Less is more

In lifestyle-related risk factor management in secondary prevention of coronary artery disease

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CHAPTER 3

Impact of cardiac rehabilitation on lifestyle-related risk factors in patients with coronary artery disease: an analysis of the CARDSS-II trial


Submitted
ABSTRACT

Background
Cardiac rehabilitation (CR) programmes contribute to secondary prevention of coronary artery disease (CAD). However, evidence on the impact of CR on lifestyle-related risk factors (LRFs): smoking, overweight and/or physical inactivity is limited. We studied the impact of CR on these 3 LRFs in patients with CAD.

Methods
We analysed data from the multicentre CARDSS-II CR study, initially conducted to improve the quality of CR centres through online feedback and educational visits. For this secondary patient-level analysis, we evaluated the proportions of patients showing improvement, or conversely: deterioration, of at least one LRF from baseline (start of CR) until follow-up (end of CR). In addition, we used a stricter definition of success: improvement of at least one LRF without deterioration of the other two.

Results
Of 10,747 patients with CAD, sufficient data on LRFs at baseline and follow-up were available in 2764 (26%) patients. Mean age was 62.7 (±10.5) years, 25% were female. After attending CR (median duration 13 weeks), 51% of patients showed improvement of at least one LRF, and 34% of the patients deteriorated in at least one LRF. According to the strict definition the success rate was 38%.

Conclusion
In our study, a reduction of at least one lifestyle-related risk factor in individual patients was seen in 51% of patients. Disappointingly, deterioration was seen in a third of the patients. Potentially, a tailored approach in CR may be superior to a general approach, and prevention of deterioration appears to be an important goal.

Trial registration: Dutch trials register: NTR3251. Registered 19 January 2012
INTRODUCTION

Patients with coronary artery disease (CAD) are at high risk for recurrent morbidity and mortality. Treatment of cardiovascular risk factors can reduce this risk, and the European Society of Cardiology (ESC) emphasize the importance of risk factor management to improve survival and reduce recurrent events.

An important part of this risk management consists of interventions aimed at lifestyle improvement, focusing on smoking cessation, a healthy diet, weight management, and regular exercise. However, achieving optimal medical treatment and control of lifestyle-related risk factors (LRFs) has been challenging. The EUROASPIRE surveys showed that CVD prevention in routine clinical practice is far from optimal, in fact showing a temporal trend of an increasing prevalence of overweight and obesity.

The ESC guidelines recommend a multifaceted approach in patients with one or more LRFs, based on the fact that LRFs influence each other. Cardiac rehabilitation (CR) programmes offer such comprehensive approaches. The ICAROS Survey showed positive self-reported results on improving LRFs in patients with CAD following a CR programme (74% smoking cessation, 72% adhered to the Mediterranean diet and 46% were physically active). Objectively measured weight loss after following a CR programme has been shown to be more challenging, with a mean weight reduction in a 12-week CR program of 0.77 kg (SD±3.2kg). In the RESPONSE2 trial, conducted in the Netherlands, lifestyle-related risk factors improved after a 12 months intervention, nevertheless this was done in a study setting and was on top of CR.

Overall, CR programmes have reported variations in the effects on improvement of LRFs, and real-life clinical data of the effect of such programmes on LRFs are limited. The CARDSS-II trial (Cardiac Rehabilitation Decision Support System), conducted in several CR clinics in the Netherlands included almost 15,000 patients. Although the aim of this study was at CR clinic level, information on patient level is available. We therefore evaluated the proportion of patients showing improvement, or deterioration, in LRFs after attending CR programmes in the Netherlands.

METHODS

Study design

The CARDSS-II trial was a multicentre, cluster randomised controlled trial conducted in 18 cardiac rehabilitation outpatient clinics in the Netherlands from July 2012 to December 2014. The trial was designed to evaluate the impact of online feedback reports combined with educational visits to participating centres to improve the performance
and the quality of cardiac rehabilitation in the Netherlands. The CARDSS-II trial has been described elsewhere and is briefly summarized below.10

**Patient Population**
Participating CR clinics registered all consecutive CR patients in the CARDSS database. For the current analysis, we included patients with coronary artery disease (CAD): myocardial infarction, unstable and stable angina pectoris, and/or patients who underwent percutaneous coronary interventions or coronary artery bypass graft surgery, and with complete data on the following LRF at baseline and follow up: (1) self-reported smoking status (2) body mass index (BMI) (3) self-reported physical inactivity level. The institutional committees on human research of all recruiting hospitals approved the protocol.

**Data collection**
For the current analysis, we used data collected at baseline and follow-up of the CR programme. Data was collected by a CR nurse during the regular assessment and follow-up visit. (not mandatory and different per CR clinic). We collected data on age, gender, civil status, diagnoses, treatments, cardiovascular history, family history, smoking status, dietary status, weight, height, and level of physical activity. LRFs were smoking, overweight and physical inactivity. Smoking status was self-reported with yes/no, body mass index (BMI) was calculated, and BMI $\geq 25$ kg/m$^2$ was defined as overweight, and an inadequate physical activity level was self-reported with yes/no, defined as not reaching the international goal for physical activity (moderate- to high-intensity physical activity for at least 30 minutes per day on at least 5 days per week).

**Study Outcomes**
The primary outcome was the proportion of patients who showed improvement of at least one LRF from baseline to follow up. Goals for improving LRFs were defined according to the ESC guidelines: 1) self-reported non-smoking status; 2) BMI $< 25$ kg/m$^2$, or weight loss more than 1 kg. As participation in a CR programme (in general $\approx 12$ weeks$^4$) is too short to expect a weight reduction of at least 5% of the initial weight (as per current guidelines), we defined success as any weight loss of more than 1 kg; 3) self-reported adequate physical activity ($\geq$30 minutes of moderate intensity activity for 5 days per week).

Secondary outcomes included differences in isolated LRFs and deterioration of LRFs from baseline to follow-up. We added a stricter definition of success: improvement of (at least one) LRF without deterioration of the other LRFs. Deterioration was defined as: (1) reporting smoking at follow up in former non-smoking patients, (2) $>1$kg weight gain in combination with a BMI $> 25$kg/m$^2$, (3) reporting physical inactivity at follow-up in former physically active patients.
**Statistical Analysis**

Continuous variables were presented as mean and standard deviation (SD) for normal distributed data, non-normal distributed data as median and Q1 and Q3. Categorical variables were presented as counts and percentages. Change scores were calculated as the difference between follow-up and baseline. Comparisons between groups for continuous data were analysed by independent samples t-tests or Mann Whitney U-tests, categorical data by χ² tests or Fisher’s exact tests, as appropriate. All statistical tests were two-tailed and a p-value of ≤0.05 used to indicate statistical significance. SPSS statistics version 22.0 was used for all statistical analyses.

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**Figure 1.** Study flowchart.

CAD = Coronary artery disease, AP = agina pectoris, BMI = body mass index, LRF = Lifestyle-related Risk Factor.
RESULTS

In total, 14,847 patients were registered in the CARDSS II database, of whom 10,747 were diagnosed with CAD. Of these, 9,566 patients had data on LRFs at baseline, and 2764 (26%) had outcome data on LRFs at follow-up (Figure 1). Patients who had no follow-up data on LRF were slightly older, were more often diagnosed with unstable angina, were more often current smokers, were more often physically inactive, and had a greater number of LRFs per individual. (Table 1)

<table>
<thead>
<tr>
<th>Table 1. Baseline Characteristics.</th>
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<td>n=2764</td>
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Demographics

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<tr>
<td>Demographics</td>
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<tr>
<td>Age, years</td>
<td>62.7 (±10.5)</td>
<td>63.4 (±11.1)</td>
<td>0.01</td>
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<tr>
<td>Female</td>
<td>676/2764 (25%)</td>
<td>1783/6802 (26%)</td>
<td>0.08</td>
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<tr>
<td>Married / cohabitating</td>
<td>415/539 (77%)</td>
<td>2240/2836 (79%)</td>
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Diagnoses

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<td>Myocardial infarction</td>
<td>1618/2764 (59%)</td>
<td>3855/6802 (57%)</td>
<td>0.10</td>
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<tr>
<td>Unstable angina</td>
<td>535/2764 (19%)</td>
<td>1743/6802 (26%)</td>
<td>&lt; 0.001</td>
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<td>Stable angina</td>
<td>511/2764 (18%)</td>
<td>829/6802 (12%)</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Revascularisation</td>
<td>100/2764 (4%)</td>
<td>375/6802 (6%)</td>
<td>&lt; 0.001</td>
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Treatment

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<td>PCI</td>
<td>1710/2670 (64%)</td>
<td>4153/6437 (65%)</td>
<td>0.47</td>
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<tr>
<td>CABG</td>
<td>711/2670 (27%)</td>
<td>1648/6437 (25%)</td>
<td>0.13</td>
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<tr>
<td>Optimal medical therapy</td>
<td>218/2670 (9%)</td>
<td>468/6437 (10%)</td>
<td>0.09</td>
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Cardiovascular risk factors

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<tr>
<td>Positive family history</td>
<td>986/1960 (50%)</td>
<td>2259/5124 (44%)</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>History of diabetes mellitus</td>
<td>376/1960 (14%)</td>
<td>1140/6293 (18%)</td>
<td>&lt; 0.001</td>
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<tr>
<td>Hypertension (SBP&gt;140mmHg)</td>
<td>641/2624 (24%)</td>
<td>1610/6417 (25%)</td>
<td>0.11</td>
</tr>
<tr>
<td>Dyslipidaemia (LDL&gt;1.8 mmol/l)</td>
<td>1535/1940 (79%)</td>
<td>3389/4238 (80%)</td>
<td>0.45</td>
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<tr>
<td>Current smoking</td>
<td>795/2764 (29%)</td>
<td>2129/6802 (31%)</td>
<td>0.02</td>
</tr>
<tr>
<td>Overweight (BMI&gt;25 kg/m²)</td>
<td>1917/2764 (69%)</td>
<td>4711/6802 (69%)</td>
<td>0.94</td>
</tr>
<tr>
<td>BMI, kg/m²</td>
<td>27.29 (±4.2)</td>
<td>27.37 (±4.2)</td>
<td>0.37</td>
</tr>
<tr>
<td>Physically inactive</td>
<td>1112/2764 (40%)</td>
<td>3334/6802 (49%)</td>
<td>&lt; 0.001</td>
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Cardiac rehabilitation (CR)

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<tr>
<td>Duration of CR, weeks</td>
<td>13 (9-18)</td>
<td>10 (7-15)</td>
<td>0.02</td>
</tr>
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PCI percutaneous coronary intervention, CABG coronary artery bypass surgery, SBP systolic blood pressure, LDL lower density lipoprotein, BMI body mass index, CR cardiac rehabilitation
Patient characteristics are presented in Table 1. Mean age was 62.7 years (±10.5) and 25% were female. At time of entering CR, smoking was reported in 29%, overweight (BMI ≥25 kg/m²) in 69%, and physical inactivity in 40% of the patients.

The median follow-up time of CR was 13 weeks (Q1-Q3 9-18 weeks). During CR 46% (1262/2764) of the patients followed one or more components of the CR programme; 24% (672/2764) followed the exercise programme (median number of sessions 12, Q1-Q3 9-19 sessions), 26% (727/2764) followed the relaxation programme (median number of sessions 2, Q1-Q3 1-5 sessions), 13% (368/2764) followed the lifestyle programme (median number of sessions 4, Q1-Q3 3-4 sessions), and 3% (88/2764) received individual counselling from a dietician (median number of sessions 1, Q1-Q3 1-2 sessions).

Figure 2 shows the changes of LRFs from baseline to follow-up. In total, 1411 (51%) patients showed improvement of at least one LRF; 1117 (40 %) patients reduced their overall number of LRFs with one LRF, 283 (10%) patients by 2 risk factors, and 11 patients (0.4%) improved all three LRFs. In 936 (34%) patients at least one LRF deteriorated; 891 (32 %) patients increased the number of LRFs with one, 71 (3%) patients with two risk factors, and 1 patient deteriorated on all three LRFs. After following CR, the proportion of patients who improved their number of LRFs without deterioration of the other LRFs (stricter definition of success) was 38% (1036/2764).

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**Figure 2.** Change in LRFs after following CR. 2A Improvement of at least one LRF; overall number and stratified by type of LRF. 2B Deterioration of at least one LRF; overall number and stratified by type of LRF.

* or BMI<25 kg/m²

# and BMI>25 kg/m²

LRF = Lifestyle-related Risk Factor, CR = cardiac rehabilitation, BMI = body mass index
Success rates for isolated LRFs differed. At baseline, 795 patients were smokers; of these, 509 (64%) stopped smoking. Of the 1,917 patients with overweight at baseline, 680 (35%) achieved at least 1 kg weight loss. Notably, 34% of all patients with overweight at baseline gained weight during CR (Figure 3). At baseline, 1,112 patients were physically inactive, of whom 527 (47%) reported to be on target for physical activity at follow-up.

**Figure 3.** Waterfall plot; weight change after following CR
CR = cardiac rehabilitation, BMI = body mass index

**Figure 4.** Distribution of LRFs at baseline and follow-up in patients following a CR program.
LRF = Lifestyle-related Risk Factor; i.e. smoking, BMI > 25 kg/m² and physically inactive
Figure 4 shows the number of LRFs in individual patients. At baseline there were 399 (14%) patients with no LRFs, 1166 (42%) with one, 939 (34%) with two, and 260 (9%) patients had three LRFs. After following CR 552 (20%) patients had no LRFs, 1437 (52%) had one LRF, 719 (26%) had two LRFs, and 83 (3%) patients had three LRFs.

**DISCUSSION**

The main finding of our study is that in a contemporary CR population, 51% of the patients with CAD improve at least one LRF, demonstrating that improvement of LRFs is feasible in a substantial proportion of patients. However, in 34% of patients deterioration in at least one LRF was observed, mostly caused by weight gain. Using a stricter definition of success, taking deterioration into account, only 38% of the patients improved the lifestyle-related components of their cardiovascular risk profile. Success rates differed per LRF, with smoking cessation in 64% of pre-event smokers, weight reduction in 35%, and improved physical activity levels in 47%. Compared with patients not following a CR programme, where only 14% stopped smoking, no weight loss was seen and 46% of the patients met the levels for adequate physical activity, a CR programme clearly shows beneficial effects on LRFs.11

While a large percentage of patients showed improvement of at least one LRF, this was offset by a large proportion in which LRFs deteriorated. As we consider that improvement should not come at the cost of deterioration of other LRFs. Using a stricter definition of success, the success rate was significantly lower (38% vs 51%, p<0.01) Our results emphasize that while improvement of at least one LRF is a primary goal in the setting of CR, prevention of deterioration may be equally important.

The success rates for isolated LRFs differed. Smoking cessation showed the highest percentage of success, with 64% self-reported quitters. The overall success rate for weight reduction (35%) was lower compared with the improvement seen in the other LRFs, while this LRF was most prevalent at baseline. In our analysis, we defined success as any weight loss of more than 1 kg, as participation in a CR programme (in general 6 to 20 weeks) is too short to expect weight reduction of ≥5% of the initial weight (as defined by guidelines). Possibly, the intensity, frequency, and duration of weight reduction elements in CR programmes are insufficient to have more beneficial effects in the short term, and besides the majority of patients did not follow a lifestyle program during CR. In a pilot study, evaluating referral of obese patients with CAD to a commercial, community-based weight management programme (in addition to CR), 91% of the 35 patients achieved weight loss. While these results are encouraging, this was a selected population in an uncontrolled study, and it remains to be established if these results can be duplicated in a large-scale, randomised trial12.
Physical activity programmes are a key component of CR. In our analysis, an overall improvement of 47% was seen in physical activity, while only 26% of the patients followed exercise training, leaving considerable room for improvement. Between Dutch CR centres there is a wide variation in methods for determination of exercise intensity, there is no uniformity in training volume and intensity13 and it is unclear whether these programmes focus on improving fitness or the amount of regular physical activity.

The prevalence of patients without any LRFs at baseline was low (14%), which improved to 20% at follow-up. This suggests that there is room for improvement in 80% of all patients. The prevalence of LRFs not on target in individuals should, in our opinion, be part of a routine assessment and should lead to selection of the LRFs that the patient would (first) like to improve. Based on our findings, assessment of the individual patients’ LRFs and their motivation to address them, followed by tailored programmes with different frequencies and duration per patient, could significantly improve CR programmes.7 In addition, awareness of the potential for deterioration of LRFs may be an important component of effective CR programmes.

**Strengths and Limitations**

The strength of our study was that data is derived from a large trial aiming to investigate the implementation of guideline-based recommendations for CR. Therefore, our findings reflect the levels of the contemporary standard of care of CR in the Netherlands. Some aspects of our study should be taken into account. First, the majority of the patients (63%) were not included in our primary analysis due to missing data on LRFs at follow-up. This was possibly a result of the fact that patients were not routinely scheduled for an evaluation visit (follow-up), as this is not mandatory and therefore dependent on local practice. Patients excluded due to missing data were different (selection bias), although similar results were seen in another Dutch CR participation study14. Second, the follow-up duration was short, as CR only takes an average of 3 months in the Netherlands. Especially for LRFs, a longer follow-up period would be preferable, as these risk factors take time to change, and considering that maintaining such changes can be challenging.

**Conclusion**

In patients attending CR, improvement in LRFs was seen in 51% of patients, while 34% showed deterioration. The number of patients without any LRF was only 14% when entering CR, and improved slightly to 20% at the end of CR, meaning that there is room for improvement in 80% of all patients following CR. New approaches to successful LRF modification are needed, such as tailored programmes, in addition to prevention of deterioration in LRFs already on target.
REFERENCES


