e-Coaching for Intensive Cardiac Rehabilitation

A Requirement Analysis

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Abstract. In this paper, the rationale and requirements are presented for an e-coaching system in the domain of intensive cardiac rehabilitation. It is argued that there is a need for a personalized program with close monitoring of the patient based on medical needs and needed lifestyle changes in a setting with other participants such as family and a human coach. Two roles are distinguished for the e-coach: support of the organizational process of the program (e.g. collecting and analyzing data) and support of the patient's process of making lifestyle changes (e.g. triggering and motivational support). Motivational interviewing is introduced as a means to minimize the discrepancy between undesired behavior and future goals of the patient. It is concluded that digital products that offer e-coaching support for these types of programs should coexist with human coaching.

Keywords: Intensive cardiac rehabilitation · e-Coaching · Requirements · Motivational interviewing · Lifestyle change

1 Introduction

Every day a thousand people are hospitalized in The Netherlands due to heart disease. Fortunately, the large majority (90%) of these patients survive. Currently, there are one million people with a heart disease in The Netherlands [1, 2]. This indicates that a large number of people has to rehabilitate from some kind of heart problem and adjust their lifestyle.

Cardiac rehabilitation has proven to be an effective secondary prevention measure for cardiovascular disease (CVD) [3, 4]. However, lifestyle changes necessary to modify risk factor profiles seem to be difficult to maintain long-term. Up to 60% of patients relapse within 6 months. 1.5 years after discharge from the hospital most beneficial effects of cardiac rehabilitation on risk factor profiles have been lost. Fortunately, lifestyle modification programs based on self-regulation theories seem to have more lasting effects [5]. The EUROASPIRE IV study [6] concluded that a new approach to cardiovascular prevention is required which integrates cardiac rehabilitation and secondary prevention into modern preventive cardiology programs with appropriate adaptation to medical and cultural settings.

In this paper, we argue that there is a need for a personalized rehabilitation process that is closely monitored and adjusted to each patient's needs. However, due to the massive amount of heart patients it is impossible to have such a personalized rehabilitation process supervised by doctors or other caregivers alone. Thus, we advocate an e-coach to support and monitor the patients during and after the rehabilitation period.

Here, we discuss the rationale and basic requirements for such an e-coach. In Sect. 2, we will analyze the relation between lifestyle change and cardiac rehabilitation and especially the elements that are of importance for coaching the patients. We will describe an intensive cardiac rehabilitation program (ICR) that tries to combine the rehabilitation with lifestyle changes. In Sect. 3, we will elaborate on the process of coaching in relation to behavioral models. In Sect. 4, we discuss how these elements are important requirements for the e-coach design and we present a first design for an e-coach for ICR. Finally, in Sect. 5, we draw some conclusions.

2   Cardiac Rehabilitation and Lifestyle Change

As imposed by the Dutch Health Care Inspectorate [7], we assume that in most cases lifestyle change is promoted in cardiac rehabilitation programs in The Netherlands. However, many factors influence participation in rehabilitation programs and also the uptake and maintenance of healthy behaviors [8, 9].

First of all, there are many *causes of heart disease* that may require a different approach for the rehabilitation process. A patient that has had a heart attack due to arteriosclerosis can often be treated by inserting a stent, recover quickly and likely perform all tasks normally. A patient that has cardiomyopathy might not recover completely, certainly cannot get an instant treatment through an operation, and may have to learn to cope with a low heart efficiency.

Secondly, the *overall health condition* of patients can differ widely. Some patients are fanatic sportsmen and have a good condition, while others can be elderly and not very active outside their homes. Of course, cardiac rehabilitation programs should be adjusted to these individual conditions.

Thirdly but not lastly, many heart problems, like heart attacks, seem to appear suddenly, but are the result of a *long process* caused by an unhealthy lifestyle, genetic factors or other 'hidden' factors. This may influence commitment to change lifestyle. Choosing to change lifestyle after a heart attack is probably more difficult, because the relation between cause and effect is long-term and indirect. Unfortunately most studies have not attempted to link behavioral change after cardiac rehabilitation to any particular period of time or event [10]. Also, older adults tend to confuse the cause of their symptoms of their unhealthy lifestyle to normal aging or other chronic disease processes and may therefore be less likely to participate in cardiac rehabilitation [3]. On the other hand, when a heart problem is treated with a surgical (eg. acute) intervention, a high degree of cardiac rehabilitation participation is seen [1]. The acuteness of the intervention may trigger a need for rehabilitation, but not necessarily a need to change lifestyle. These assumptions are coherent with the acute and chronic models of the Common-Sense Model of Self-Regulation (CSM) [11].

2.1 Personalization in Cardiac Rehabilitation Programs

The above issues lead to the conclusion that there is a strong need for a *personalized* rehabilitation process that is *closely monitored* and *adjusted* to the needs of the individual patient. In order to personalize a cardiac rehabilitation program, the following steps have to be taken.

First, one has to establish the current situation of the patient and the desired end situation in order to establish possible plans to get from one situation to the other. Although this sounds simple, there are some major issues. First of all, there may be an important discrepancy in the perception of the current situation between the cardiologist and the patient. To some extent, the cardiologist will be aware of the medical situation of the patient, but the patient may be unaware of his own medical condition. Even though the specialist can indicate the patient exactly what happened, what caused it, etc., the interpretation of this medical condition will still be radically different for the cardiologist and the patient. A cardiologist can compare the situation with many other cases and judge how severe the situation is (or was). The patient usually does not have this comparison and is inclined to judge his medical condition by how he 'feels' and how it affects his life, an area where the patient may be informed better than the cardiologist. Does the patient exercise or used to exercise? How socially active is the patient? Does the patient have a partner? And so on. Even if the patient tries to inform the cardiologist as well as possible, their subjective perceptions of the situation will influence the starting point and the rehabilitation process differently. Thus, a first step in the rehabilitation process will be to create common understanding and align the initial situation.

Similar steps should be taken to establish the goal of the rehabilitation. Again, this end situation has two sides: the first part is the medical condition of the patient's heart and the second is the lifestyle of the patient that should be geared towards preventing further heart problems. Especially lifestyle is difficult to manage. Maybe, the patient should become physically active for at least 30 min each day, start to eat healthy and avoid stress at work. But that might not be feasible in the current situation of the patient. A realistic goal should therefore be set, such that both the patient and the cardiologist feel that the goal is feasible and satisfies some minimal requirements on healthy living.

Finally, the patient and cardiologist have to determine a path to get from the initial situation to the desired situation. The cardiologist has knowledge about steps that will rehabilitate the heart condition, while the patient has to consider whether these steps are feasible and sustainable. It is important that the plan is frequently monitored and adjusted whenever necessary.

Setting goals is linked with better disease management in cardiac patients. Self-regulation theories propose that these goals should be hierarchically organized, such that if (healthy lifestyle) behaviors are not innately interesting, they can still be engaged in if they satisfy or reward another goal [5]. Leventhal's CSM model explicates this process, but it needs methods that allow this process to be translated for patient care [11]. The model starts with mental constructs that steer behavior and focuses on 'w*hat'* the specific rules for solving problems are in the current context and timeframe. It will help to interpret fear, attitude, focus, trust and attention of the patient. In the following section, we will elaborate on some of these methods.

2.2   An Intensive Cardio Rehabilitation Program

We will now briefly discuss an existing successful cardio rehabilitation program propagated by Ornish [12–14] and analyze which elements can be used as the basis for our e-coach design. This program has its focus on lifestyle change and incorporates the issues with lifestyle change discussed above. This so-called intensive cardio rehabilitation (ICR) program is based on a combination of experiencing (acting) and awareness (lessons). It consists of 18 sessions of 4 h, which are currently delivered within 18 weeks as required by the Social Security Act in the United States. Each session, there are four components: exercise, stress management, nutrition and group support. They correspond to the different areas of a lifestyle that should be considered in order to live a healthy life. By having lectures as well as practice, the program creates awareness and moments of feedback. By performing all exercises regularly, they can become part of habits of everyday life. Group support is an incentive to stick to the program in between meetings, to create a health-oriented peer group and to give support while coping with new situations. Participants of the program adhere to the program very well after 1 and 5 years. They show good reduction of risk factors and some show significant reversal of angiographic changes.

The most important issue from a coaching perspective is that patients are participating in extensive meetings outside their normal environment and experience the difference of living a healthy lifestyle in those meetings. The meetings stretch over a longer period and are repeated 18 times, making a habit breaking behavior possible. Because of the setting in which the program runs (USA hospital based), group support is felt as positive and safe; the new healthy behavior is associated with a positive attitude and thus more likely to persist. Interesting to see is that for male patients more partners participate in the program in order to sustain the changes in the home environment than for female patients. Patients that had a participating partner had more positive results than the ones that did not have their partners participate. Thus, including family and social environment in the program seems an important component [14]. One can suspect that rather homogeneous groups would be the most effective. If differences are large, the groups might lead to discouragement (e.g. 'I cannot keep up with them'), detachment and isolation (e.g. 'I don't fit with those young people having children at home'), as patients may have completely different concerns in their home environment and have completely different health prospects.

The cultural context of the program may be problematic for the Dutch culture. The ICR program assumes that people can and like to meet 18 times at moments of the day that include dinner time. In a Dutch situation, people may try to avoid any sessions that include dinner time. Dinner is an important social and family experience. One could also question whether people would join a support group for cardio rehabilitation at all. Making autonomous decisions about behavior is very important in the Dutch culture. Becoming part of the ICR program can be felt as being forced, because the primary reason will be their heart problem and not their personal choice. The medical necessity of a rehabilitation program might be acknowledged, but patients probably want to be autonomous about the timing of lifestyle changes. This leads to the demand for persuasion technology that supports patients individually in their lifestyle change while maintaining the persuasive elements of the collective ICR program.

3   Coaching the Patient

As we have explained, a patient and a cardiologist have to find a mutual understanding of the initial situation, set realistic goals and create a comprehensive action plan including monitoring of the outcome. The intended change during cardiac rehabilitation is usually one of the general goals of cardiovascular risk management. E.g. low-density lipoprotein cholesterol < 100 mg/dL, body mass index < 25 kg/m^2, smoking cessation and at least 150 min of physical exercise weekly [15].

Patients should only choose what they are motivated for. Then they can start figuring out 'how' they want to reach their chosen goals. This could include creating to-do-lists tailored to the patient's personal goals, circumstances, wishes, believes, drive and history. Motivational Interviewing (MI) [16] is a method that doctors can use to motivate patients in healthcare and seems a natural choice to start the ICR process.

3.1   Motivational Interviewing

Motivational interviewing (MI) has proven to be a successful guiding style for caregivers to help their patients, while they are in the process of resolving ambivalent feelings towards lifestyle changes. MI is 'a collaborative, person-centered form of guiding to elicit and strengthen motivation for change' [17]. It is testable and has scientifically proven positive effects on motivation and adherence; not only in cardiovascular prevention [18]. The effect of MI does not depend on the characteristics of the caregiver, but on a combination of empathy and a structured way of working. MI departs from traditional Rogerian client-centered therapy [19] through its use of direction, in which caregivers attempt to influence patients to consider making changes, rather than to let them explore themselves.

The caregiver should use the ambivalence towards unhealthy behavior to start 'moving' the patient. Thus, the caregiver should ask questions in a way that the patient feels competent to resolve the discrepancy. The main instrument of this communication style is empathic active listening and not to inform or to advise. The goal is to uncover sources of ambivalence, to avoid resistance or discussion and to give the existing ambivalence a positive direction. The positive internal voice is given more room to grow, while the negative counterpart is muted. Any resistance from a patient should be interpreted by the caregiver as a signal to change strategy, because the caregiver should try to stay away from the persuasion trap in which he argues for change and the patient argues against it.

MI can be divided into five steps: Step 1: Ask permission to talk about (un)healthy behavior. Step 2: Ask the 'why' question: Ask why a patient himself would like to change any behavior, but first why his current behavior is useful to him. Step 3: Ask the motivation-score question: listen for reasons or urges to change and rate the motivation. Step 4: Ask the confidence-score question: this is similar to step 3, but this time relates to their confidence to be able to change. Step 5: Ask the 'when' question: Ask at what moment they see themselves start concretely.

After this first step two things are achieved. The patient is aware of the situation and has made explicit why a change is desirable. And the patient has resolved the discrepancy together with the caregiver, who now can function as an external reference point for the

patient to motivate and include social pressure. This is fundamentally different from performing the same process without accountability to the caregiver, which would lead to a much lower commitment to the results. At this point, the caregiver will have sufficient reason to offer patient-specific scientific information to support any motivation to change and to enhance self-confidence.

3.2   Coaching for Behavior Change

Besides MI there are other methods that can be used in the process of coaching and self-determination. Although it is what people 'believe' in that drives them, humans can also moderate decisions by conscious reasoning. This point of view is applied in Cognitive Behavioral Theory (CBT). CBT is the most widely used evidence-based practice for treating mental disorders [20] and will in some form be used by coaches in regular group and individual meetings of ICR programs. At regular moments in an ICR program, patients can reflect on behavior outside normal circumstances and decide (consciously) upon a course of action.

Still, most of our daily behavior consists of schema's and habits. A habit will develop consistently, if a specific behavior is performed repeatedly in an unvarying context. Once formed, habits may be difficult to inhibit, even when they conflict with conscious (healthy) intentions, because the habits bypass the intentions [21]. Thus, this type of behavior is not regulated by conscious decision making and cannot easily be changed by CBT. What is needed is some additional coaching method that prevents the patient from getting into situations that trigger the unhealthy behavior or have some trigger set up, that leads to healthy behavior in those situations. Forcing a patient to exercise more every day might be done by creating a cue, for example parking the car a few blocks away. This cue makes it harder to use the car and easier to use the bike. One can also get partners involved. For example, have them buy healthy food, such that unhealthy alternatives are not present any more.

When trying to change a behavior in a particular situation, the trigger for the healthy behavior will have to be part of this situation. Having a human coach present (or a buddy) to trigger behavior, is an option, but expensive and not always possible. A virtual coach, however, can be omnipresent and can remind the patient of the right course of action at the right time and situation.

4   e-Coaching

A recent systematic review and meta-analysis of web-based interventions showed that these interventions can be effective in improving cardiovascular risk factor profiles of middle-aged and older people, but effects are modest. Sustainability is of particular importance, because long-term effects are required for primary and secondary prevention to truly contribute to the prevention of cardiovascular disease. Web-based interventions combined with human support are considered to be more promising than electronic-only interventions [22].

Although pursuing a health promotion intervention based explicitly on a habit formation model is still rare [21], we argue that e-coaching combined with specific human support at regular intervals and based on a habit formation model will be the most effective way to affect lifestyle change in an ICR.

4.1   e-Coaching for a Rehabilitation Program

We will now discuss what the above means for e-coaches that support a cardio rehabilitation program. Especially at what moments they can support the patient and what the requirements are for the interaction such that they work effectively. How could the process of a behavioral change be enhanced by using an electronic support? Which tasks can computers do better than or just as good as humans? How can behavioral theories help us to structure an e-coach in a logical and practical form? From the previous discussion, we see a role for an e-coach in:

1. the organizational process of the cardio rehabilitation program: establish common grounds between the patient and caregiver about the initial situation; build trust during the process; establish a desired end situation; balance the program intensity and content according to the goals and taxability of the heart; create regular habit breaking situations to change the lifestyle of the patient; involve the social environment of the patient; include a close monitoring system to quickly react to non-adherence of the program and to detect progress or deterioration of the patient.
2. the patient's process of making lifestyle changes: determine the motivation of a patient ('why'), assist with setting goals ('what'), implement a planning process and support execution of new habit formation ('how')

An e-coach is well suited for offering structured information based on patient-specific data and can therefore add value to coaching. Also, an e-coach can support with asking questions. Based on the answers given, it can put together new questions. This results in a so-called 'digital consultation' (see e.g. [23]). A precondition is that the expected answers fall within predictable response categories. Subsequently, a logical follow-up question can be constructed. It seems that step 1 and 5 of MI are suitable for such a digital consultation. Steps 2 through 4 will depend on live-sessions with the caregiver. A digital consultation is not a questionnaire or survey, but rather a structured interview. An e-coach could also add a meaningful and time saving contribution by administering a questionnaire to gather data concurrent with the live sessions [24, 25]. Due to the increasing sophistication of natural language processing methods for automated coding, computers are learning to understand and encode human language better. Currently, this is used in research to encode MI interviews. In the future, it may serve 'digital consultation', when it would permit less rigid question-response category preconditions or when it could select follow-up questions according to the perceived mood [26, 27].

In general, an e-coach contributes to the experience of guidance and is patient-friendly as it allows for answering questions at a self-chosen moment. Furthermore, documenting answers and small steps of self-evaluation makes the patient aware of even the smallest successes achieved, which is essential to manage self-motivation.

The second part of an e-coach contribution could be monitoring and guiding the process that concerns planning and execution of 'how' to develop healthy habits. To develop a habit, a conscious desire needs to transform from an intention to a decision, to a behavior, to a context-dependent repetition of this behavior and finally into a habit. The Fogg Behavior Model states that three elements must converge at the same moment for a behavior to occur: Motivation, Ability, and Trigger 'B = MAT' [28]. Coherent with the preceding arguments in this article, we could argue to add a humanistic factor to the equation, 'B = MATH', that would acknowledge the influence of human mind setting as described above.

Following the behavioral point of view, an e-coach can assist the process of cardio rehabilitation by *setting cues* and *triggers* and *implementation intentions* (rigid if/then patterns) to initiate desired behavior. Triggers can be based on different contexts, e.g. location, time, a preceding event or emotion. The most effective cues for implementation intentions seem to be distinct events in daily life which are unlikely to be missed. It is also better to associate former cues with a new healthy response than to a non-response [21]. For example, an e-coach could trigger a response based on GPS location and remind patients to use the stairs instead of the elevator when they arrive at work. Humans tend to 'forget to remember' so-called prospective memory tasks. Electronic support systems are better at 'remembering' than people. So, to enhance intended medication compliance in an ICR, the e-coach could trigger an alarm to remember to take medication, e.g. medicine boxes with alarms. The e-coach can also help setting up a schedule or planning or help structure and plan 'implementation intentions'. For example, every day before I have dinner, I will go for a walk for 30 min. Or, every time I go to the fridge for a snack I will take 500 ml of cold water and wait for three minutes to see if I still want the snack. Another example where an e-coach could be beneficial is when it would assist patients with chunking of desired behavior by asking sensible questions. Behavior that is perceived as hard will be perceived as more doable when chunked. Additionally, if 'chunked' behavior is linked in a sequence by planning, doing one chunk of behavior can trigger the next chunk. For example, people who have initiated 'going for a run' by putting on their running shoes and leaving the house are more likely to continue with their run than those who have not initiated the process with the previous 'chunk' of behavior.

An e-coach can also *facilitate repetition of behavior* e.g. compliance with therapy, because it can give guidance for a prolonged time. Often, the effectiveness of conventional behavior change interventions is constrained because, when the active intervention period ends, so does attention for the desired target behavior, like going for a walk, eating more vegetable, attending yoga classes, etc. With conventional intervention, short-term behavioral gains tend to get lost in the long-term [21].

An e-coach can *monitor behavior* or outcomes and attach consequences to them, like praising and reprimands to assist with automation of behavior. Satisfaction is likely to be important in maintaining novel behavior, while dissatisfaction typically disengages people. The gaming industry uses sophisticated cues and triggers to keep people from disengaging.

Finally, an e-coach can contribute its strengths of *digital data processing* to the empathic and therapeutic management by healthcare professionals. Healthcare professionals tend to get overwhelmed by the vast amount of data that is produced in health

care nowadays, including data produced by the world of sensors and wearables that people carry with them in their smartphones, watches, domotics or other applications. An e-coach can assist with careful selection and clear presentation of useful data, e.g. measurements of heartrate, weight, blood pressure, glucose levels or activity level. Tracking of how good or how bad patients are doing in between (healthcare) visits can offer healthcare information that would not be available otherwise.

4.2 Design of an e-Coach for ICR

Given the previous discussions, the contents of an ICR program and the possibilities for an electronic coach to support the patient and caregiver, we arrive at the following requirements that should be covered by an e-coach.

1. Collecting data about the initial situation of the patient at the start of the ICR program. This data consists of three parts:
   a. Medical data that can be imported from the electronic patient file concerning diagnosis, severity and all information that can influence the contents or course of the ICR;
   b. Data measured at the patient in a particular period that are linked to the secondary prevention goals in cardio vascular risk management (see Table 1);
   c. Data concerning the social situation of the patient that could influence adherence to the ICR program, for example, whether a partner smokes or not.
2. Support during consultations with the caregiver at the start of the ICR program.
   a. Show how some combination of habits and physical conditions bring about heart conditions and how this changes when the habits are changed.
   b. Support the determination of the 'why' of the intended change of habits and explicitly show contributing factors (e.g. work stress, unhealthy eating, no activity and smoking).
   c. Support the caregiver and patient to determine achievable goals and optimize what is medically possible (e.g. 30 min of activity could be swimming, running, playing soccer with children, …with a heartrate of 120–150 bpm).
3. Monitoring and triggering of the patient during the ICR program.
   a. Monitoring can be done by sensors that automatically collect data that can show progress of secondary prevention goals in cardio vascular risk management. To enhance adherence, it seems important to include sensors that patients already use, e.g. apps, smartwatches and phones. Data can also be collected through forms from the patient and possibly relatives and/or friends. Furthermore, results can be obtained at designated points in time (once a day or week). The results of the monitored data should be visible for the patient at any time. Under certain conditions data can be sent to the caregiver or to other designated relatives or friends for feedback on a patient's behavior.
   b. The e-coach can give triggers for activities when it is time for these actions according to the schedule or based on other contexts, e.g. location, time, a preceding event or emotion. It should be possible to automatically schedule activities in the agenda such that new appointments can be taken care of.

4. If the ICR program includes meetings with patient groups, a social media group or intranet can be created for these patients, such that they can keep contact outside these meetings for feedback, for accountability to their goals and to celebrate victories and results together.

Table 1. Secondary prevention goals for CHD

Factor	NHG goal	ACC goal
Systolic Blood Pressure (SBP)	≤140 mmHg*	<140 mmHg
Diastolic Blood Pressure (DBP)	<90 mmHg*	<90 mmHg
Low-Density Lipoprotein (LDL)	≤2.5 mmol/L	<100 mg/dL
Fasting Blood Glucose	<6 mmol/L	<100 mg/dL
Body Mass Index (BMI)	≤25 kg/m^2**	18.5–24.9 kg/m^2
Waist circumference	♂ < 94 cm; < 80 cm	♂ < 102 cm; < 88 cm
Physical activity (brisk)	5 times 30 min/wk	≥150 min/wk
Smoking, Food, Stress	Guideline compliance	Guideline compliance
Medication	Compliance***	Compliance

Abbreviations: ACC, American College of Cardiology; NHG, Nederlands Huisartsen Genootschap.
*≥80y SBP: 150–160 mmHg; With chronic kidney disease or proteinuria: <130/80 mmHg.
**>70y weigh (dis)advantage of medication against life expectancy; >70y BMI goal ≤ 30 kg/m^2.
***Medication is required when SBP > 180 mmHg or TC/High-density-lipoprotein ratio > 8 mmol/l.

From these concrete points mentioned above, it can be concluded that the first meetings of the ICR program between patient and caregiver are very important. The result of these meetings is a personalized recovery program of which the patient is convinced that it is achievable and medically useful (because he can see the basis from which it is constructed and thus also trust what the caregiver gives as advice) and for which the patient is motivated (because the patient has set the goals himself and can see that these are achievable and useful in his personal situation).

5   Conclusions and Future Work

To conclude, we envision an electronic support for intensive cardiac rehabilitation, that is driven by our belief that we can help patients change their unhealthy behavior by adding value to the physical process of coaching. A caregiver should discover together with the patient 'why' the patient wants to change and agree upon medical rehabilitation goals that are coherent with the patient's motivation. An e-coach can assist with processing data and offering clear data presentation. An e-coach may offer digital consultations and create triggers when people tend to forget. The possibility of close monitoring through a mobile device, forms and sensors gives the patient continuous feedback on progress, gives assurance and can give triggers to avoid bad habits. If data

is shared in a digestible format with others, this can also build up a community that supports good behavior.

Digital products tend to be based on rules, but rules are never a substitute for thinking, so coaching and e-coaching should learn to coexist. Therefore, an e-coach should adapt to behavioral mechanisms and caregivers should learn to incorporate e-coaches in their workflow, where digital support adds value or saves time.

References

1. Koopman, C., Van Dis, I., Vaartjes, I., Visseren, F.L.J., Bots, M.L.: Hart- en vaatziekten in Nederland 2014, cijfers over kwaliteit van leven, ziekte en sterfte. Hartstichting, Den Haag (2013)
2. Zinnige Zorg - Screeningsfase: Systematische Analyse hart- en vaatstelsel. Zorginstituut Nederland, Diemen (2015)
3. Keib, C.N., Reynolds, N.R., Ahijevych, K.L.: Poor use of cardiac rehabilitation among older adults: a self-regulatory model for tailored interventions. Heart Lung. **39**(6), 504–511 (2010)
4. De Vries, H., Kemps, H.M.C., Van Engen Verheul, M.M., Kraaijenhagen, R.A., Peek, N.: Cardiac rehabilitation and survival in a large representative community cohort of Dutch patients. Eur. Heart J. **36**, 1519–1528 (2015)
5. Janssen, V., De Gucht, V., Van Exel, H., Maes, S.: A self-regulation lifestyle program for post-cardiac rehabilitation patients has long-term effects on exercise adherence. J. Behav. Med. **37**, 308–321 (2014)
6. Kotseva, K., et al.: EUROASPIRE IV: A European Society of Cardiology survey on the lifestyle, risk factor and therapeutic management of coronary patients from 24 European countries. Eur. J. Prev. Cardiol. **23**, 636–648 (2016)
7. Diemen-Steenvoorde van, J.A.M.: Instroom hartrevalidatie en naleving richtlijn op onderdeel leefstijlbegeleiding onvoldoende verbeterd. Inspectie voor de Gezondheidszorg, Utrecht (2013)
8. Kelly, S., Martin, S., Kuhn, I., Cowan, A., Brayne, C., Lafortune, L.: Barriers and facilitators to the uptake and maintenance of healthy behaviours by people at mid-life: a rapid systematic review. PLoS ONE **11**, e0145074 (2016)
9. Murray, J., Fenton, G., Honey, S., Bara, A., Hill, K., House, A.: A qualitative synthesis of factors influencing maintenance of lifestyle behaviour change in individuals with cardiovascular risk. BMC Cardiovasc. Disord. **13**, 48 (2013)
10. Murray, J., Honey, S., Hill, K., Craigs, C., House, A.: Individual influences on lifestyle change to reduce vascular risk: a qualitative literature review. Br. J. Gen. Pract. **62**, 403–410 (2012)
11. Leventhal, H., Phillips, L.A., Burns, E.: The Common-Sense Model of self-regulation (CSM): a dynamic framework for understanding illness self-management. J. Behav. Med. **39**(6), 935–946 (2016)
12. Ornish, D., Brown, S.E., Billings, J.H., Scherwitz, L.W., Armstrong, W.T., Ports, T.A., McLanahan, S.M., Kirkeeide, R.L., Gould, K.L., Brand, R.J.: Can lifestyle changes reverse coronary heart disease? Lifestyle Heart Trial. Lancet. **336**, 129–133 (1990)
13. Ornish, D., Scherwitz, L.W., Billings, J.H., Brown, S.E., Gould, K.L., Merritt, T.A., Sparler, S., Armstrong, W.T., Ports, T.A., Kirkeeide, R.L., Hogeboom, C., Brand, R.J.: Intensive lifestyle changes for reversal of coronary heart disease. JAMA **280**, 2001–2007 (1998)
14. Billings, J.H.: Maintenance of behavior change in cardiorespiratory risk reduction: a clinical perspective from the Ornish Program for reversing coronary heart disease. Heal. Psychol. **19**, 70–75 (2000)

15. Ton, V.-K., Martin, S.S., Blumenthal, R.S., Blaha, M.J.: Comparing the New European cardiovascular disease prevention guideline with prior American heart association guidelines. Clin. Cardiol. **36**, E1–E6 (2013)
16. Rollnick, S., Miller, W.R., Butler, C.: Motivational Interviewing in Health Care: Helping Patients Change Behavior. Guilford Press, New York (2008)
17. Miller, W.R., Rollnick, S.: Ten things that motivational interviewing is not. Behav. Cogn. Psychother. **37**, 129–140 (2009)
18. Thompson, D.R., Chair, S.Y., Chan, S.W., Astin, F., Davidson, P.M., Ski, C.F.: Motivational interviewing: a useful approach to improving cardiovascular health? J. Clin. Nurs. **20**, 1236–1244 (2011)
19. Rogers, C.R.: Client-Centered Therapy: Its Current Practice, Implications and Theory. Constable, London (1951)
20. Gaudiano, B.A.: Cognitive-behavioural therapies: achievements and challenges. Evid. Based Ment. Health **11**, 5–7 (2008)
21. Gardner, B.: A review and analysis of the use of "habit" in understanding, predicting and influencing health-related behaviour. Health Psychol. Rev. **9**, 277–295 (2015)
22. Beishuizen, C.R., Stephan, B.C., van Gool, W.A., Brayne, C., Peters, R.J., Andrieu, S., Kivipelto, M., Soininen, H., Busschers, W.B., Moll van Charante, E.P., Richard, E.: Web-based interventions targeting cardiovascular risk factors in middle-aged and older people: a systematic review and meta-analysis. J. Med. Internet Res. **18**, e55 (2016)
23. Beun, R.J., Brinkman, W.P., Fitrianie, S., Griffioen-Both, F., Horsch, C., Lancee, J., Spruit, S.: Improving adherence in automated e-coaching. In: Meschtscherjakov, A., De Ruyter, B., Fuchsberger, V., Murer, M., Tscheligi, M. (eds.) Persuasive Technology, pp. 276–287. Springer International Publishing, Salzburg (2016)
24. Friederichs, S.A.H., Oenema, A., Bolman, C., Lechner, L.: Long term effects of self-determination theory and motivational interviewing in a web-based physical activity intervention: randomized controlled trial. Int. J. Behav. Nutr. Phys. Act. **12**, 101 (2015)
25. Geissler, H., Hasenbein, M., Kontouri, S., Wegener, R.: e-Coaching: conceptual and empirical findings of a virtual coaching programme. Int. J. Evid. Based Coach. Mentor. **12**, 165–186 (2014)
26. Tanana, M., Hallgren, K.A., Imel, Z.E., Atkins, D.C., Srikumar, V.: A comparison of natural language processing methods for automated coding of motivational interviewing. J. Subst. Abuse Treat. **65**, 43–50 (2016)
27. Can, D., Marín, R.A., Georgiou, P.G., Imel, Z.E., Atkins, D.C., Narayanan, S.S.: "It sounds like…": a natural language processing approach to detecting counselor reflections in motivational interviewing. J. Couns. Psychol. **63**, 343–350 (2016)
28. Fogg, B.J.: A behavior model for persuasive design. In: Chatterjee, S., Dev, P. (eds.) Persuasive 2009 Proceedings of the 4th International Conference on Persuasive Technology. ACM, Claremont (2009)