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[Deliverable 6.6-D41]  
WP6 – Validation and evaluation of tools and services

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This report entails the evaluation of Phase 1 of the Do CHANGE project, which is an official deliverable, due on the 1st of June 2018.

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Internal reviewers: Alex Galobart and Valentina Tageo (BSA), Ben Fletcher (DSD), Peter Peters (TUE) and Ad van Berlo (SmH)
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Statement of originality:
This deliverable contains original unpublished work except where clearly indicated otherwise. Acknowledgement of previously published material and of the work of others has been made through appropriate citation, quotation or both.
Executive Summary

Current deliverable describes the results of the total six months of the Do CHANGE 1 trial (data collection between January 2017 and September 2017). This trial has been set up to pilot the ecosystem and generate data and input for the second trial (Do CHANGE phase 2) where all devices will be provided to patients together with the Do Something Different program. The results of the current trial will reflect the effectiveness of the phase 1 intervention where patients received the CarePortal, a blood pressure monitor and Moves app together with the Do Something Different program. It is important to keep in mind that this deliverable entails the first 4 domains of the proposed MASH model (e.g. Health problem and characteristics of the application, Data privacy and patient security, Effectiveness, and User aspects) and that the tested only a part of the total ecosystem that will be implemented in the Do CHANGE 2 trial. Statistical analyses were performed in order to measure the effectiveness of the Do CHANGE 1 ecosystem.

Current study is considered and presented as a proof of concept. Considering the relatively small sample size (N = 149), it was not expected to find any significant results. Nevertheless, blood pressure was significantly reduced in the intervention group. Furthermore, the Dutch intervention group showed a decrease in reported negative habits after 6 months compared to the care as usual group. Other changes in the overall intervention group versus the care as usual group could not be found. An explanation might be the ecosystem implemented with Do CHANGE 1 was not personalized enough in order to have a real positive effect on lifestyle change in patients with hypertension, cardiovascular disease and/or heart failure.

A remarkable 82.4% of the patients participating in the Do CHANGE 1 trial fulfilled the intervention. The ecosystem is experienced as useful, easy to use and seems to be integrated relatively well into the daily life of the patients. It made the participants more aware of the fact that they must undertake activities themselves in order to feel better. Also, patients report to feel more ‘safe’, because healthcare professionals were watching along. It reduced some burden regarding the cardiac disease.
List of abbreviations

**BSA**
Badalona Serveis Assistencials

**CAD**
Coronary Artery Disease

**Do CHANGE**
Do Cardiac Health Advanced New Generation Ecosystem

**DSD**
Do Something Different

**ETZ**
Elisabeth-Tweesteden Ziekenhuis

**GAD-7**
Generalized Anxiety Disorder questionnaire 7

**HF**
Heart Failure

**HPLP-II**
Health-Promoting Lifestyle Profile II questionnaire

**HT**
Hypertension

**PHQ-9**
Patient Health Questionnaire 9

**UTAUT2**
Unified Theory of Acceptance 2 questionnaire

**WHOQOL-Bref**
World Health Organisation Quality of Life questionnaire
Table of Contents

1. About this Document 6
   1.1 Purpose of this document 6
   1.2 Deliverable context 6
   1.3 Structure of this document 6
   1.4 How to use this document 6
2. Study design 7
   2.1 Introduction 7
   2.2 Objectives 7
   2.3 Methods 7
   2.4 Statistical Analysis 10
3. The Do CHANGE evaluation framework: the MASH model 12
4. MASH – Domain 1: Health problem and characteristics of the application 13
   4.1 Introduction 13
   4.2 Health problem 13
   4.3 Baseline characteristics 14
      4.3.1 Baseline characteristics patients 14
      4.3.2 Baseline characteristics healthcare professionals 15
   4.4 Number of eligible patients 16
5. MASH – Domain 2: Data privacy and patient security 17
   5.1 Introduction 17
   5.2 Perspective patients 17
   5.3 Perspective Healthcare professionals 17
6. MASH – Domain 3 & 4: Effectiveness & User aspects 18
   6.1 Introduction 18
   6.2 Patient experience 18
      6.2.1 Quantitative patient experience 18
      6.2.2 Qualitative patient experience 19
   6.3 Caregiver & Healthcare professional experience 20
      6.3.1 Caregiver experience 20
      6.3.2 Healthcare professional experience 20
   6.4 Physical outcomes 20
   6.5 Do Something Different (DSD) 22
   6.6 Lifestyle 26
      6.6.1 Total score HPLP II 26
      6.6.2 Subscales HPLP II 27
   6.7 Quality of life 27
   6.8 Depression 30
   6.9 Anxiety 31
   6.10 Healthcare Consumption 32
   6.11 Subgroup analysis 33
7. Discussion 35
8. Conclusion 38
1. About this Document

1.1 Purpose of this document

This document aims to present the evaluation of the outcomes of the first phase trial of the Do CHANGE ecosystem. This evaluation takes into account the data collected on baseline (T0), three - (T1), and six months (T2) after implementation of the Docobo CarePortal™, Do Something Different program, blood pressure monitor, and Moves App at the pilot sites in Spain (Badalona Serveis Assistencials) and The Netherlands (Elisabeth-Tweesteden Ziekenhuis). Because of difficulties performing the first phase trial in Taiwan, it was decided that Buddhist Tzu-Chi Dalin General Hospital would only recruit patients in the second phase trial. This data is generated to further explore and improve the options for the second phase trial.

1.2 Deliverable context

This deliverable is part of Work Package 6: Validation and evaluation of tools and services. The main objectives for this work package involve: (1) detailing and finalising the evaluation framework and methodology for the new technological tools and services developed in the context of the project and to test them in controlled environments, (2) detailing and finalizing the study design and the methodology for pilot evaluation, (3) defining the implementation and deployment planning for the trial sites, to consolidate and set-up all the necessary structure for pilot deployments, (4) recruiting users to participate in the pilots’ interventions according to the specifications of D6.3, (5) setting-up and carrying user mentoring and operation support, (6) ensuring that the pilot sites follow the Ethical and Legal Manual according to the specifications of D1.4, (7) ensuring that each trial is carried out in accordance with the common protocol, (8) reporting on the results of implementation and testing activities to feed the iterative co-design process in WP2, and (9) reporting on the results of all pilots according to common scientific standards and feeding the evaluation results into exploitation and support activities.

1.3 Structure of this document

Chapter 2 gives an overview of the study design of the first phase trial of Do CHANGE.

Chapter 3 describes shortly the MASH model that is used as the starting point of the evaluation of the ecosystem.

Chapters 4 to 6 entail the description of the general results based on the MASH model.

Chapter 7 and 8 contain the discussion based on the results and conclusions that can be drawn from it.

1.4 How to use this document

Each piloting site has been provided with a template to present its individual report on the Phase 1 Evaluation Report. A clear versioning system (e.g. ETZ_Deliverable_6.6_v0.1.docx) has been put in place due to the considerable amount of document exchanges and subsequent improvements.
2. Study design

2.1. Introduction

To evaluate the ecosystem that is implemented in the first phase trial of Do CHANGE, a mixed-methods assessment was used. Information that was drawn out of this method will be used to further improve the ecosystem for the evaluation of the second phase trial, which entails the entire intended ecosystem that uses different additional lifestyle devices (e.g. Fitbit, Beddit, etc.).

2.2. Objectives

As defined in the research proposal, the objectives for the current pilot trial are:

**Primary objectives:**

- To improve self-management and lifestyle.
- To increase quality of life.
- To improve behavioral habits and flexibility of patients with coronary disease, heart failure or hypertension.

**Secondary objectives:**

- To assess satisfaction, usability, and acceptance of the intervention (tools).
- To assess cost effectiveness of the intervention*.
- To evaluate changes in health care consumption.

**Exploratory:**

- To assess subgroups that are more likely to benefit from the intervention based on their psychological, clinical, and demographic profile*.
- To examine whether physiological measures (e.g. ECG, blood pressure, weight) improve (in the intervention group)*.
- To gain more insight in patients’ sleep patterns and physical activity (in the intervention group)*.

*Not described in current deliverable.*

2.3. Methods

*Study design*
Do CHANGE is a H2020 Research and Innovation Action project, including a multicenter, international (Taiwan, Spain, and the Netherlands), randomized controlled trial (RCT) that aims to encourage behavioral lifestyle change in patients with heart failure (HF), coronary artery disease (CAD) and/or hypertension (HT). The evaluation of the Do CHANGE service consists of two separate randomized controlled trials. This report focuses on the first trial, which is used as an input for the second one. Recruitment for this first phase trial took place at two pilot sites (Elisabeth-Tweesteden Ziekenhuis (ETZ) in the Netherlands and Badalona Serveis Assistencials (BSA) in Spain. Participating patients were requested to fill out a set of standardized and validated questionnaires within six months after randomization at three different time points (e.g. baseline, 3 and 6 months). The Do CHANGE 1 trial has been registered on www.clinicaltrials.gov (NCT02946281).

Participants
Hundred and forty-nine patients with a primary diagnosis of coronary artery disease (CAD) (having encountered a myocardial infarction, experienced angina pectoris, underwent percutaneous coronary intervention and/or coronary artery bypass graft surgery), symptomatic heart failure (HF) (New York Heart Association class I-IV), and patients diagnosed with hypertension (HT) (as defined by values ≥140 mmHg of systolic blood pressure (SBP) or ≥90 mmHg of diastolic blood pressure (DBP)) were included in the study. Participants between 18 and 75 were eligible for participation in case they had at least two of the following risk factors: smoking, positive family history, increased cholesterol, diabetes, sedentary lifestyle, psychosocial risk factors. Furthermore, patients should have access to the Internet at home and have a smartphone which is compatible with the applications that will be used in the study (and have sufficient knowledge on using personal computer or phone), and speak the countries’ native language. Patients who did not meet the inclusion criteria or had significant cognitive impairments (e.g. dementia), were on the waiting list for heart transplantation, had a life expectancy <1 year, had life-threatening comorbidities (e.g. cancers), and/or had a history of psychiatric illness other than anxiety/depression were excluded from participation.

Study procedure
Due to differences in the health care organization between the three (two in this first phase) participating countries, the logistics with respect to patient recruitment might have slightly differed. Overall, patients with a primary diagnosis of heart failure (HF), coronary artery disease (CAD) or hypertension (HT) were approached between January 2017 and June 2017 by the attending cardiologist or nurse practitioner during a regular outpatient clinic visit. Eligible patients were informed about the study both by writing and orally. Patients interested in participating were contacted by the researcher within 10 working days, to schedule a baseline study appointment in which the patients received additional information about the study. During this appointment, the informed consent was provided and randomization was done in presence of the patient by drawing an envelope with a note in it with either care as usual or intervention group. Patients randomized into the intervention group received additional information about the CarePortal, blood pressure monitor usage, the Moves App, and the Do’s of Do Something Different. Furthermore, both groups filled out the baseline questionnaires on paper. If a patient scored ≥10 on the PHQ, this indicates the presence of likely depressive symptomatology; therefore, his general practitioner was informed. At last, an appointment was scheduled (3 months after inclusion) for collecting the CarePortal and blood pressure monitor.
At 3 and 6 months after inclusion, ETZ patients received a link (by e-mail) to access the T1 and T2 questionnaires online with the instruction to fill them out at home within 10 working days. Patients were contacted by telephone when the questionnaires were not filled out within the given period. They received up to 2 reminder calls. At BSA patients have been administered the questionnaire either face to face or by phone by the nurse in charge of the patients’ recruitment, inclusion and follow up.
Participants could withdraw from the study at any given time.

**Randomization**
Patients were randomized (2:2) to either the intervention group or the control group (usual care). Patients were randomized using computerized block randomization (stacks of 4). The computer generated randomization sequences and these were sealed by an independent researcher. Patients with the same diagnosis were randomized per stack.

**Do CHANGE Phase 1 intervention**
The intervention of Do CHANGE 1 is designed to generate data that will help to develop the second trial. Patients allocated into the intervention group have all received a CarePortal, blood pressure monitor, the Moves app and the Do Something Different program (behavioral program).

**CarePortal**
The intervention group received a CarePortal (Docobo Ltd.) which was installed at their home. The CarePortal is a clinically certified portable device that allows the patients to monitor their disease symptoms daily (by answering a set of predefined questions every day) and send these to the health care professional (cardiologist). ECG data, symptomatic data, blood pressure, and weight were gathered by the device twice a day. The data was sent directly to the cardiologist who could to access those via an online platform and contact the patient if necessary.

**Moves app**
Moves app is an activity and GPS tracking application installed on the mobile phone. The app helps to provide information useful for assessing the behavioral indicators—social opportunity, variety, and activity—used for generating and develop ToDo’s in the second trial. All patients participating in the intervention had to install the Moves app on their mobile phone.

**Blood pressure monitor**
All patients in the intervention group received the digital blood pressure monitor ‘UA -767 Plus’, which is a CE-marked medical device. Patients were asked to measure their blood pressure daily and log the blood pressure values through the CarePortal. This was done by manual input by the patients themselves.

**Care as Usual**
Patients allocated to the comparator group after randomization received care as usual. Patients in this condition were allowed to seek additional care and also use other tools, which will enhance their disease / well-being, provided that they would report this in the purpose designed questionnaires at follow-up.

**Measures**
In order to assess the study objectives, patients were asked to fill out some questionnaires. For the primary study objectives in this first evaluation report, these are as follows:

**Lifestyle:** the *Health Promoting Lifestyle Questionnaire (HPLP-II)* [16] is a self-report that assesses health-promoting lifestyle habits. The data gathered with this survey will evaluate whether the subjective perception of patients regarding their lifestyle is changed.

**Behavioral flexibility:** the purpose designed questions by the *Do Something Different program* will assess whether patients in the intervention group have a bigger behavioral repertoire (behavioral flexibility) than the patients that have received the care as usual.
Quality of life: the World Health Organisation Quality Of Life (WHOQOL-Bref) [17] questionnaire is used to administer changes in quality of life.

The secondary study objectives are assessed using the following questionnaires:

Satisfaction with intervention: purpose designed questions are administered in order to assess whether patients were satisfied with the intervention in general.

Usability of the tools: the System Usability Scale (UTAUT2) [18] will be administered to measure the perceived usability of tools. Furthermore, this will also be asked in focus groups with patients and their relatives.

Acceptance of the tools: The Unified Theory of Acceptance will assess patients’ acceptance of the tools and Use of Technology (UTAUT2) [18]. This will also be asked in focus groups.

Willingness to pay: One part of the UTAUT2 [18] will be used in order to assess the willingness to pay for the used tools. In addition, patients will be asked to list the price they would be willing to pay for the product.

Cost effectiveness: The EQ-5D questionnaire [19] will be used to administer the cost-effectiveness of the intervention.

Healthcare consumption: to assess the healthcare consumption of the participants, purpose designed questions are used.

For this first evaluation, the following study parameters are assessed:

Depression: depressive symptoms in this sample are assessed by the Patient Health Questionnaire (PHQ-9) [20].

Anxiety: Levels of anxiety will be assessed using the Generalized Anxiety Disorder (GAD-7) questionnaire [21].

2.4. Statistical Analysis

Data will be analyzed using SPSS (IBM statistics 22) statistical package. Continuous and discrete variables will be compared using respectively Students’ T-test and Chi² test. The General Linear Models (GLM) procedure will be performed to evaluate the treatment effectiveness over time. The GLM procedure is similar to variance analyses, except that in GLM the dependent variable is measured at multiple time points and between two different groups. If the interaction effects are not significant, the main effects only will be interpreted.

An alpha of .05 will be used to indicate level of significance.

Summary of main findings

Current study is considered and presented as a proof of concept. Considering the relatively small sample size (N = 149), we did not expect to find any significant results. However, against our expectations, we did find a significant decline in systolic and diastolic blood pressure over three
months within the total intervention group. Furthermore, for ETZ, we found that patients participating in the intervention group reported significantly less negative habits (e.g. smoking, alcohol consumption) compared to patients participating in the care as usual group. No significant results were found on other outcome measures, as we expected. Analyses will be described in further extent in the following chapters.
3. The Do CHANGE evaluation framework: the MASH model

As previously described in deliverable 6.1 ‘First Version of the Do CHANGE Evaluation Framework’, in order to properly evaluate the outcomes of the Do CHANGE service, the MASH model will be used. This model is an adaptation of the MAST model in the mHealth environment. The Do CHANGE service of the first phase trial will be primarily evaluated based on the second domain of this framework (e.g. Axis 2: Assessment domains). This domain entails different assessment goals, reflecting the different aspects related to implementation. Based on this classification, the outcomes in current deliverable will be presented. Table 1 shows the assessment domains of MASH.

Table 1: Assessment domains of the MASH model

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<th>Do CHANGE / MASH model assessment domain</th>
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<td>2. Data privacy and patient security</td>
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<tr>
<td>3. Effectiveness</td>
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<tr>
<td>4. User aspects</td>
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<td>5. Economic aspects*</td>
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<td>6. Organisational aspects*</td>
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<td>7. Socio-cultural, ethical and legal aspects*</td>
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*Not described in this deliverable. These domains of the MASH model will be assessed after Do CHANGE 2, in which the whole ecosystem will be tested.
4. MASH – Domain 1: Health problem and characteristics of the application

4.1 Introduction

The first domain of the MASH model gives an overview of the target health problem, a description of the pilot sites involved, and the general characteristics of the patients and healthcare professionals that were involved in the evaluation.

4.2 Health problem

Heart diseases come with a large burden, as they are related to high health care costs and a leading cause of death worldwide [1]. Explanations for the disease burden of these diseases can be largely found in behavioral factors (e.g. unhealthy diet, low physical activity) [2]. Not surprisingly, approximately 80% of heart diseases and other non-communicable diseases could be prevented by constraining or terminating these behavioral health risk factors [3, 4]. The American Heart Association has recently underscored the importance of lifestyle management, with a call for action regarding better lifestyle counseling and the development of interventions focusing on health behavior change support [5].

Even though evidence shows that improving health behaviors leads to better (mental) health outcomes and lower health care costs [5], currently, education about the right lifestyle behaviors is not routinely part of the physicians’ daily practice [6]. More specifically, this type of counselling is only provided in 34% of clinic visits [7]. Face-to-face counseling is time-consuming, and can therefore be one of the major reasons why this type of counselling is lacking.

Technologies that can be used remotely provide a new model for delivering promotion of health behavior and are used more often in health care facilities [8]. Despite the fact that these contemporary developments arrange great opportunities to provide behavior change interventions to a large group of patients that is now under-served, the effect sizes reported have been disappointingly small [8]. This could be due to the limited duration of the interventions [8], the small amount of health-related behaviors addressed within the intervention [9], the mismatch between the intervention and patients’ needs or preferences, or the absence of solid adopted methods for behavior change [10]. As shown in previous trials, the relevance of addressing patients’ needs and personalizing the care plan is absolutely relevant: the ‘one size fits all’ approach within the cardiac population does not seem to work [11].

The current Do CHANGE trial will deliver a theory-based behavior intervention program for three months that addresses various health behaviors at the same time in order to produce sustainable change in health behaviors. Cardiac patients’ unhealthy habits are aimed to be addressed and changed by increasing patients’ behavioral flexibility. Patients using the Do CHANGE service will thus be provided with innovative tools to support behavior change, but will also be offered behavioral substitutes. This will carefully assess patients’ needs on using these innovative tools. Despite health education and campaigns, people do not always do what they know is right for them [12]. That is why the behavior change approach of Do CHANGE dissociates from an information deficit model similar to traditional methods. The Do Something Different methodology is adopted [13]. Implicit behavioral prompts that are part of this methodology will guide the patients to re-adapt their lifestyle habits. The objective of the current trial is to evaluate the effectiveness and implementation...
of the personalized Do CHANGE service in improving the quality of life in cardiac patients and changing unhealthy lifestyle.

4.3 Baseline characteristics

4.3.1 Baseline characteristics patients

A total of 149 patients were recruited in both pilot sites (BSA N=74 & ETZ N =75) between January 2017 and June 2017. BSA randomized a total of 74 patients, whereas ETZ randomized 75. The mean age of the total sample was 63.57 years old, of whom 66.4% is male. An independent-samples t-test was conducted to compare the Do CHANGE intervention group with the Care as usual group on baseline continuous variables. For dichotomous variables, possible differences between the intervention and care as usual group were conducted by using a $\chi^2$ test. There were significant differences observed in mean completed education in years between the Do CHANGE intervention group ($M = 14.30, SD = 6.23$) and the Care as usual group ($M = 11.79, SD = 7.91$; $t (147) = 2.15$, $p = .033$, two tailed). This means that patients in the intervention group completed more years of education in comparison to the care as usual group. Furthermore, a significant difference between the two groups was found on the mean PHQ-9 baseline scores, with a higher mean score on depressive symptoms in the Care as usual group ($M = 5.56, SD = 4.17$; $t (147) = -3.06$, $p =.003$, two tailed). Patients receiving the care as usual reported more depressive symptoms compared to patients receiving the Do CHANGE intervention at baseline. No other systematic differences were found between the intervention and Care as usual group on baseline medication, clinical and demographic characteristics. Table 1 presents an overview of the baseline characteristics of the current sample.

Table 1: Baseline characteristics of the total sample (N = 149)

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<th>Care as usual (N=75) mean ±SD; N(%)</th>
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<td>74 (49.7)</td>
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<td>ETZ</td>
<td>75 (50.3)</td>
<td>37 (49.3)</td>
<td>38 (50.7)</td>
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<td><strong>Demographics</strong></td>
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<td>Age</td>
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<td>63.26±8.35</td>
<td>63.88±8.30</td>
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<td>Gender (male)</td>
<td>99 (66.4)</td>
<td>52 (70.3)</td>
<td>47 (62.7)</td>
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<td>Education (in years)</td>
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<td>Diagnosis CAD</td>
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<td>SBP (Baseline)</td>
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<td>DBP (Baseline)</td>
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<td>78.76±10.33</td>
<td>79.77±9.87</td>
<td>.54</td>
</tr>
<tr>
<td>Heart Rate (rest)</td>
<td>69.41±11.97</td>
<td>69.95±14.43</td>
<td>68.88±11.57</td>
<td>.59</td>
</tr>
</tbody>
</table>

Medication

| Antiplatelet    | 81 (51.4) | 38 (51.4) | 43 (58.7) | .57 |
| Statins         | 92 (61.7) | 42 (56.8) | 50 (66.7) | .28 |
| Beta-blockers   | 90 (60.4) | 46 (62.2) | 44 (58.7) | .79 |
| ACE-inhibitors  | 50 (33.6) | 24 (32.4) | 26 (34.7) | .91 |
| ARB             | 56 (37.6) | 31 (41.9) | 25 (33.3) | .36 |
| Calcium antagonist| 35 (23.5)| 20 (27.0) | 15 (20.0) | .41 |
| Psychotropic medication | 22 (14.8)| 9 (12.2) | 13 (17.3) | .51 |

Psychological

| PHQ-9           | 4.59±4.00  | 3.61±3.60  | 5.56±4.17  | .003 |
| GAD-7           | 4.03±4.37  | 3.35±4.07  | 4.69±4.59  | .061 |

ACE-inhibitors=Angiotensin-Converting-Enzyme inhibitors; ARB=Angiotensin II Receptor Blocker; BSA=Badalona Serveis Assistencials; CAD=Coronary Artery Disease; DBP=Diastolic Blood Pressure ETZ=Elisabeth-Tweesteden Ziekenhuis; HF=Heart failure; HT=Hypertension; SBP=Systolic Blood Pressure.

4.3.2 Baseline characteristics healthcare professionals

Healthcare professionals that were involved in the implementation of Do CHANGE in the pilot site ETZ were all male and were either employed as cardiologist or cardiac nurse. The mean years of working experience in cardiology was 34 years, with 4 years of experience in e-Health. For BSA, healthcare professionals involved in the project were males and females by equal, were either employed as cardiologist, cardiac nurse, emergency nurse, internal medicine physician, internal medicine nurse or GP. The average years of working experience in cardiology was 17 years, and 23 years for the other professionals. All of them have consolidated experience in implementation of e-Health solutions.
4.4 Number of eligible patients

Each pilot site has provided an overview of the eligible patients that could benefit from the Do CHANGE service and were approached for participation. These numbers vary because of the different options of recruitment in each country (for example, in Spain patients were also approached at the GP, while in The Netherlands patients were only approached during a hospital visit).

In The Netherlands, a total of 139 patients were approached. Of this total, 59 patients refused participation. Some reasons for refusal were that it would be too time-consuming, not wanting to be confronted with their heart disease every day, and being reluctant to use technology. Of the remaining 80 patients, 5 participants did not show up or did refuse on second hand.

In Spain, a total of 147 were approached. 73 of these patients refused participation. The reasons were very similar to the ETZ pilot: they did not have enough time to spend learning how to use the devices and were reluctant to be confronted with their disease every day as well as to use technology. Finally, patients recruited were 74, whereas only one dropped out the trial before month 3. This patient belonged to control group.
5. MASH – Domain 2: Data privacy and patient security

5.1 Introduction

The second domain of the MASH model entails the data privacy and security of the patients participating. Specific additional regulations for data protection (e.g. information encryption and anonymity) and for data privacy (e.g. informed consent) will be considered and evaluated. This will be done by carrying out focus groups with patients, caregivers and healthcare professionals. Their perspectives on these matters will thus be evaluated by using qualitative research assessments. Transcripts of the qualitative sessions as well as the semi-structured interviews are available upon request. Below a comprehensive summary of the main findings is provided.

5.2 Perspective patients

Since part of the Do CHANGE service is delivered online through a technological platform, patients were asked whether they feel that the data that is shared by them is safe. The focus groups pointed out that patients do not think that their data is completely safe against for example hackers. However, they did not worry about it if the data is anonymous. They indicated the value of collecting data for research purposes. Most important for them is that the data will not be available for health insurers and/or employers, as they fear that the data might be used for the wrong purposes (e.g. shortening on reimbursements).

5.3 Perspective Healthcare professionals

Healthcare professionals were asked whether they feel that the Do CHANGE ecosystem is safe for the patient. They emphasized the importance of patient privacy, as this is considered as one of the most important aspects of good clinical practice. It is essential to develop a system that guarantees the safety of patients at all times. According to the healthcare professionals, the ecosystem makes the impression to meet this goal.
6. MASH – Domain 3 & 4: Effectiveness & User aspects

6.1 Introduction

Domain 3 contains information regarding the effectiveness of the intervention implemented in the first phase trial. The effectiveness is measured on a broad scale of aspects that entail the patient domain (e.g. patient reported outcomes and clinical outcomes), but also the perspectives of healthcare professionals and caregivers are considered. Mixed-methods are used to describe the outcomes, as both focus groups and statistical analyses are performed in order to come to the conclusions. Since this study is a proof of concept, and therefore the sample is considered as small, we did not expect to find an effect of the intervention on any of the (quantitative) patient reported outcomes. However, against our expectations, the findings showed that in a part of the sample positive results were found in the intervention group with respect to reduction in blood pressure over time and a significant decrease in negative habits over time compared to patients in the care as usual condition. Appurtenant analyses are described in the following sections 6.4 and 6.5. In addition, adherence rates were very high and both patients and healthcare professionals indicated the intervention as useful (as described in sections 6.2 & 6.3).

6.2 Patient experience

Patient experience focuses on the envisaged advantages of using the technology implemented in the trial, including self-perceived autonomy, self-management of the disease and motivation to change health related habits.

6.2.1 Quantitative patient experience

In order to assess whether patients in the intervention group were satisfied with the general intervention and adhere to the intervention, after three months purpose designed questions were administered. These were as follows:

1) Did you follow the whole program (e.g. carried out all instructions?); if not,
2) Why did you not adhere to the program?
3) Do you think the program was useful?

In total, 61 (82.4%) patients fulfilled the total program, whereas 13 (17.6%) did not. All of these 13 patients had another reason for not continuing the intervention than getting ill, not feeling like it or not having time. Altogether, 83.8% (N= 62) patients did find the Do CHANGE intervention useful.

CSQ 8

The CSQ 8 is a general questionnaire for client satisfaction, with total scores that can range from 8 to 32. A higher total score indicates being more satisfied. The mean satisfaction score at 6 months was 26.22 ± 4.82, indicating that people were quite satisfied with the intervention they received.

UTAUT 2
The UTAUT 2 questionnaire focuses on the acceptance and use of information technology, and consists of 8 scales, namely: 1) Performance expectancy, 2) Effort expectancy, 3) Social influence, 4) facilitating conditions, 5) Hedonic motivation, 6) Habit, 7) Behavioral intention, and 8) Price value. The subscale ‘price value’ is left out, because of ambiguity of the price patients will pay for the total service. The total score per subscale can range from 4 to 20, with a higher score indicating more agreement with the statements within a certain subscale.

1.) Performance expectancy

Performance expectancy is defined as the degree to which using the technology will provide benefits to patients in performing certain activities. The mean score of this subscale was 13.88 ± 3.96, indicating that the Do CHANGE service is experienced as relatively useful.

2.) Effort expectancy

Effort expectancy is defined as the degree of ease associated with the patients’ use of the Do CHANGE service. On this scale, the mean score was 17.07 ± 2.57, which means that the ecosystem of Do CHANGE 1 is easy to use.

3.) Social influence

Social influence is the extent to which patients perceive that important others (e.g. friends and family) believe that they should use the Do CHANGE 1 ecosystem. The mean score of 9.85 ± 3.63 shows that patients do not experience the ecosystem this way. They do not feel the pressure of their spouses to use the technology.

4.) Facilitating conditions

Facilitating conditions refer to the perceptions of patients of the resources and support available to perform a behavior. Patients report to be quite satisfied with the possibilities to receive support (mean 15.44 ± 2.43).

5.) Hedonic motivation

The hedonic motivation is seen as the pleasure or fun derived from using the Do CHANGE 1 ecosystem. Patients report to have a neutral opinion regarding the pleasure in using the ecosystem: mean 10.63 ± 2.44.

6.) Habit

Habit is the extent to which patients tend to perform the behaviors related to using the ecosystem automatically because of learning. The mean score of 11.71 ± 3.05 indicates that the ecosystem is relatively well integrated in patients’ lives.

7.) Behavioral intention

Behavioral intention refers to the intention to use the technology in the future. The mean score of 8.40 ± 3.34 indicates that patients report not to plan to use the ecosystem in the future.

6.2.2 Qualitative patient experience
Qualitative research methods were used to get an in depth understanding of how the intervention was experienced (transcripts available upon request). Most patients participating in the focus group were satisfied with the intervention. The ‘Do’s’ within the Do Something Different program made them more aware of their lifestyle, and the Moves app was a good reminder of moving. It made the participants more aware of the fact that they must undertake activities themselves in order to feel better. Also, because of the CarePortal, patients report to feel more ‘safe’, because the cardiologist or other healthcare professionals are watching along. It reduces some burden regarding the cardiac disease. Furthermore, because of the intervention participants feel that they make other choices. In the focus groups it was also mentioned that home monitoring of cardiac complaints was frightful for some patients. Past experiences regarding heart attacks, cardiac arrests or angina pectoris made some of them reluctant, as the monitoring kept confronting them with the possibility that it could go wrong again. Also, if patients do not meet the proposed ‘Do’s’ (for example because of physical reasons related to their cardiac disease) some of them feel guilty for not accomplishing what is ‘expected’ of them.

6.3 Caregiver & Healthcare professional experience

6.3.1 Caregiver experience

Caregivers notice that the intervention helps their partner to better manage their disease and lifestyle related factors. Some of them mention to participate in healthier behavior as well (e.g. walking more, eating healthier).

6.3.2 Healthcare professional experience

During the intervention, the cardiologist was able to intervene with for example change of medication prescription in order to lower blood pressure. To intervene at an earlier stage made the patient feel safer. Sometimes there were difficulties with the connection, but this was no reason for not being satisfied with the system. It was fortunate to notice that patients were more aware of their disease and the effect of lifestyle factors on its symptoms.

6.4 Physical outcomes

Physical outcomes are based on data from the total intervention group sample. Weight was administered during the morning measurement, while both systolic and diastolic blood pressure were inserted in the morning and evening. The results are shown below.

**Weight**

A paired-samples t-test was conducted to evaluate weight after three months. There was no statistically significant decrease from baseline (M = 80.85, SD = 12.13) to three months (M = 80.81, SD = 12.12), t (41) = 0.114, p = 0.910 (two tailed). No difference in weight was found.

**Systolic blood pressure**
A paired-samples t-test was conducted to evaluate the impact of the intervention on morning systolic blood pressure after three months. There was a statistically significant decrease in systolic blood pressure, measured in the morning, from baseline (M = 137.58, SD = 23.65) to three months (M = 128.67, SD = 18.54), t (32), p = 0.04 (two tailed). Furthermore, a significant decline in evening administered blood pressure from baseline (M = 139.31, SD = 22.70) to three months (M = 126.58, SD = 18.68), t (35) = 2.91, p = 0.006 (two tailed) was found. See Figure 9.

**Diastolic blood pressure**

A paired-samples t-test was conducted to evaluate the impact of the intervention on diastolic blood pressure after three months. There was a statistically significant decrease in diastolic blood pressure, administered in the morning, from baseline (M = 78.97, SD = 10.88) to three months (M = 74.41, SD = 10.42), t (33) = 2.54, p = 0.016 (two tailed). We also found a significant decrease in diastolic blood pressure, measured in the evening, from baseline (M = 80.27, SD = 10.26) to three months (M = 72.32, SD = 10.71), t (36) = 0.114, p < 0.001 (two tailed). See Figure 9.

![BPM change evening](image.png)

![BPM change morning](image.png)

**Figure 9.** Change in both diastolic blood pressure and systolic blood pressure over 3 months.
6.5 Do Something Different (DSD)

Whether the patients’ behavioral flexibility (having a bigger behavioral repertoire which makes it easier to perform alternative behaviors) has increased and thus whether behavior change (as conceptualized by Do Something Different program) has occurred, is assessed using the purpose designed questions by the Do Something Different program.

**Habits (How often do you...?)**

This part of the DSD questionnaire can be interpreted as a higher score indicates a positive change, whereas a lower score indicates a negative change. Some questions are classed as negative (e.g. ‘How often do you smoke?’), in this case a higher score indicates a negative change and vice versa.

Because of missing data, only the baseline data of ETZ for this subscale of the DSD questionnaire was available. Therefore, the outcomes should be interpreted with caution.

**Positively classed questions**

A mixed between-within subjects’ analysis of variance was conducted to assess the impact of the Do CHANGE intervention on participants’ scores on the ‘Habits’ scale of the DSD questionnaire, at three time periods (e.g. baseline and post-intervention at three months and at six months follow-up). There was no significant interaction between the allocation of group (e.g. care as usual or Do CHANGE intervention group) and time, Wilks’ Lambda = .924, F (2,69)=2.836, p=.066, partial eta-squared=.040. Furthermore, no significant main effects were found. The main effect comparing the two types of groups was not significant, F (1,70)=.128, p=.722, partial eta-squared=.002, suggesting no difference in the effectiveness of intervention on Habits over the period of six months follow-up (Table 3). No differences were found between the intervention and care as usual group.

**Table 3.** Positive classed Habit scores for the Do CHANGE intervention and Care as usual group across three time periods

<table>
<thead>
<tr>
<th>Time period</th>
<th>Do CHANGE intervention</th>
<th></th>
<th></th>
<th>Care as usual</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>M</td>
<td>SD</td>
<td>N</td>
<td>M</td>
<td>SD</td>
</tr>
<tr>
<td>Baseline</td>
<td>37</td>
<td>800.92</td>
<td>188.22</td>
<td>35</td>
<td>795.77</td>
<td>165.85</td>
</tr>
<tr>
<td>T1 (3 months follow-up)</td>
<td>37</td>
<td>835.97</td>
<td>187.71</td>
<td>35</td>
<td>771.09</td>
<td>217.78</td>
</tr>
<tr>
<td>T2 (6 months follow-up)</td>
<td>37</td>
<td>763.11</td>
<td>215.20</td>
<td>35</td>
<td>787.37</td>
<td>232.41</td>
</tr>
</tbody>
</table>

**Negative classed questions**
A mixed between-within subjects analysis of variance was conducted to assess the impact of the Do CHANGE intervention on participants’ scores on negative classed questions on the ‘Habits’ scale of the DSD questionnaire, at three time periods (e.g. baseline, post-intervention at three months and after 6 months follow-up). There was no significant interaction between the allocation of group (e.g. care as usual or Do CHANGE intervention group) and time, Wilks’ Lambda = .946, F (2,69)=1.964, p=.148, partial eta-squared=.008. Furthermore, no significant main effect of time was found. The main effect comparing the two types of groups was significant, F (1,70)=5.970, p=.017, partial eta-squared=.079, suggesting the effectiveness of intervention on Habits across 6 months follow-up. The intervention group shows a decrease in reported negative habits after 6 months (Table 4). Figure 3 shows an overview of the total scores of both groups over time.

**Table 4.** Negative classed Habit scores for the Do CHANGE intervention and Care as usual group across three time periods

<table>
<thead>
<tr>
<th>Time period</th>
<th>N</th>
<th>M</th>
<th>SD</th>
<th>N</th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline</td>
<td>37</td>
<td>98.92</td>
<td>63.49</td>
<td>35</td>
<td>142.46</td>
<td>79.71</td>
</tr>
<tr>
<td>T1 (3 months follow-up)</td>
<td>37</td>
<td>116.92</td>
<td>82.45</td>
<td>35</td>
<td>135.31</td>
<td>84.68</td>
</tr>
<tr>
<td>T2 (6 months follow-up)</td>
<td>37</td>
<td>94.43</td>
<td>62.08</td>
<td>35</td>
<td>148.34</td>
<td>105.257</td>
</tr>
</tbody>
</table>

**Figure 3.** Overview of the total scores over time of the intervention and care as usual groups on the DSD negative scored habit questions.

**Behavioral Flexibility**
One section of the DSD questionnaire contains 30 different descriptions of behavior. These behaviors consist of 15 pairs of opposites (see Figure 4). Patients are asked at each measurement point to select the behaviors that best describe them.

Based on a formula, the behavioral flexibility for each participant at each time point is calculated. This formula is the following:

$$100\% \times \frac{1}{2} \left( \frac{\text{number of behaviors selected}}{30} + \frac{\text{number of opposite pairs selected}}{15} \right)$$

Every addition of a behavior raises the score, as well as when both of a pair of opposite behaviors are added. The model interprets this seemingly contradictory behavior as evidence of flexibility: based on what a given situation demands, the person has the capacity to use different reactions. Patients of both BSA and ETZ were included in the analysis.

**Figure 4:** 30 different behaviors, matched as 15 opposite pairs.
The mixed between-within subjects analysis of variance shows no significant interaction between the allocation of group (e.g. care as usual or Do CHANGE intervention group) and time, Wilks’ Lambda = .986, F (2,141)= 1.003, p = .369, partial eta squared=.014. Furthermore, no significant effect for time (F (1, 141) = 1.833, p = .164) nor the allocation to group (F (1, 142) = 2.488, p = .117) was found (Table 5).

Table 5. Flexibility scores for the Do CHANGE intervention and Care as usual group across three time periods

<table>
<thead>
<tr>
<th>Time period</th>
<th>Do CHANGE intervention</th>
<th>Care as usual</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>M</td>
</tr>
<tr>
<td>Baseline</td>
<td>73</td>
<td>28.36</td>
</tr>
<tr>
<td>T1 (3 months follow-up)</td>
<td>73</td>
<td>30.09</td>
</tr>
<tr>
<td>T2 (6 months follow-up)</td>
<td>73</td>
<td>29.02</td>
</tr>
</tbody>
</table>

Figure 5. Change flexibility score over three time points for intervention and care as usual group
Wellbeing

Participants were asked to indicate to what extent they did agree with 8 different statements about their wellbeing. These scores were summed to a wellbeing score from 0 to 800, with a higher score indicating a better wellbeing in the past month.

A mixed between-within subjects analysis of variance was conducted to assess the impact of the Do CHANGE intervention on the wellbeing score, at three time periods (e.g. baseline and post-intervention at three months and after six months follow-up). There was no significant interaction between the allocation of group (e.g. care as usual or Do CHANGE intervention group) and time, Wilks’ Lambda = .988, F (2,141) = .861, p=.425, partial eta squared=.012. Furthermore, no significant main effects were found. The main effect comparing the two types of groups was not significant, F (1,142) = .1.167, p=.282, partial eta squared=.008, suggesting no difference in the effectiveness of intervention on wellbeing scores across 6 months follow-up. There was no difference found between the intervention and care as usual group.

6.6 Lifestyle

The Health Promoting Lifestyle Profile II questionnaire is administered in order to measure the possible changes in healthy lifestyle behavior in patients receiving the Do CHANGE ecosystem in comparison to patients that receive the care as usual.

6.6.1 Total score HPLP II

Looking at the total mean score of lifestyle behavior over the 6 months period, analysis shows a significant and main effect for time, Wilk’s Lambda = 0.88, F (2, 142) = 9.38, p = <0.001. As shown in table 2, both groups report an increase in lifestyle behavior across the three time periods (e.g. baseline, after the intervention and at 6 months follow-up). However, no significant effect of allocation to group was found F (1, 138) = 0.231, p = 0.63, partial eta squared = 0.002. This suggests no difference in the effectiveness of the intervention (Figure 1.). There is no difference found between the intervention and care as usual group.

<table>
<thead>
<tr>
<th>Time period</th>
<th>N</th>
<th>M</th>
<th>SD</th>
<th>N</th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline</td>
<td>74</td>
<td>2.54</td>
<td>0.367</td>
<td>71</td>
<td>2.57</td>
<td>0.375</td>
</tr>
<tr>
<td>T1 (3 months follow-up)</td>
<td>74</td>
<td>2.69</td>
<td>0.392</td>
<td>71</td>
<td>2.62</td>
<td>0.396</td>
</tr>
<tr>
<td>T2 (6 months follow-up)</td>
<td>74</td>
<td>2.69</td>
<td>0.431</td>
<td>71</td>
<td>2.64</td>
<td>0.389</td>
</tr>
</tbody>
</table>

Table 2. Mean HPLP II total scores for the Do CHANGE intervention and Care as usual groups over three time periods
6.6.2 Subscales HPLP II

The HPLP II total score consists of different subscales reflecting different aspects of a healthy lifestyle. In order to get better insight into the effect of the intervention on the facets of lifestyle, a mixed between-within ANOVA is performed on the domains 1) Health Responsibility (HR), 2) Nutrition (NU), 3) Interpersonal Relationships (IR), 4) Spiritual Growth (SG), 5) Physical Activity (PA), and 6) Stress Management (SM).

For subscales Health Responsibility (HR), Nutrition (NU), and Spiritual Growth (SG), no significant effects were found. However, a significant effect of time was reported for the subscales Interpersonal Relationships (IR) (Wilk’s Lambda = 0.929, F (2, 142) = 5.43, p = 0.005, partial eta squared 0.071), Physical Activity (PA) (Wilk’s Lambda = 0.837, F (2, 142) = 5.43, p < 0.001, partial eta squared 0.163), and Stress Management (SM) (Wilk’s Lambda = 0.908, F (2, 142) = 7.17, p = 0.001, partial eta squared 0.092). Over time, there is an increase in reported scores on all subscales. The main effects comparing the Do CHANGE intervention group with the care as usual (CAU) group were not significant, suggesting no difference between intervention and CAU.

6.7 Quality of life

To administer changes in quality of life, the World Health Organization Quality of Life - BREF (WHOQOL-BREF) is used. This assessment allows detailed quality of life data gathered on this particular cardiac population. It contains different domains of quality of life, e.g. physical health, psychological, social relationships, and environment.
**Overall quality of life**

Mean overall perception quality of life on baseline was 3.83±.73. This indicates a ‘neutral’ quality of life in general. No significant main effects across the six-month follow-up were found. The main effect comparing the two types of groups was not significant, F (1,143) = .335, p=.56, partial eta squared =.002, suggesting no difference in the effectiveness of intervention on overall perception of quality of life (Table 6 & Figure 5). No difference between the intervention and care as usual group was found.

**Table 6.** Total quality of life scores for the Do CHANGE intervention and Care as usual group across three time periods

<table>
<thead>
<tr>
<th>Time period</th>
<th>Do CHANGE intervention</th>
<th>Care as usual</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>M</td>
</tr>
<tr>
<td>Baseline</td>
<td>74</td>
<td>100.38</td>
</tr>
<tr>
<td>T1 (3 months follow-up)</td>
<td>74</td>
<td>101.49</td>
</tr>
<tr>
<td>T2 (6 months follow-up)</td>
<td>74</td>
<td>100.28</td>
</tr>
</tbody>
</table>

**Figure 6.** Change quality of life score over three time points for intervention and care as usual group.
Domains

1. Physical health

Facets incorporated within this domain are as follows: activities of daily living, dependence on medicinal substances and medical aids, energy and fatigue, mobility, pain and discomfort, sleep and rest, and work capacity.

A mixed between-within subjects analysis of variance was conducted to assess the impact of the Do CHANGE intervention on participants’ scores on physical health domain across three time periods (e.g. baseline and post-intervention at three months and after six months follow-up). No significant main effects were found. The main effect comparing the two types of groups was not significant, F (1,143) = .718, p=.40, partial eta-squared= .005, suggesting no difference in the effectiveness of intervention on physical health domain across 6 months follow-up. There was no difference found between the intervention and care as usual group.

2. Psychological

The following facets are incorporated within this domain: bodily image and appearance, negative feelings, positive feelings, self-esteem, spirituality/religion/personal beliefs, thinking/learning/memory and concentration.

A significant interaction between the allocation of group (e.g. care as usual or Do CHANGE intervention group) and time was found, Wilks’ Lambda = .906, F (2,142) =7.350, p=.001, partial eta squared= .094. This suggests that the change in scores in time between the Do CHANGE intervention group and the care as usual group differ. Main effects can therefore not be interpreted.

3. Social relationships

This domain integrates the following facets: personal relationships, social support, and sexual activity.

A mixed between-within subjects analysis of variance was conducted to assess the impact of the Do CHANGE intervention on participants’ scores on social relationships domain across three time periods (e.g. baseline, post-intervention at three months, and after six months follow-up). There was no significant interaction between the allocation of group (e.g. care as usual or Do CHANGE intervention group) and time, Wilks’ Lambda = 1.00, F (2,142) =.010, p=.990, partial eta squared= <.001. The main effect for time was significant, Wilks’ Lambda = .893, F (2, 142) = 8.48, p <.001, partial eta squared = .107. The main effect comparing the two types of groups was not significant, F (1,139) =.013, p=.908, partial eta squared= <.001, suggesting no difference in the effectiveness of intervention on social relationships across 6 months follow-up. There was no difference found between the intervention and care as usual group.

4. Environment

Facets related to this domain are: financial resources, freedom/physical safety and security, health and social care: accessibility and quality, home environment, and opportunities for acquiring new information and skills, participation in and opportunities for recreation/leisure activities, physical environment (pollution/noise/traffic/climate), and transport. No significant main effects were found. The main effect comparing the two types of groups was not significant, F (1,143) =.087, p=.769, partial eta squared= .001, suggesting no difference in the effectiveness of intervention on
environment domain across 6 months follow-up. There was no difference found between the intervention and care as usual group.

6.8 Depression

A mixed between-within subjects analysis of variance was conducted to assess the impact of two conditions (e.g. Do CHANGE intervention, Care as usual) on participants’ scores on the PHQ-9 questionnaire, across three time periods (Baseline, at three months follow-up, and after six months follow-up). There was no significant interaction between condition and time, Wilks’ Lambda = .974, F (2,142) = 1.923, p = .15, partial eta squared = .026. There was a substantial main effect for time, Wilks’ Lambda = .838, F (2,142) = 14.21, p = ≤.001, partial eta squared = .17, with both groups showing a reduction in PHQ9 scores across the three time periods (see Table 7 & Figure 6). The main effect comparing the Do CHANGE intervention group with the Care as usual group was significant as well, F (1,143) = 5.42, p =.021, partial eta squared = .036, suggesting effectiveness of the allocation to group on lowering self-reported depression scores.

Table 7: PHQ-9 Scores for the Do CHANGE intervention and Care as usual group across three time periods

<table>
<thead>
<tr>
<th>Time period</th>
<th>Do CHANGE intervention</th>
<th>Care as usual</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>M</td>
</tr>
<tr>
<td>Baseline</td>
<td>74</td>
<td>3.61</td>
</tr>
<tr>
<td>T1 (3 months follow-up)</td>
<td>74</td>
<td>2.65</td>
</tr>
<tr>
<td>T2 (6 months follow-up)</td>
<td>74</td>
<td>2.85</td>
</tr>
</tbody>
</table>

Figure 7. Change depression score over three time points for intervention and care as usual group.
However, because the baseline scores between the two groups differed significantly, it is hypothesized that the PHQ-9 scores at baseline are of great influence on the depression scores over time. Therefore, a multiple regression analysis was used in order to examine whether the allocation of group predicts depression scores at 3- and 6 months after randomization, controlled for baseline depression scores. However, no significant results were found. This indicates no effect of the intervention on depression scores across six months. No difference between the intervention and care as usual group was found.

6.9 Anxiety

A mixed between-within subjects analysis of variance was conducted to assess the impact of two conditions (e.g. Do CHANGE intervention, Care as usual) on participants’ scores on the GAD-7, across two time periods (Baseline, three months follow-up and six months after inclusion). There was no significant interaction between condition and time, Wilks’ Lambda = .394, F (2,142) = .987, p = .394, partial eta squared = .013. There was a substantial main effect for time, Wilks’ Lambda = .901, F (2,142) = 7.77, p = 0.001, partial eta squared = .099, with both groups showing first a reduction in GAD-7 scores across three months, and a slight increase in anxiety scores after six months (see Table 8 & Figure 7). The main effect comparing the Do CHANGE intervention group with the Care as usual group was not significant, F (1,143) = 1.67, p =.20, partial eta squared =.012, suggesting no difference in the effectiveness of the intervention on GAD-7. No difference between the intervention and care as usual group was found.

**Table 8.** GAD-7 Scores for the Do CHANGE intervention and Care as usual group across three time periods

<table>
<thead>
<tr>
<th>Time period</th>
<th>Do CHANGE intervention</th>
<th></th>
<th>Care as usual</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>M</td>
<td>SD</td>
</tr>
<tr>
<td>Baseline</td>
<td>74</td>
<td>3.35</td>
<td>4.01</td>
</tr>
<tr>
<td>T1 (3 months follow-up)</td>
<td>74</td>
<td>2.53</td>
<td>3.19</td>
</tr>
<tr>
<td>T2 (6 months follow-up)</td>
<td>74</td>
<td>2.80</td>
<td>3.50</td>
</tr>
</tbody>
</table>
6.10 Healthcare Consumption

The total healthcare consumption per time point was calculated and used as an outcome measure. Because of the differences in administration (Spain used a scale from 0 to 100 and asked the patients ‘How often on a scale from 0 to 100 have you visited...?’; The Netherlands asked for frequencies ‘How many times have you visited...?’), analysis were done per pilot site.

**Spain**

A mixed between-within subjects analysis of variance was conducted to assess the impact of the Do CHANGE intervention on healthcare utilization across three time periods (e.g. baseline, post-intervention at three months and after six months follow-up). There was no significant interaction between the allocation of group (e.g. care as usual or Do CHANGE intervention group) and time, Wilks’ Lambda = .941, F (2, 70) = 2.178, p=.121, partial eta squared=.059. A main effect of time was found, Wilks’ Lambda = .566, F (2, 70) =26.83, p=<.001, partial eta squared=.434. The main effect comparing the two types of groups was not significant, F (1, 71) =.002, p=.961, partial eta squared < 001, suggesting no difference in the effectiveness of intervention on healthcare utilization at 3 months follow-up. No difference between the intervention and care as usual group was found.

**The Netherlands**

The mixed between-within subjects analysis of variance was also conducted by using data from The Netherlands in order to assess the impact of the Do CHANGE intervention on healthcare utilization across three time periods (e.g. baseline, post-intervention at three months and at 6 months follow-up). There was no significant interaction between the allocation of group (e.g. care as usual or Do CHANGE intervention group) and time, Wilks’ Lambda = .945, F (2, 69) = 1.764, p=.179, partial eta squared=.049. A main effect of time was found, Wilks’ Lambda = .901, F (2, 69) =3.781, p=0.28, partial eta squared=.099. The main effect comparing the two types of groups was not significant, F (1, 70) =.223, p=.639, partial eta squared= .003, suggesting no difference in the effectiveness of
intervention on healthcare utilization at 6 months follow-up. No difference between the intervention and care as usual group was found.

6.11 Subgroup analysis

In order to get a first impression of patients that will possibly benefit from the intervention, analyses based on gender and Type D personality were performed for the primary objectives (e.g. improvement of lifestyle, improvement of quality of life and improvement in habits & behavioral flexibility). Further subgroup analysis will be described in the evaluation of the second phase trial Do CHANGE 2.

Gender

1. Lifestyle improvement

When looking at the effects of the intervention on lifestyle change across six months in men, a significant effect of time was found Wilks’ Lambda = .812, F (2, 94) = 10.88, p<.001, partial eta squared=.019. Indicating that based on the mixed between-within ANOVA analysis, men participating in the study in general show improvement of lifestyle behavior over time. However, no effect of the intervention was found, which means that no difference between the intervention and care as usual group in men was found. When focusing on women only, no main effects were found. This indicates that based on the analysis women specifically do not benefit from the intervention regarding lifestyle improvement.

2. Quality of life

Within men, there is found a significant interaction effect between time and the allocation of group. This means that the change over time is influenced by the group, and therefore no conclusion can be drawn from the effect of the intervention nor time on the quality of life of men within this sample. Within females, no significant main effects were found. Indicating that the intervention and care as usual group did not differ within this population. Also, time did not have a significant effect on the reported quality of life scores of women.

3. Behavioral flexibility

Regarding behavioral flexibility, for both men and women, there was a significant interaction effect between time and allocation to group. This means that the change over time between the intervention and care as usual group was different. Therefore, the main results of time and the differences between the care as usual and intervention group in and women could not be interpreted.

Type D personality

Distressed personality is characterized by the characteristics of negative affectivity (NA) (e.g. the tendency to experience negative emotions across time and situations) and social inhibition (SI) (e.g. the tendency not to express emotions). People with this personality are at greater risk for recurrent cardiac events [27].

1. Lifestyle improvement

Regarding patients without a Type D personality, results show that lifestyle improves over time Wilks' Lambda = .891, F (2, 107) = 6.54, p=.002, partial eta squared=.080. No differences between the
intervention and care as usual group were found. Results of patients with a Type D personality show that there is an interaction effect between time and the allocation to group Wilks’ Lambda = .789, F (2, 32) = 4.28, p=.023, partial eta squared=.211. This means that the change over time between the intervention and care as usual group within patients with Type D personality. Therefore, the main results of time and the differences between the care as usual and intervention group cannot be interpreted. This means that patients without type D personality will benefit from the intervention regarding lifestyle improvement over time the most.

2. Quality of life

For patients without Type D personality, results from the analysis regarding the influence of the intervention on overall quality of life across 6 months follow up show no main effects. This means that there is, based on these analyses, no effect of time or difference between care as usual and intervention group on the quality of life within patients without Type D personality. Again, for the group Type D personality, there is an interaction effect between time and the allocation to group Wilks’ Lambda = .791, F (2, 32) = 4.22, p=.024, partial eta squared=.209. This means that the change over time between the intervention and care as usual group within patients with Type D personality. Therefore, the main results of time and the differences between the care as usual and intervention group cannot be interpreted.

3. Behavioral flexibility

Regarding behavioral flexibility, for both patients without and with Type D personality, there was a significant interaction effect between time and allocation to group. This means that the change over time between the intervention and care as usual group was different. Therefore, the main results of time and the differences between the care as usual and intervention group in patients without as well as patients with a Type D personality could not be interpreted.
7. Discussion

Current deliverable describes the results of total 6 months of the Do CHANGE 1 trial. This trial has been set up in order to use the outcomes for the development of the second trial following (Do CHANGE 2). It is important to keep in mind that this deliverable entails the description of results based on a part of the total ecosystem that will be implemented in the Do CHANGE 2 trial.

At baseline, the intervention group and care as usual group showed some differences in mean years of completed education and mean scores on depressive symptoms. The care as usual group scored significantly higher on both variables. This outcome could be explained by multiple factors. Statistical testing for baseline differences is often done in order to assess whether randomization was performed properly. However, the randomization was done completely unbiased, implicating that the differences found are a coincidence.

As the current trial was set up to provide proof of concept data and examine the feasibility of the ecosystem no significant effects of the intervention on any of the outcome measures were expected. The number of participants was not sufficient to provide sufficient power for statistically significant findings. However, based on our analyses it appeared that both systolic and diastolic blood pressure were decreased in the intervention group after three months. For ETZ, patients within the intervention group report significantly less negative behavioral habits (e.g. smoking, alcohol consumption) compared to the care as usual group. No significant results were found for the other outcome measures.

The sample of current study is representative for the cardiac population, as 66.4% of the patients participating is man and the mean age is 64 years. This is in accordance with what is found in other studies [23]. It is safe to say that the Do CHANGE ecosystem is feasible to implement in the cardiac population. Non-adherence is a common issue in web-based interventions for promoting health-related behavior, and the average study results in only 50% of participants adhering to the intended intervention [24]. However, a remarkable 82.4% of the patients participating in the Do CHANGE 1 trial fulfilled the intervention. The ecosystem is experienced as useful, easy to use and seems to be integrated relatively well into the daily life of the patients. It made the participants more aware of the fact that they must undertake activities themselves in order to feel better. Also, patients report to feel more ‘safe’, because healthcare professionals were watching along. It reduced some burden regarding the cardiac disease. These reports might explain the high number of patients that fulfilled the intervention.

Improving lifestyle was one of the main objectives of current study. Considering reported scores on lifestyle behavior, there is shown that lifestyle behavior improves over time in both the intervention and care as usual group. Between baseline and three months follow-up, people report to behave healthier in general. This level stays continuously stable between 3 and 6 months after randomization. One explanation for this finding could be attributed to participating in a RCT which focuses on lifestyle change. This could create awareness and increase knowledge in patients’ own lifestyle in general. This awareness could unknowingly lead to adaptation of lifestyle, independent of the allocation to the Do CHANGE intervention or care as usual group. Previous research in cardiac patients affirms that there is a relation between general knowledge about cardiac risk factors and self-reported lifestyle changes [25]. In recent European guidelines for preventive cardiology, it is mentioned that in the population of currently diagnosed cardiac patients, a modest reduction in risk behaviour could halve mortality rates [15]. Just participating in current study can therefore be seen as beneficial and explain the improved lifestyle behaviour in the care as usual group.
Current sample showed a ‘neutral’ score for quality of life on baseline in general. This means that participants were already satisfied with their quality of life from the start. This could be one of the reasons why no significant differences over time between the care as usual and intervention group were found.

This was the first study implementing the core Do’s of the Do Something Different program in the cardiac population. The program was delivered in combination with the different devices for monitoring patients’ health. Although previous studies show that the Do Something Different behavioral program was effective in other study populations focusing for example on weight loss [26], no significant effect of the behavioral flexibility, positive behavioral habits and wellbeing subscales were found. However, patients within the intervention group showed a significant decline in reported bad habits. It must however be taken into account that for the behavioral habit scale, only a part of the data was available. In addition, the delivered program in the current trial was of a rather general content. Participants might have felt that the Do’s were not applicable to them as a person and not feel motivated to accomplish the Do’s as a consequence. Furthermore, there was no direct feedback on whether patients were completing the Do’s, which might lead to non-adherence. One final explanation for this finding could be that patients reported that they did their Do’s, but did not really what was asked them to do.

In the Do CHANGE 2 trial, this problem will be encountered by gathering and processing real-time data of different lifestyle devices that will be used in order to generate personalized messages that more precisely meet the patients’ needs. Furthermore, this will give a more detailed insight in the actual fulfillment of the proposed Do’s.

Mean scores on depressive symptoms declined significantly over the 6 months period, resulting in a main effect of time within the analysis. Literature suggests that there might be an overlap between cardiac complaints and depressive symptoms which leads to the decline of reported depression scores over time [22]. In addition, the allocation to group shows to have a significant effect on the scores, with participants allocated to the care as usual group showing a larger decline in the mean depression scores compared to the participants allocated in the intervention group. Patients allocated in the care as usual group scored significantly higher on depression at baseline. Therefore, a bigger decline over time is to be expected, as they have more to gain over time. However, after controlling for baseline depression scores, there was no difference found in depression scores across 6 months between the intervention and care as usual group.

In the preliminary results of the subgroup analysis, it was found that men participating in the study in general show improvement of lifestyle behavior over time. However, no effect of the intervention was found, which means that no difference between the intervention and care as usual group in men was found. However, a more advanced method should be used (e.g. Latent Class Analysis (LCA)) in order to get a more detailed insight into which patients will benefit from the intervention the most, while controlling for variables that might intervene. This will be done in the second phase trial (Do CHANGE 2).

Limitations

One limitation of current study is that only a part of the patients included in the intervention group used the Moves app. This was because some patients had an older smartphone that was not capable of downloading the application or to use GPS tracking. The absence of the information on physical activity derived from the Moves app could possibly have affected the outcomes, as not all participants had the direct feedback from the Moves application that could lead to self-evaluation (and therefore self-reported behavior change). Furthermore, the sample was rather small in order to find solid effects. Future research should focus on eHealth interventions within the cardiac population based on a larger and significant power in order to draw firm conclusions.
Overall, 83% of the participating patients that used the ecosystem (e.g. CarePortal, blood pressure monitor, Moves app and DSD program) found the intervention useful. This might be an indication of social desirability and should therefore be interpreted with caution. Hence, focus groups that will be performed during trial Do CHANGE 2 may give better insight in the experienced usefulness of the total Do CHANGE service.
8. Conclusion

Based on the analysis of the first phase trial of Do CHANGE, we can conclude that an intervention program based on daily measurements with several devices (CarePortal, blood pressure monitor and smartphone) is feasible to implement into the cardiac population, particularly when seeing the high compliance up to the end of the study. Home monitoring of patients is experienced as beneficial by both the patient and the healthcare professional.

Blood pressure was significantly reduced in the intervention group. Furthermore, the Dutch intervention group showed a decrease in reported negative habits after 6 months compared to the care as usual group. Other changes in the overall intervention group versus the care as usual group could not be found. An explanation might be the ecosystem implemented with Do CHANGE 1 was not personalized enough in order to have a real positive effect on lifestyle change in patients with hypertension, cardiovascular disease and/or heart failure.

Overall, the reactions of participants who used the devices were promising and therefore the extended version of the ecosystem (including more lifestyle devices and personalized feedback), which will be evaluated in the second trial of Do CHANGE might have more clear effects on behavioral change in the intervention group.
9 References


