Early programmes of high and low intensity exercise and quality of life after acute myocardial infarction

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Abstract

Objective—To determine whether a group programme of light exercise could improve quality of life in patients after acute myocardial infarction to the same extent as a high intensity exercise training programme.

Setting—Australian teaching hospital.

Patients—224 men from a consecutive series of 339 men under 70 admitted to a coronary care unit with transmural acute myocardial infarction.

Intervention—Patients were randomly allocated in hospital to a group programme lasting eight weeks of either high intensity exercise training or light exercise.

Main outcome measures—Physical working capacity based on metabolic equivalents achieved from treadmill exercise tests at entry, after 11 weeks, and after one year. Quality of life based on self report scores of anxiety, depression, denial, and wellbeing and interview assessments of activities and psychosocial adjustment at entry, after four months, and after one year.

Results—The two groups were well matched at entry. At 11 weeks the mean results of treadmill testing were 10.7 (95% confidence interval 10.20 to 11.20) metabolic equivalents for exercise training and 9.7 (9.26 to 10.14) for light exercise ($t=2.85$, $df=181$, $p=0.005$). Apart from this small temporary benefit in mean physical working capacity, there were no significant differences between groups. Improvement in occupational adjustment score from baseline to four months was greater after exercise training than after light exercise, but at one year repeated measures analysis of variance showed no significant effects of treatment or interaction between treatment and time point.

Conclusion—The effects on quality of life of a low cost programme of light exercise are similar to those obtained from a high intensity exercise training programme.

Introduction

Psychological and social problems after acute myocardial infarction are often considerable and may persist for months or years.¹⁻³ Exercise training programmes have been recommended to facilitate recovery from myocardial infarction.⁴⁻⁶ Such programmes are usually based on walking and jogging, starting in the third week after myocardial infarction and lasting for six to eight weeks.⁶

High intensity exercise training improves performance on a treadmill⁷ and psychological functioning.⁸⁻⁹ These benefits, however, may result not from the exercise training itself but from supervised group activity. Thus a light exercise programme could provide the same physical, social, and psychological benefits.

Light exercise is the basis of most of the group exercise programmes offered in Australian outpatient departments. Such programmes aim at giving patients confidence to undertake a walking programme at home and to resume normal daily activities, facilitating

spontaneous recovery of physical performance after myocardial infarction. Aerobic exercise training programmes are expensive, requiring repeated exercise testing, medical supervision, and, in view of the risk of cardiac arrest,⁶ facilities for cardiopulmonary resuscitation. Light exercise programmes, however, are cheap and the risks of training do not need to be comprehensively assessed for each patient. They are usually conducted by a nurse or physiotherapist in a hospital room and are therefore convenient for patients to attend during convalescence.

The Austin Hospital cardiac rehabilitation trial was set up to determine whether the benefits of group exercise training could be equally well achieved by a less costly group programme of light exercise. We previously reported that exercise training compared with light exercise produced only a small temporary benefit in physical working capacity.¹⁰ We now report a comprehensive evaluation of the possible benefits of exercise training compared with light exercise on the quality of life.

Methods

Men under 70 years who had been admitted consecutively to a single coronary care unit with transmural (Q wave) acute myocardial infarction were eligible for the study. Transmural myocardial infarction was determined according to electrocardiographic criteria of the World Health Organisation—namely, new abnormal Q waves and the development of characteristic ST and T wave changes.¹¹

Short and long term prognostic indices were calculated for all patients.^{12,13} The site of infarction was determined from an electrocardiogram.¹⁴ Clinical heart failure was graded by Killip class.¹⁵ Gratings of radiological heart size were assessed from a portable chest radiograph.¹² A history of ischaemia and infarction was noted, as was electrical reversion from ventricular fibrillation. Patients were excluded from the study for defined medical and other reasons.¹⁰

At discharge from the coronary care unit patients were randomly allocated to a rehabilitation programme of exercise training or light exercise.¹⁶ All patients were treated by the same staff and given the same advice and printed information, and they had the same baseline evaluations. All patients gave their informed consent to participation in the study.

EXERCISE PROGRAMMES

The exercise training programme complied with the recommendations of the American Heart Association.⁶ It consisted of three one hour classes a week conducted by a teacher of physical education in a gymnasium owned by the YMCA (Young Men's Christian Association) and attended by a doctor.¹⁰ Light exercise consisted of two one hour classes a week of light calisthenics and intermittent exercises with rests between. Classes were conducted by a physiotherapist in the outpatient physiotherapy room.¹⁰ Most patients first attended their programme in the second week (8-14 days) after infarction to watch the class and started exercising in the third week (15-21 days).

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Patients in both groups were also asked to walk each day at a comfortable pace for at least 30 minutes.

Maximal, symptom limited treadmill tests were performed in the third and 11th week after myocardial infarction and at 12 months. Test results were converted to metabolic equivalents (or multiples of resting metabolic expenditure) determined from standard nomograms.^{17 18}

ASSESSMENT OF QUALITY OF LIFE

Quality of life is complex and many faceted. Several psychological and social indices were used rather than a composite index of quality of life so that each variable could be measured separately. The Spielberger state trait anxiety inventory¹⁹ and IPAT (Institute for Personality and Ability Testing) depression scale²⁰ have been used in various clinical populations and research settings^{9 19-21} and are considered to be suitable for measuring affective responses of patients with a medical illness. Spielberger's trait anxiety scale measures the stable condition of anxiety proneness, while state or current anxiety reflects the degree of anxiety, which may fluctuate after illness.¹⁹ The Hackett-Cassem denial scale was developed to investigate the degree of psychological denial in patients with heart disease.²² The Eysenck personality inventory is commonly used for measuring neuroticism and extroversion.²³ Sense of wellbeing was determined from patients' ratings on a visual analogue scale, with responses ranging from "never felt worse" to "never felt better" being scored on a scale from 0 to 10.²⁴

TABLE I—Baseline clinical characteristics of patients randomly allocated to exercise training or light exercise after myocardial infarction. Values are numbers (percentages) of patients with 95% confidence intervals unless stated otherwise

	Exercise training (n=108)	Light exercise (n=116)
Mean (SE) age (years)	54.8 (0.8) 53.2 to 56.2	53.9 (0.8) 52.3 to 55.3
Mean (SE) peak enzyme activity (IU):		
Creatine kinase	1942 (110) 1722 to 2162	2179 (127) 1925 to 2433
Aspartate aminotransaminase	303 (17) 269 to 337	327 (18) 291 to 363
Mean (SE) coronary prognostic indices:		
Norris short term	5.8 (0.2) 5.4 to 6.2	5.6 (0.2) 5.2 to 6.0
Norris long term	3.9 (0.3) 3.3 to 4.5	3.9 (0.3) 3.3 to 4.5
Infarct site:		
Anterior or lateral	53 (49) 39.6 to 58.5	41 (35) 26.6 to 44.0
Inferior or posterior	55 (51) 41.5 to 60.4	75 (65) 56.0 to 73.4
Clinical heart failure:		
Lungs clear	58 (54) 44.3 to 63.1	71 (61) 52.3 to 70.1
Basal crepitations	42 (39) 29.7 to 48.1	37 (32) 23.4 to 40.4
Upper crepitations	8 (7) 2.5 to 12.3	8 (7) 2.3 to 11.5
Radiological heart size		
Normal	67 (63) 57.9 to 71.2	77 (66) 57.8 to 75.0
Borderline	30 (28) 19.3 to 36.2	28 (24) 16.4 to 31.9
Enlarged	9 (9) 3.1 to 13.5	11 (10) 4.2 to 14.8
Previous infarction	11 (10) 4.5 to 15.9	12 (10) 4.8 to 15.9
Previous ischaemia	30 (28) 19.3 to 36.2	30 (26) 17.9 to 33.8
Electrical reversion	11 (10) 4.5 to 15.9	7 (6) 1.7 to 10.4

*Normal values <180 IU.

†Normal values <30 IU.

TABLE II—Baseline sociodemographic characteristics of patients randomly allocated to exercise training or light exercise after myocardial infarction

	Exercise training (n=108)		Light exercise (n=116)	
	No (%) of patients	95% Confidence interval	No (%) of patients	95% Confidence interval
Education (No of years):				
<9	36 (33)	24.4 to 42.2	37 (32)	23.4 to 40.4
9-10	43 (40)	30.6 to 49.0	53 (46)	36.6 to 54.8
>10	29 (27)	18.5 to 35.2	26 (22)	14.8 to 30.0
Occupational class:				
White collar	54 (50)	40.6 to 59.4	47 (41)	31.6 to 49.5
Blue collar	54 (50)	40.6 to 59.4	69 (59)	50.5 to 68.4
Employment status:				
In workforce:				
Employed	81 (75)	66.8 to 83.2	88 (76)	68.1 to 83.6
Unemployed	0	66.8 to 83.2	4 (3)	64.3 to 80.5
Retired	27 (25)	16.8 to 33.2	28 (24)	0.1 to 6.8
Smoking status:				
Smoker	60 (56)	46.2 to 64.9	62 (53)	16.4 to 31.9
Non-smoker	48 (44)	35.1 to 53.8	54 (47)	44.4 to 62.5
Sexual activity:				
Active	92 (85)	78.5 to 91.9	97 (84)	37.5 to 55.6
Non-active	16 (15)	8.1 to 21.5	19 (16)	76.9 to 90.4

Baseline measures of denial, extroversion, neuroticism, anxiety, depression, and wellbeing were obtained in hospital and before entry to the programmes. Anxiety, depression, and sense of wellbeing were also assessed after four and 12 months. Inventories and scales were completed before the interviews and scored by an independent rater.

The semistructured interview to investigate social functioning was adapted from the structured and scaled interview to assess maladjustment²⁵—which has been used in previous investigations of outcome after myocardial infarction,⁸—and the social adjustment scale developed from it.²⁶ The schedule was tested during a pilot study and appropriately modified. Structured questions were followed by suitable probing questions; responses referred to the previous two months.

Total scores for each scale ranged from 0 to 24 for social adjustment, 0 to 20 for marital adjustment, and 0 to 16 for occupational adjustment. Higher scores reflected better adjustment. Sexual recovery was assessed according to whether patients perceived their usual sexual activities to be as satisfying as or more satisfying than before they were admitted to hospital. Whether patients smoked and the effect of their myocardial infarction on employment were included among the psychosocial end points of the study. Occupational class was defined for current or last occupation as white or blue collar. Men in professional, managerial, or clerical jobs were defined as white collar workers, while those with skilled, semiskilled, or unskilled manual jobs were defined as blue collar workers.²⁷ Interviews were tape recorded and scores independently checked.

ANALYSIS

Analysis was undertaken on an intention to treat basis. All patients were followed up for 12 months. Baseline and end point (at four and 12 months) measures for the two groups were compared, as were changes in patients' scores between assessments. For categorical variables χ^2 or Fisher's exact tests were used when appropriate. For numerical data *t* tests were used. As some data were skewed, non-parametric Mann-Whitney and Kolmogorov-Smirnov two sample tests were also performed. For patients who underwent assessment on psychosocial measures at all three assessment times repeated measures analysis of variance were performed to assess the interaction between treatment group and time point, as well as the effect of treatment. All tests were performed using SPSS-X.²⁸ Differences between groups not achieving significance at a 0.05 level (two sided) are described as not significant.

The psychosocial assessments constitute part of the last three years of our five year study.¹⁰ The numbers of patients recruited to this part of the study were calculated to be sufficient to detect, for numerical measures, a difference between group means of 0.5 SD at 5% significance with 95% power, and, for dichotomous measures, a difference of 20% in the proportion showing the attribute, with similar levels of significance and power.

Results

During the three years of enrolment 339 men satisfied the criteria for entry to the study. One hundred and fifteen were excluded because of death (29), cardiogenic shock (four), physical disability (24), distance from the programme venues (24), inadequate command of English (12), anticipated non-compliance with the programme (11), psychological disability

Eligibility, random allocation, and follow up of patients in study

TABLE III—Baseline personality scores of patients randomly allocated to exercise training or light exercises after myocardial infarction

	No of patients	Exercise training		No of patients	Light exercise	
		Mean (SE)	95% Confidence interval		Mean (SE)	95% Confidence interval
Denial (Hackett-Cassem scale)	108	11.43 (0.53)	10.39 to 12.46	116	12.85 (0.53)	11.81 to 13.88
Extroversion (Eysenck personality inventory)	101	10.33 (0.40)	9.55 to 11.00	104	10.56 (6.38)	9.83 to 11.33
Neuroticism (Eysenck personality inventory)	101	9.54 (0.53)	8.50 to 10.57	104	9.60 (0.51)	8.59 to 10.60
Trait anxiety (Spielberger state trait anxiety inventory)	99	34.89 (0.78)	33.37 to 36.41	100	35.69 (0.83)	34.07 to 37.81

(three), contamination, based on expressed preference for one or other programme (five), and early transfer to another hospital or administrative error (three). The figure shows the distribution of patients who were excluded from the study, who were randomly allocated to an exercise programme, and who attended the follow up examinations.

Patients in each group were well matched on all physical, sociodemographic, and personality characteristics (tables I-III); there were no significant differences

between groups. Eight patients in each group had pulmonary oedema. Furthermore, there were no significant differences between the two groups in the use of cardioactive or other drugs at baseline, at four months, or at 12 months.¹⁰

Table IV shows the reasons for non-attendance. The most common reason was death. Ten patients died in the exercise training group and nine in the light exercise group. Of these 19 patients, nine died before their entry exercise test, seven before completing the programme, and three before the 12 month review. A few patients in each group declined to be interviewed or to undergo exercise testing.

As previously reported,¹⁰ results from treadmill tests showed no differences between the groups except immediately on completion of the programmes. At entry patients were well matched in terms of their mean results on treadmill testing (6.7 (95% confidence interval 6.22 to 7.18) metabolic equivalents in exercise training group *v* 6.6 (6.10 to 7.10) metabolic equivalents in light exercise group). After eight weeks the results were 10.7 (10.20 to 11.20) metabolic equivalents for exercise training and 9.7 (9.26 to 10.14) metabolic equivalents for light exercise ($t=2.85$, $df=181$, $p=0.005$). At the 12 month review there was no significant difference between groups (10.6 (10.14 to 11.06) metabolic equivalents in exercise training group *v* 10.5 (10.06 to 10.94) metabolic equivalents in light exercise group).

No significant differences were found between groups in any of the measures of psychological functioning or quality of life at the four and 12 month reviews (tables V and VI). Analyses of skewed numerical data using Mann-Whitney and Kolmogorov-Smirnov two sample tests also showed no significant differences. Furthermore, there was no overall difference between groups in the rate of return to work of survivors who were previously in the workforce. The four men in the light exercise group who were unemployed at entry remained unemployed throughout the year. Although the mean improvement in the score for occupational adjustment was significantly greater in the exercise training group (0.70 (0.16 to 1.23) *v* -0.29 (-0.93 to 0.36); $t=2.27$, $df=123$, $p=0.025$), there was no significant difference between the two groups in the change from baseline to 12 months. Repeated measures analysis of variance showed no significant effects of treatment or interactions between treatment and time point, although for occupational adjustment the interaction effect approached significance ($p=0.054$).

Some patients were unable to complete self report inventories or respond adequately to interview questions. Therefore, there are varying numbers of patients whose personality characteristics are recorded in table III and whose psychosocial scores are recorded in table V. Working, sexual, and smoking outcomes (table VI) refer only to those patients who at the time of hospital admission were respectively in the workforce, sexually active, or smokers.

Discussion

The physical and psychological benefits of exercise training have been extensively investigated, but they

TABLE IV—Reasons for non-attendance at four and 12 month reviews in both groups of patients

	At 4 months		At 12 months	
	Exercise training (n=22)	Light exercise (n=15)	Exercise training (n=18)	Light exercise (n=14)
Death*	9	7	10	9
Bypass surgery	4	—	1	—
Physical disability	3	2	2	1
Non-compliance	6	6	5	4

*Cumulative scores: three patients died between reviews, one in exercise training group and two in light exercise group.

TABLE V—Psychosocial scores in patients four and 12 months after random allocation to exercise training or light exercise

	Exercise training (n=108)			Light exercise (n=116)		
	No of patients	Mean (SE)	95% Confidence interval	No of patients	Mean (SE)	95% Confidence interval
Anxiety state:						
On admission	100	33.65 (0.94)	31.81 to 35.49	100	33.27 (1.05)	31.21 to 35.33
At 4 months	83	30.95 (1.16)	28.68 to 33.22	92	31.78 (1.17)	29.50 to 34.07
At 12 months	83	31.59 (1.02)	29.60 to 33.58	90	32.24 (1.04)	30.20 to 34.29
Depression:						
On admission	90	10.99 (0.89)	9.25 to 12.73	98	12.76 (1.02)	10.76 to 14.75
At 4 months	84	11.32 (1.04)	9.29 to 13.35	92	11.74 (1.06)	9.67 to 13.81
At 12 months	83	11.48 (1.03)	9.47 to 13.49	90	13.06 (1.23)	10.65 to 15.46
Wellbeing:						
On admission	106	7.91 (0.18)	7.55 to 8.26	113	8.01 (0.19)	7.64 to 8.37
At 4 months	85	8.33 (0.16)	8.03 to 8.63	100	8.08 (0.18)	7.72 to 8.43
At 12 months	87	7.91 (0.19)	7.54 to 8.27	100	7.77 (0.19)	7.39 to 8.12
Social adjustment:						
On admission	108	17.56 (0.34)	16.90 to 18.21	116	16.87 (0.38)	16.17 to 17.87
At 4 months	85	16.87 (0.42)	16.05 to 17.70	101	16.68 (0.37)	15.96 to 17.40
At 12 months	90	17.00 (0.35)	16.31 to 17.69	102	16.69 (0.39)	15.92 to 17.45
Marital adjustment:						
On admission	98	16.07 (0.28)	15.52 to 16.62	106	15.63 (0.26)	15.12 to 16.15
At 4 months	76	15.34 (0.34)	14.69 to 16.00	93	15.68 (0.29)	15.11 to 16.24
At 12 months	81	14.89 (0.35)	14.20 to 15.58	93	15.13 (0.28)	14.58 to 15.68
Occupational adjustment:						
On admission	79	11.79 (0.26)	11.29 to 12.28	84	11.44 (0.31)	10.83 to 12.05
At 4 months	60	12.33 (0.28)	11.79 to 12.88	66	11.42 (0.37)	10.70 to 12.15
At 12 months	59	12.29 (0.28)	11.75 to 12.83	60	11.65 (0.35)	10.97 to 12.33

TABLE VI—Behavioural characteristics of patients four and 12 months after random allocation to exercise training or light exercise

	Exercise training			Light exercise		
	Total No of patients	No (%) of patients	95% Confidence interval	Total No of patients	No (%) of patients	95% Confidence interval
Working status:						
Working on admission	81	81 (100)		88	84 (95)	
Working at 4 months	75	67 (89)	82.3 to 96.3	83	71 (86)	78.0 to 93.1
Working at 12 months	75	64 (85)	77.3 to 93.3	83	66 (80)	70.8 to 88.2
Sexual status:						
Active on admission	92	92 (100)		97	97 (100)	
Recovered at 4 months	64	51 (80)	69.8 to 89.5	86	66 (77)	67.8 to 85.2
Recovered at 12 months	69	55 (80)	70.2 to 89.2	89	71 (80)	71.4 to 88.1
Smoking status:						
On admission	60	60 (100)		62	62 (100)	
At 4 months	45	4 (9)	0.6 to 17.2	55	10 (18)	8.0 to 28.4
At 12 months	50	14 (28)	15.6 to 40.4	51	19 (37)	24.0 to 50.5

are not directly attributable to the intensity of the exercise itself. In a smaller study by Blumenthal *et al* no difference was found between high and low intensity exercise training in either physical working capacity²⁹ or psychosocial functioning.³⁰ We found that, although exercise training confers a greater physical benefit in the short term,¹⁰ a programme of light exercise can produce essentially the same level of psychosocial functioning as that achieved through exercise training. The effects of group exercise programmes on the quality of life, as reflected by psychological or social adjustment scores, seem to be independent of exercise intensity and whether groups are held two or three times a week.

The improvement in occupational adjustment in the exercise training group at four months (but not at 12 months) may be related to the slightly greater physical working capacity temporarily present in that group. The increase in the occupational adjustment score of the exercise training group was none the less small and should be seen in the context of multiple end points.

Our findings therefore do not support the claim that three classes a week of high intensity exercise are needed to improve aerobic capacity and psychosocial functioning after acute myocardial infarction. Given the wide eligibility criteria, large sample size, low drop out rate, and comprehensive range of outcome criteria of our study, these results should apply widely.

State anxiety scores in both groups are comparable with those of other patients who have been enrolled in group exercise programmes after having had an infarction.⁹ The low depression scores recorded for patients in our study are similar to those reported by others, who also found that most patients with heart disease have scores within the normal range on standard depression inventories.^{8,30} Depression usually has a subtle presentation and is often masked by denial.³¹ Therefore any impact of a rehabilitation programme on depression may be difficult to show. In any event, depression scores did not vary between the two groups of patients in our study.

To avoid observer bias psychological outcomes were measured by standard self report inventories rather than clinical assessment. These inventories were completed before follow up interviews because repeated interviews and physical assessments, including treadmill testing,³² could influence patients' perceptions of wellbeing.

The early enrolment of patients in a group exercise programme probably contributed to the high rate of return to work achieved by both groups in our study. As other studies have shown, early participation in a rehabilitation programme seems to be essential for a

high rate of returning to work after acute myocardial infarction.³³ We emphasise, however, that patients with multiple disabilities, cardiogenic shock, and poor English were excluded from our study.

Group light exercise and high intensity exercise training produce similar benefits after acute myocardial infarction. This finding has implications for the development of future low cost cardiac rehabilitation programmes.

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Clinical implications

- High intensity exercise programmes facilitate physical and psychological recovery after acute myocardial infarction
- These benefits may accrue from participation in supervised group activity rather than from the intensity of exercise
- This study shows that high intensity exercise produces a higher level of fitness and a greater improvement in occupational adjustment than light exercise but such benefits are only temporary
- Similar long term effects on quality of life can be achieved by light exercise
- Light exercise programmes (which are less costly than exercise training) are recommended after acute myocardial infarction