allow the practice a monitored physical exercise, even due to the insufficiency of health professionals with competence of providing care to these patients.

The year 2020 and the pandemic situation caused by the SARS Cov2 virus, further aggravated this situation. Therefore, it is urgent to introduce new strategies that aim to reduce these problems and that contribute in a more effective and efficient way in the dynamism of CR programs. To monitoring the patient after hospital discharge, the platform to be developed allows constant and continuous contact between professionals and patients in an interactive social network, with the aim of improving the quality of life. It is intended to promote systematic monitoring of patients after cardiac intervention, minimizing the associated costs and optimizing the human resources and structures / equipment existing in the cardiology service of a given hospital. It is therefore essential to monitor CR programs in phase II of all patients accepted for the program after acute myocardial infarction, as well maintaining safety strategies in view of the current pandemic.

3. Home-based solutions based on technology for rehabilitation of patients with myocardial infarction – STEMI-CR

3.1. STEMI-CR project – Characterization

STEMI-CR consists of a digital platform with integrated features of an application for health professionals, a web for patients integrated into the CR program, and a mobile application for smartphones and tablets. The digital application allows the delivery of home services of a CR program in post-myocardial infarction patients through the automation of PROM's and biometric and electrocardiographic data monitored in real time, which can be incorporated into the records hospital clinics.

The functionalities allow access to different profiles, such as exercise prescription, diet and medication, monitoring of the exercise plan, history of prescriptions, symptom registration, avatar with gamification challenges and a social network communication area for patients in the program that is expected to be a means of interaction for the sharing of experiences regarding the practices of recommended activities and their impact on improving the quality of life.

3.2. Designing a solution for addressing the needs of people with rehabilitation need

There are a variety of applications that combine several features designed to be applied in CR programs that we propose to develop. In general, the solutions based on technologies that have been used to address the delivery of CR services remotely between patients and health professionals allow to overcome some of the barriers in the participation of the CR and show potential as an alternative or complementary options for individuals who consider traditional CR programs based on difficult-to-access centers and allowing interventions without continuous personal contact, which offers an opportunity to reach large numbers of people and the potential to provide long-term follow-up (9). CR care can start during hospitalization, but its most significant component occurs in the long term in an outpatient setting, as an integrated program.

Regarding quality assurance, standard's already known from other existing applications were used and discussed previously. Regarding quality control, periodic verification of requirements is carried out, as well as the final review of the effective functionality of the designed application.

4. Benchmarking

For our analysis we only consider apps designed specifically for the CR context. In these context mobile health apps have the potential to enhance the CR through a set of available features that combined help to achieve the desired results. Our application aims to bring together all the features that we find separated in other apps and that we believe can add value to the CR program. Most of the applications have medication, diet, and exercise monitoring but less of them have psychological support and gamification. Social networks and virtual avatars are the less found features (10)

Table 1 - Benchmarking - Technologic solutions

Features	SmartCR (11)	Movida.eros (12)	VA fitHeart (13)	STEMI-CR
Biometric Data	✓	✓	✓	✓
Medication	✓	✓	✗	✓
Diet	✗	✓	✗	✓
Exercise Monitoring	✓	✓	✓	✓
Symptom record	✗	✓	✗	✓
Psychosocial support	✗	✗	✗	✓
Personalized Clinical feedback	✓	✓	✓	✓
Social Network	✗	✗	✗	✓
Gamification Rewards	✗	✗	✗	✓
Virtual Avatar	✗	✗	✗	✓
Notifications	✓	✓	✓	✓
Education Material	✓	✓	✓	✓
Public Access	✗	✗	✗	✗
electrocardiographic monitoring	✗	✗	✗	✓

5. Conclusion

CR care can start during hospitalization, but its most significant component occurs in the long term in an outpatient setting, as an integrated program.

Integration into CR programs begins upon hospitalization, and its implementation is an asset after clinical discharge. It intends to present a technological solution that consists of a remote monitoring system or as a complement to the conventional CR program. Thus, it will be possible to provide real-time feedback of various biometric and clinical parameters between users and health professionals and, if necessary, with the appropriate pharmacological and non-pharmacological medical guidelines, and which is expected to improve patient adherence to CR programs and with a positive and significant impact on patient's prognosis.

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