EFFECT OF SELF-MONITORING APPROACH DURING CARDIAC REHABILITATION ON EXERCISE MAINTENANCE, SELF-EFFICACY, AND PHYSICAL ACTIVITY OVER A 1-YEAR PERIOD AFTER MYOCARDIAL INFARCTION

KAZUHIRO P. IZAWA, PT, PhD1,2, SATOSHI WATANABE PT1,2, KOICHIRO OKA, PhD2,3, NAOHIKO OSADA, MD, PhD2,3, and KAZUTO OMIYA, MD, PhD3,3

Abstract

We conducted a randomized, controlled trial to evaluate the effect of self-monitoring approach (SMA) on exercise maintenance, self-efficacy for physical activity (SEPA) and objective physical activity (OPA) over the long-term after supervised cardiac rehabilitation (CR). Forty-five myocardial infarction (MI) patients (mean age 64.2 years) were recruited following completion of an acute-phase exercise-based CR program. Patients were randomly assigned to a SMA or control group. Along with CR, the SMA group performed self-monitoring of their weight and OPA for 6-months; the control group participated in CR only. Twelve months after MI onset, exercise maintenance, SEPA scores, and OPA as a caloric expenditure were assessed. More patients maintained their exercise routine in the SMA than the control group. Mean SEPA score and mean OPA after CR were significantly higher in the SMA than control group. SMA during CR may effectively increase exercise maintenance, SEPA, and OPA over a 1-year after MI.


key word: Exercise Maintenance, Self-Efficacy, Physical Activity

INTRODUCTION

Cardiac rehabilitation (CR) is important in maintaining both exercise capacity and the caloric expenditure associated with reduced mortality1.2. Although many reports relate the effectiveness of CR, long-term maintenance of compliance has proven to be a major problem in CR3,4. When studying the rate of exercise maintenance after CR, Oldridge et al.1 found through use of a self-reported questionnaire that an over 20% reduction in attendance occurred after 6 months of CR after myocardial infarction (MI). On the other hand, CR in Japan is covered by national health insurance for the first 6 months after MI; thereafter, patients must then continue exercise of their own volition.

Previously, researchers have shown that self-efficacy is commonly found to be associated with the adoption and maintenance of exercise behaviors5,6. Several earlier studies also reported that self-monitoring approach (SMA) uses strategies to increase and maintain physical activity behavior7,8. When compared with standard exercise information, SMA significantly improves short-term physical activity levels in sedentary people with diabetes7,8. We hypothesized that a SMA in addition to exercise training would increase exercise maintenance, self-efficacy, and physical activity in MI patients. Thus, we conducted a randomized, controlled trial to evaluate the effect of SMA on exercise maintenance, self-efficacy, and physical activity over the 6-month period after supervised CR.

METHODS

Study design and subjects

This study was a randomized, control trial in which subjects were selected from among consecutive patients admitted to St. Marianna University Hospital...
School of Medicine Hospital for evaluation of MI. A total of 50 CR patients were recruited following successful completion of an acute-phase inpatient CR program and offered participation in the recovery-phase CR program. Baseline readiness for exercise, self-efficacy and physical activity level were measured. Participant flow through the trial is shown in Figure 1.

The ethics committee of St. Marianna University School of Medicine institutional committee on human research approved the study (No. 356), and written informed consent was obtained from all patients.

Clinical characteristics of the patients

Peak serum creatine kinase-myocardial band (CK-MB) and left ventricular ejection fraction (LVEF) as an index of cardiac function were assessed by a cardiologist. We also evaluated several patient characteristics, including age, sex, body mass index (BMI).

Evaluation of readiness for exercise before CR and exercise maintenance over the 6 months after CR program

Readiness for exercise before CR and exercise maintenance after CR were evaluated on the basis of the transtheoretical model of exercise behavior change.9,10 This model suggests that when changing exercise behavior, the individual progresses through five stages: 1) pre-contemplation; 2) contemplation; 3) preparation; 4) action; and 5) maintenance. Patients determined to be in the preparation, action, or maintenance stages were included in the exercise group (Ex group), and patients determined to be in the pre-contemplation or contemplation stages were included in the non-exercise group (non-Ex group).

Self-efficacy

Self-efficacy was measured with the Japanese version of the self-efficacy for physical activity (SEPA).11,12 The SEPA consists of 2 items representing 4 subscales that cover the domains of walking, stair climbing, weight lifting, and push off. We chose the domain of walking as the index of SEPA in the present study. Subscale scores range from 0 to 100, with lower scores indicating poorer and higher scores better levels of SEPA.

Physical activity

We used number of steps taken as the index of objective physical activity (OPA). This index was estimated by use of an electronic pedometer (Kenz Lifecorder, Suzuken Co., Ltd., Nagoya, Japan). All patients were taught to put on the Lifecorder themselves and were instructed to use the Lifecorder 24 hours a day for 1 week, except while bathing, from the time they received it. Additionally, the patients were asked to maintain a log of all physical activity during this period. For each patient, we calculated the mean number of steps taken daily over 1 week as follows: mean daily step count = total step count over 7 days/7.

CR program

Exercise training

CR involved an interdisciplinary team approach to
rehabilitation and included a cardiologist, nurse, physical therapist, dietician, and pharmacist. During the recovery phase of CR, exercise training was based on the results of cardiopulmonary exercise testing and muscle strength testing at the end of the acute phase of the CR program. After baseline testing, patients participated in a supervised combined aerobic and resistance exercise program that met twice weekly for 1 hour\(^{13}\). Exercise sessions were composed of a warm-up, aerobic exercise, resistance training, and cool-down period. Each session was preceded and followed by series of upper- and lower-extremity and body stretches.

_Self-monitoring approach_

For self-management purposes, the patients were asked to record body weight, OPA as measured by pedometer, blood pressure, and heart rate during the 6-month CR period. Furthermore, each patient was asked to continue these recordings for the long term after the completion of the 6-month CR period.

The goal in the SMA group was to promote SEPA and OPA. The SMA was based on Bandura’s self-efficacy theory\(^{11,12}\) and was designed to enhance confidence for exercise maintenance. It addresses the four components of self-efficacy theory: verbal persuasion, physiological states, vicarious learning, and performance accomplishment. Verbal persuasion was used to promote the benefits of regular exercise and other health behaviors. Vicarious learning was encouraged through discussion of patient successes and attainment of exercise target and barriers relative to exercise and other health behaviors. Performance accomplishments were addressed by written feedback on exercise, muscle strength test results, and body test component (% fat) results and discussion of written feedback on the self-monitoring log (body weight, physical activity measured by pedometer, blood pressure). Physical states were addressed by reviewing normal and abnormal physiological responses to exercise during CR\(^{13}\).

_Statistical methods_

Results are expressed as mean ± 1 standard deviation. Non-parametric and \( \chi^2 \) tests were used to analyze differences in clinical factors and readiness for exercise between groups. Two-way analysis of variance (ANOVA) in SEPA and OPA were computed to determine if any differences occurred for each dependent variable with regard to time after CR and interaction effects (SMA group vs. control group). Statistical analyses were performed with SPSS 12.0 statistical software (SPSS Japan, Inc., Tokyo, Japan) and a P value of <0.05 was considered significant.

RESULTS

_Subsjects and response rate to questionnaire_

Of the initial 50 patients, one patient dropped out of the control group for reasons unrelated to the present study. Of 49 patients, 47 (84%) patients returned the questionnaire and Lifecorder. However, two patients in the control group returned incomplete questionnaires, so they were also excluded from the present study. Therefore, the study sample consisted of 45 patients. Of these 45 patients, 24 patients comprised the SMA group, and 21 patients comprised the control group.

_Clinical factors between the two groups_

Patient characteristics, including age, sex, BMI, maximum CK-MB, LVEF, and readiness for exercise at baseline were almost identical between the two groups. Of the 24 SMA group patients, 24 (100%) patients continued long-term exercise after the 6-month CR program. However, 17 (80.9%) of 21 control patients continued long-term exercise after the 6-month CR program, and the remaining 4 (19.1%) quit long-term exercise after the 6-month CR program (Table 1).

_Differences in SEPA and OPA according to exercise maintenance after CR_

Differences in SEPA and OPA values in the SMA and control groups were evaluated with repeated two-way ANOVA, which showed improvement over 6 months after the CR program compared with baseline results for SEPA and OPA outcomes.

The effects of the SMA on SEPA over the two
Table 1. Clinical characteristics and exercise maintenance after CR.

<table>
<thead>
<tr>
<th></th>
<th>SMA group (n=24)</th>
<th>Control group (n=21)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean age ± SD (yrs)</td>
<td>63.9 ± 9.7</td>
<td>64.5 ± 10.1</td>
<td>ns</td>
</tr>
<tr>
<td>Gender (Male/Female)</td>
<td>21/3</td>
<td>17/4</td>
<td>ns</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>22.9 ± 2.6</td>
<td>21.9 ± 2.5</td>
<td>ns</td>
</tr>
<tr>
<td>Maximum CK-MB (IU/I)</td>
<td>198.7 ± 80.3</td>
<td>225.1 ± 151.7</td>
<td>ns</td>
</tr>
<tr>
<td>LVEF (%)</td>
<td>51.3 ± 9.8</td>
<td>51.9 ± 7.7</td>
<td>ns</td>
</tr>
</tbody>
</table>

Readiness for exercise (%)
- Doing exercise: 33/24 vs. 37/21
- Not doing exercise: 67/24 vs. 63/21

Exercise maintenance after CR
- Doing exercise: 24/24 (100%) vs. 17/21 (80.9%)
- Not doing exercise: 0/24 (0%) vs. 4/21 (19.1%)*

Mean length of time from the MI event (months)
- SMA group: 12.1 ± 1.3 vs. Control group: 12.2 ± 1.2

ns, not significant; BMI, body mass index; CK-MB, creatine kinase-myocardial band; LVEF, left ventricular ejection fraction; MI, myocardial infarction; SMA, self-monitoring Approach; CR, cardiac rehabilitation *p<0.05

The effects of the SMA on OPA over the two time periods are also presented in Figure 2. Significant period by group interactions (F[1/43] = 20.5, P < 0.05) were detected, and post hoc analyses focused on the main effects of period (F[1/43] = 49.8, P < 0.05). Although there were no significant differences in SEPA values between the groups before treatment (72.0 ± 25.6 vs. 70.2 ± 18.8 points), SEPA at 6 months after CR in the SMA group was significantly higher than that of the control group (72.7 ± 25.8 vs. 90.5 ± 13.3 points, P < 0.05).

![Self-efficacy for physical activity vs Objective physical activity](image)

Figure 2. Comparison of SEPA, and average steps taken per day for 1 week between the SMA and control groups. Significant period by group interactions were detected.
SMA group was significantly higher than that in the control group (10458.7 ± 3310.1 vs. 6922.5 ± 3192.9 steps).

DISCUSSION

The main finding of the present study was that although clinical findings at baseline between the two groups were no different, exercise maintenance rate in the SMA group was higher than that in the control group. These findings are consistent with other randomized controlled trials showing the effectiveness of exercise maintenance in sedentary healthy individuals and patients with diabetes mellitus. The present study suggests that such intervention may be applied to the CR setting to assist with exercise behavior. However, with regard to exercise adherence, it was previously reported that prior readiness for exercise results in more effective adherence to exercise maintenance in healthy people. Important in the present study was the fact that readiness for exercise between the two groups was not different; therefore, it appears that prior readiness for exercise over the 6-month after CR may not be essential for exercise maintenance.

The self-efficacy theory posits that the performance of a specific behavior is strongly influenced by the individual's confidence in his or her ability to perform that behavior. Although there were no significant differences in SEPA values between the groups before treatment, SEPA at 6 months after CR in the SMA group was significantly higher than that in the control group. In the present study, to improve the rate of exercise maintenance after CR, we encouraged the patients to self-monitor their OPA, body weight, and blood pressure during the 6-month CR period and to continue monitoring over the 6-month after CR. Because the self-efficacy of a patient may be raised by self-management, this may have resulted in continuation of exercise by our patients. However, many patients have difficulty maintaining physical activity habits and lifestyle changes over the long term after completion of a supervised exercise program. Therefore, further studies are needed to evaluate the effectiveness of SMA over the long term after CR programs.

The OPA after CR in patients in the SMA group was higher than that in the control group. Berlanga et al. previously investigated the impact of focused individualized advice compared with routine advice on physical activity level over a 1-year period in patients with diabetes. The study reported a significant increase in total weekly energy expenditure measured via a physical activity questionnaire. However, physical activity was not measured objectively. In the present study, objective evaluation showed the average number of steps taken per day for 1 week in the SMA group to be over 10000. Because these two studies differ in terms of evaluation tools, we could not directly compare our results with those of Berlanga et al. However, the average number of steps taken in our study compares favorably with the level of physical activity recommended for management of patients with diabetes mellitus and/or hyperlipidemia. Therefore, we thought that OPA in the SMA group was effective from the viewpoint of promoting secondary prevention.

CONCLUSION

At more than 6 months after CR, the rate of exercise maintenance, SEPA, and OPA in the SMA group were relatively high in comparison with that in the control group. Therefore, we concluded that the SMA during CR might effectively increase exercise maintenance, SEPA, and OPA after CR. Future trials should be continued for longer periods, and long-term follow-up will be required to evaluate whether these benefits continue over time.

References
3) Oldridge, N. B., Cardiac rehabilitation services: what are they and are they worth it? Compr Ther. (1991)