Optimising secondary prevention: Effect of cardiac rehabilitation duration on cardiovascular risk profile modification

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CLINICAL POINTS

- Exercise-based Cardiac Rehabilitation is a valuable tool in the secondary prevention of cardiovascular disease.
- St. James's Hospital, Dublin, runs 6-week and 8-week exercise-based Cardiac Rehabilitation programmes aimed at improving the risk factor profile of discharged cardiac patients.
- Attendance at Cardiac Rehabilitation in St. James's Hospital is typically poor, with a completion rate of only 70%.
- Cardiac Rehabilitation programmes of longer duration have lower attendance rates and are less cost effective than shorter programmes. Limited current evidence suggests that programmes with increased duration are no more efficacious at reducing cardiovascular risk, when compared with shorter programmes.
- Healthcare expenditure and patient adherence might be optimised by employing shorter Cardiac Rehabilitation programme durations. This could increase the efficacy of cardiovascular risk factor reduction through Cardiac Rehabilitation by reducing the high withdrawal rate and increasing attendance.

ABSTRACT

Background: Cardiovascular disease is the leading cause of mortality in Ireland, accounting for 36% of all deaths. While it is well documented that exercise programmes are of benefit in risk factor modification in the cardiac population, the optimal exercise rehabilitation programme duration remains unclear.

Study Aim: This study aimed to analyse the effect of cardiac rehabilitation programme duration on cardiovascular risk factor modification in patients with established coronary artery disease, whilst assessing the effectiveness of existing programmes.

Methods: In this retrospective, observational study, subjects (male, low risk cardiac patients, aged 50-69 years, mean age = 59 ± 4 years) were randomised into a 6-week or 8-week exercise programme. Each programme consisted of 15 exercise sessions, of 50 minute duration, with equal time distribution on each of 7 exercise stations (treadmill, cross-trainer, exercise bicycle, ball, rowing machine, arm ergometer and weights) at 60% of maximal heart rate. During the programme, resting heart rate, blood pressure, waist circumference and body mass index were monitored at regular intervals.

Results: There was no significant reduction in any of the parameters for either the 6-week or the 8-week programme. There was no significant difference between the 6-week and 8-week programmes in modification of any risk parameters.

Conclusion: This study revealed no significant difference between a 6-week and 8-week cardiac rehabilitation programme in cardiovascular risk factor modification in the cardiac population.

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INTRODUCTION

Cardiovascular disease (CVD) is the leading cause of mortality in Ireland, accounting for 36% of all deaths and 22% of premature deaths (under 65 years old)[1]. CVD is also a leading cause of mortality worldwide, accounting for approximately 16.7 million or 29.2% of deaths in 2003[2,3]. Furthermore, the World Health Organisation (WHO) estimates that CVD will be the leading cause of death in developing countries by 2010[2]. It is clear that CVD represents a serious worldwide health problem. There is strong evidence suggesting that Cardiac Rehabilitation (CR), involving exercise based interventions, with or without psychosocial counselling and education is an effective form of secondary prevention[4,5]. Epidemiological studies have demonstrated that risk factor modification using CR can result in a decrease in mortality of up to 50%, compared with population matched controls[6].

It is well documented that exercise produces improvements in cardiovascular health[7,8]. In addition, when prescribed as part of a CR programme, exercise has been shown to be beneficial to the cardiac patient, by optimising exercise tolerance, stroke volume, heart rate, blood pressure, serum low- and high- density lipoprotein levels, capillary density, psychosocial well-being and improving symptoms of angina[4,5,9]. A variety of

different exercise training paradigms are used as part of CR programmes, including aerobic exercise, anaerobic exercise and resistance training. While each has been shown to be beneficial[7,10,11,12,13], there is little evidence to demonstrate what training paradigms are most effective at improving cardiac risk profiles. It is clear that the mode of exercise influences the effect of exercise training within a cardiovascular (CV) population. However, it is also likely that intensity, frequency and duration of exercise are also significant factors affecting exercise induced CV risk factor reduction in the cardiac patient group. While it has been established that exercise session duration of 40-60 minutes is optimal in this target population[14], the most efficacious session frequency and programme duration have yet to be fully elucidated and literature in this area is sparse.

The optimal exercise programme must improve the CV profile of the patient, properly utilize hospital resources and be cost effective. Patient adherence to a CR programme is typically poor[15,16], due to a combination of motivational and logistic issues (e.g. lack of time), with the latter accounting for 47% of CR patient withdrawals[15]. Therefore, expediency to the patient must be considered when designing and analysing the efficacy of a CR programme. It is likely that shorter programme duration may both increase patient attendance and facilitate greater patient throughput, thus increasing the economic efficiency of such programmes and making CR resources available to a greater proportion of cardiac patients. This preliminary study aims to analyse the effect of CR programme duration on CV risk factor modification in patients with established coronary artery disease (CAD), whilst assessing the efficacy of the existing 6- and 8-week training programmes in St. James's Hospital. The objectives of this study were (a) to analyse the efficacy of existing CR programmes by taking easily accessible biometric readings before and after completion of CR, and (b) to compare the efficacy of a 6-week and 8-week CR programme to establish whether there is an optimal programme duration for CV risk factor modification.

This research should contribute findings for a more informed and evidence-based approach to exercise training in cardiac patients.

	Combined		6-Week Programme		8-Week Programme	
	n=13		n=8		n=5	
	Pre	Post	Pre	Post	Pre	Post
BP (mmHg)	129/80	131/79	127/80	132/81	131/79	129/78
SBP	±23.05	±18.41	±28.46	±20.15	±6.29	±18.32
DBP	±8.97	±7.35	±11.12	±8.66	±2.50	±5.79
RHR (bpm)	67.813	75.459	63.625	76.667	72	74.25
	±6.92	±16.86	±6.16	±16.86	±4.30	±3.77
BMI	31.68	31.757	30.461	30.347	32.9	33.167
	±4.24	±4.26	±4.53	±4.47	±3.60	±3.67
WC	107.95	106.28	105.57	101.89	110.33	110.67
	±8.35	±12.05	±6.35	±12.66	±13.01	±9.02

▲ **Table 1:** Summary of Data Showing Study Population Risk Factor Dynamics
BP: Blood Pressure, RHR: Resting Heart Rate, BMI: Body Mass Index, WC: Waist Circumference

MATERIALS AND METHODS

Study Design and Programme Overview

This was a retrospective, non-interventional study; all measurements were routinely taken as part of the CR programme. Cardiac patients enrolled in phase 3 of an outpatient CR programme in the Physiotherapy Department of St James's Hospital, Dublin, were recruited to participate in the study (n=13). Eligible subjects were male, low risk cardiac patients and aged between 50-69 years. Low risk was defined by the following criteria: no or stable angina, under 70 years of age and no positive exercise stress test (EST). Patients were excluded from the study if they were unable to give informed consent, had a positive stress test, had an existing co-morbidity which would affect their ability to participate in CR or they were a smoker. All medications were continued as per usual.

Patients were randomly assigned to either a 6-week or 8-week programme. Both programmes consisted of 15 exercise sessions, 3 and 2 sessions per week, respectively. Exercise sessions lasted approximately 50 minutes and consisted of a warm up, an exercise circuit consisting of aerobic and resistance exercise stations, and a cool down period. The exercise circuit included seven stations employing a treadmill, an arm ergometer, a cross-trainer, a rowing machine, an exercise bicycle, a ball and weights.

The warm up consisted of a 250m brisk walk with a series of dynamic upper limb movements. Thereafter, patients were guided through upper and lower limb muscle stretches. In accordance with standard recommendations[17], exercise prescription

was individualised such that patients exercised within their target heart rate (HR) range. Target HR was calculated using the Karvonen formula[i]. The exercise intensity was 60% of maximum, as determined by pre-CR stress testing. For the weights station, patients lifted 60% of their one repetition maximum. For safety purposes, patients were monitored throughout each session by telemetry[ii]. Following exercise, a cool down was performed in order to return the HR to within 10% of resting values, after which patients were guided through upper and lower limb muscle stretches. Following the exercise component of the CR programme, patients attended a 1 hour educational and personal development session. Educational and personal development sessions covered topics such as nutrition, cardiovascular risk, pharmacotherapy, stress management and exercise.

Measured Parameters

All measurements were taken in accordance with standard recommendations. Blood pressure (BP) and resting HR were measured at the start and end of the exercise sessions using upper arm automated BP/HR monitors[iii]. Patients were seated and at rest when measurements were taken. In addition to pre- and post-training measurements, HR was monitored by telemetry[ii] continuously throughout each exercise session. This was for both safety purposes and to facilitate individualisation of the exercise programme.

Body anthropometrics were measured at the start and end of each programme. Patient height data[iv] were inputted into an automated body composition analyser[v]. The body composition analyser measured weight and calculated body mass index (BMI)[vi]. Waist circumference (WC) measurements were taken around the patient's bare midriff or over a light layer of clothing. The measurement site was the midpoint between the inferior margin of the lowest palpable rib and the superior iliac crest, with the tape parallel to the floor and perpendicular to the long axis of the body. In obese patients, where it was not possible to palpate the body landmarks, WC was measured at the level of the umbilicus, in accordance with standard recommendations[18].

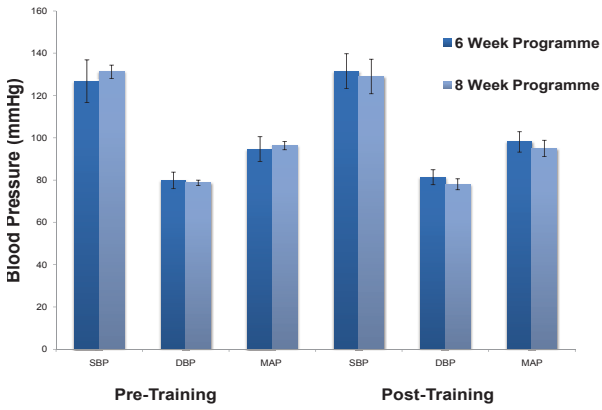


Figure 1: Effect of a 6-Week Vs. 8-Week CR Programme on BP
BP: Blood Pressure, SBP: Systolic Blood Pressure, DBP: Diastolic Blood Pressure, MAP: Mean Arterial Pressure
Data represent mean SBP/DBP/MAP values ± SEM for the 6-week (n=8) and 8-week (n=5) programmes before and after partaking in CR. There was no significant change in SBP (p=0.90), DBP (p=0.80) or MAP (p=0.90) with training and no significant programme effect was seen (p=0.92, 0.67, 0.95 respectively).

Statistical Analysis

Data were analysed using two-way repeated analysis of variance with Bonferroni *post hoc* tests. Statistical significance was $p < 0.05$. Data were analysed (a) to identify if there was a training effect and (b) to highlight any significant differences between the two CR programmes.

RESULTS

Subjects

Eight subjects were randomly assigned to the 6-week programme and five to the 8-week programme. Population risk factor dynamics throughout the study period are summarised in Table 1. The mean age of the participants Thirteen subjects were enrolled in this study in accordance with the study inclusion criteria. Eight subjects were randomly assigned to the 6-week programme and five to the 8-week programme. The mean age of the participants in the two groups was 58.8 years (59.5 ± 4.99 and 57.5 ± 2.65 for the 6-week and 8-week groups, respectively). All subjects completed the CR programmes and attendance rates for the 6-week and 8-week programmes

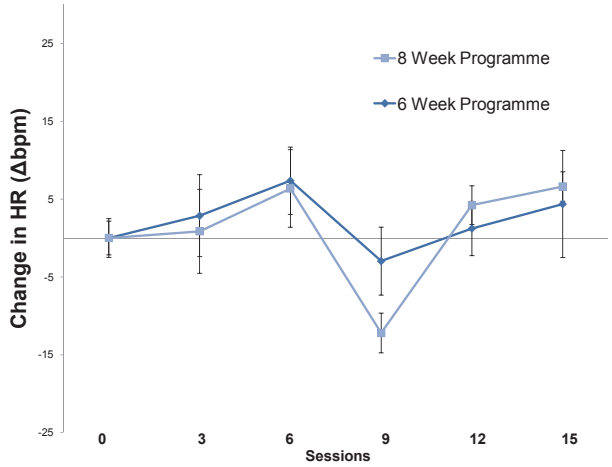
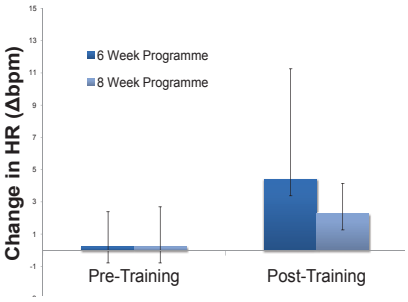


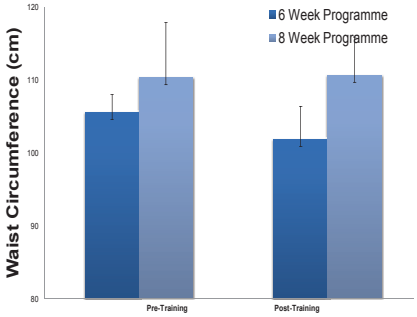
Figure 2: Effect of a 6-Week Vs. 8-Week CR Programme on HR

bpm: beats per minute
Data from sessions 3-15 represents change in mean heart rate from baseline ± SEM, for both the 6-week and 8-week programmes. Once data were normalised to baseline, training was shown to induce no significant change in resting heart rate (p=0.22). There was no significant difference between the effects of the 6- and 8-week programmes (p=0.18).



▲ **Figure 3:** Effect of a 6-Week Vs. 8-Week CR Programme on resting HR
HR: heart rate, bpm: beats per minute
Data represent change in mean resting heart rate from baseline ± SEM following attendance at CR for the 6-week (n=8) and 8-week (n=5) programmes. Training did not induce significant changes in heart rate (p=0.35). No significant difference (p=0.76) was seen between the effects of the 6- and 8- week programmes.

▲ **Figure 4:** Effect of a 6-week Vs. 8-week CR Programme on BMI
BMI: Body Mass Index
Data represent mean BMI values ± SEM for the 6-week (n=8) and 8-week (n=5) programmes before and after partaking in CR. There was no significant change in BMI (p=0.98) with training. No significant difference (p=0.23) was seen between the effects of the 6- and 8-week programmes.



▲ **Figure 5:** Effect of a 6-week Vs. 8-week CR programme on WC
WC: Waist Circumference
Data represent mean WC values ± SEM for the 6-week (n=8) and 8-week (n=5) programmes before and after partaking in CR. Training resulted in a moderate decrease in waist circumference in the 6-week group. This was not significant, however. No significant change was seen in the 8-week group, and there was no significant difference between the effects of the 6-and 8-week programmes (p=0.20).

were 77% (±6.28%) and 83% (±6.15%), respectively.

Blood Pressure

Systolic, diastolic and mean arterial pressure were analysed (Figure 1). Neither group showed a significant change in systolic blood pressure (SBP) with training (p=0.90) and no significant difference between the 6-week and 8-week programmes following training (p=0.92). There was no significant change in diastolic blood pressure (DBP) with training (p=0.80) and no significant difference between the 6-week and 8- week programmes following training (p=0.67). In addition, the CR programme did not produce any significant changes in mean arterial pressure (MAP) (p=0.90), with no significant difference between the two programmes (p=0.95).

Heart Rate

Resting HR at baseline was significantly greater in the 8-week group. To accommodate for this difference, HR data were normalised against baseline mean prior to analysis. Results showed that CR training had no effect on HR (p=0.35) and there was no significant difference between the two CR programmes (p=0.76) (Figure 2, 3).

Body Anthropometry

Neither CR training programme induced a significant change in BMI (p=0.98), as shown in Figure 4. In addition, there was no difference between the two CR programmes for BMI data (p=0.23). CR training resulted in a moderate decrease in WC in the 6-week group, but this was not significant (Figure 5). Results for WC showed no significant difference between the two programmes (p=0.20).

Medications

Table 2 summarises the use of anti-arrythmic and anti-hypertensive pharmacological therapy by both groups. 69% of subjects in this study reported using one or more anti-arrythmic agents (88% in the 6-week programme, 40% in the 8-week programme) while 92% of participants reported use of anti-hypertensive medications (100% in the 6-week programme, 80% in the 8-week programme).

DISCUSSION

While there is evidence to support the effectiveness of CR in reduction of risk factors for CVD[4,5], the optimal duration of exercise programmes remains unclear. When evaluating the efficacy of a programme, the following must be taken into consideration:

- Capacity to reduce CV risk factors
- Appropriateness to the needs of the patient
- Economic viability

Shorter programme duration has been demonstrated to be favourable in terms of the appropriateness to the needs of the patient, their lifestyle and ability to participate in CR[19], can increase patient adherence and may be associated with a reduction in healthcare costs. Therefore, it is essential that the effect of programme duration on risk factor reduction be assessed in order to facilitate an evidence-based approach to CR.

It is widely documented that exercise produces significant decreases in HR, BP, BMI and WC[3], even in an at-risk cardiac population. HR, SBP, DBP, MAP, WC and BMI were analysed in this study. Results indicated no significant change in any of these param-

eters following a 6-week or 8-week CR programme. However, 92% of patients were medicated for hypertension and 69% of patients were using an anti-arrythmic drug. The effect of poly-pharmacy on an exercising patient group is not known, though it is likely that these medications may have confounded the effects of exercise training in terms of the outcome measures employed. In addition, attendance of CR in St. James's Hospital is typically poor, with an initial average attendance rate of 89% and a completion rate of 70%[3]. It is expected that patients with poor compliance to a CR programme will not show a marked improvement in their CV risk factor profile on completion of the programme when compared with patients who attended all sessions. Poor patient attendance may have influenced the results in this study and may have contributed to the lack of observable improvements in CV risk profile following the two programmes. In addition, it is important to note that the sample size of the study was small (n=13), which may not accurately reflect the effects of a CR programme on the CV risk profile. It is clear that further research is warranted with a larger sample size and ensuring full attendance of participants to fully determine the effects of these CR programmes on the CV risk profile of medicated cardiac patients.

Although there were no improvements in the CV risk profile following either of the CR programmes, no significant differences between the programmes were observed. This result might suggest that there is no additional benefit conferred to the patient attending an 8-week CR programme as compared to a 6-week programme. Thus, healthcare expenditure and patient adherence might be optimised by employing a shorter CR programme duration. Current literature comparing the effects of long-term and short-term CR programmes is sparse. While Hevey et al (2003)[19] demonstrated that there was no significant difference in effect between a 4-week and a 10-week CR programme, and Reid et al (2005)[20] demonstrated that there was no statistically significant or clinically relevant difference between a 12-month and a condensed 3-month CR programme, few other studies have actively analysed the effects of varied programme duration. Review of the literature indicates a trend which suggests the efficacy of CR programmes of longer duration is more firmly established, when compared with short-term programmes. The current study suggests that CR programme duration does not influence outcome with regard to risk factor modification, aligning with the works of Hevey et al (2003) and Reid et al (2005). It must, however, be acknowledged that the difference in duration between the programmes analysed in this study was small. Future studies incorporating programmes with greater variance in duration are necessary to determine the minimum programme duration effective in modification of the CV risk factor profile. In addition, the potentially confounding effect of non-exercise interventions (education and personal development) must also be considered. Future studies should explore the role played by non-exercise based interventions in reducing CV risk factor profile.

CONCLUSION

No significant reduction in CV risk factor profile (HR, SBP, DBP, MAP, WC and BMI) was found following a 6-week or 8-week CR programme. In addition, there was no signicant difference in efficacy found between the two CR programmes. Expediency to the patient must be considered in the design of a CR programme in order to increase attendance and increase the degree of risk factor modification. It is likely that shorter programme duration is favourable in terms of adherence[3] and cost effectiveness, although this remains to be explored systematically.

Further research is warranted to accurately identify the CR programme duration that will produce optimal modification of the CV risk profile, while also optimising healthcare costs and remaining expedient to the patient. Importantly, future studies must incorporate more stringent monitoring of medications to elucidate the role played by poly-pharmacy. Employing shorter CR programmes would likely result in a significant reduction in healthcare expenditure, whilst increasing patient adherence. By reducing high withdrawal rates and increasing attendance, this straightforward change in protocol could increase the efficacy of cardiovascular risk factor reduction through CR and

	Combined	6-Week Programme	8-Week Programme
	n=13	n=8	n=5
% Patients Prescribed Anti-Arrythmic Agents (Vaughan-Williams Classified Drugs)	69	87.5	40
% Patients Prescribed Anti-Hypertensive Agents	92	100	80

▲ **Table 2: Summary of Anti-Arrythmic and Anti-Hypertensive Drug Use in Study Population**

hence prove most beneficial to the patient.

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APPENDIX

[i] Karvonen Formula: Target Heart Rate = [(max HR – resting HR) × %Intensity] + resting HR
[ii] Using either the IntelliVue TRx 4851A system (Philips Healthcare, Netherlands) or F1+ Polar monitors (Polar Electro, Finland)
[iii] Upper arm automated BP/HR Monitors (Microlife BP 3VTO-AP, Widnau, Switzerland)
[iv] Seca 222 height measuring instrument (Seca, Germany)
[v] Body Composition Analyser (Tanita BC-420MA, Illinois, USA)
[vi] BMI = [weight (kg) ÷ (height (m))^2]

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