Aerobic exercise and the post myocardial infarction patient: A review of the literature

Lee-Anne Gassner, RN, BN, MSC(PHC), MRCNA,[a,c] Sandra Dunn, RN, PhD, FRCNA,[a,b,c] and Neil Piller, Bsc, PhD[b,c] Adelaide, Australia

Meta analyses of randomized controlled tests of cardiac rehabilitation after myocardial infarction demonstrate that regular exercise reduces the risk of overall mortality and cardiovascular mortality. In patients with established coronary artery disease, exercise is associated with improved activity tolerance, modification of risk factors, and improvement in quality of life. Randomized controlled tests demonstrate that whereas older patients after coronary events are substantially less fit than younger patients, they obtain a similar relative improvement of aerobic capacity with a graded conditioning program. However, older adults are enrolled in such programs at a lower rate than other age groups. Despite similar clinical profiles to men, women are less likely to participate in exercise rehabilitation. In this article we discuss the principles of program development, guidelines for monitoring of patients, and facilitation of exercise programs in the Australian context. (Heart Lung® 2003;32:258-65.)

INTRODUCTION

It is generally accepted that a sedentary lifestyle is associated with a higher risk of developing coronary artery disease (CAD) and that regular physical activity is also beneficial in the secondary prevention of CAD.[1] However, approximately one third of the Australian adult population do not engage in regular physical activity.[1] Research has shown that patients most likely to participate in exercise rehabilitation are those who already have a habitual pattern of leisure exercise.[2,3] Encouraging more people to exercise and changing behaviors in relation to inactivity in patients with existing CAD poses a challenge for health professionals.

There are 3 recognized phases of cardiac rehabilitation.[4] Changes in treatments and shorter hospital stays have resulted in a blurring of these phases. However, phase 1 generally starts within the first 24 hours of admission and continues until the patient is discharged. The goal of this phase is to reduce anxiety; increase the patients' independence, confidence, and perception of control; and to reduce the deconditioning associated with bedrest. Phase 2 lasts from 4 to 12 weeks and commences within 3 weeks of discharge from the hospital. The goal of this phase is to help patients acquire the necessary knowledge and skills for behavioral changes and lifestyle modification. Phase 3 is known as the maintenance phase. The goal of this phase is to encourage lifestyle modification and a focus on self-regulation and wellness behaviors.[5]

Although the number of programs in Australia is steadily increasing, many hospitals do not offer rehabilitation programs, and for those that do provide programs, not all patients are referred.[1] Despite numerous benefits associated with rehabilitation programs, uptake of programs remains low and reported attendance rates range from 15% to 53%.[1,6-8] The population being served in most programs is relatively young, white, professional, and male.[1,6] Those invited to attend cardiac rehabilitation programs are likely to have a good prognosis and to have received thrombolysis.[9] In addition, there is the problem of patient *dropout*. It is estimated that the dropout rate is 50% to 60% by the end of a 12-month cardiac rehabilitation program.[10] Given that formal rehabilitation programs serve a minority of cardiac patients, it is highly desirable that nurses are able to counsel patients regarding exercise and physical activity after cardiac events. Nurses must work closely with the patient and other health pro-

From the [a]Flinders Medical Centre, Adelaide, [b]Flinders University, Adelaide, [c]Department of Public Health, Flinders University, Adelaide, Australia.

Reprint requests: Ms. Lee-Anne Gassner, Department of Nursing Education and Research, Flinders Medical Centre, Bedford Park 5042, South Australia.

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fessionals to ensure that programs are individualized and tailored to each patient's needs.

PURPOSE

Our interest here is to: (a) review the evidence that regular physical activity is beneficial in the secondary prevention of coronary artery disease, (b) review the effects of aerobic exercise training, (c) examine the benefits of exercise training, namely increased peak aerobic power, coronary risk reduction, and quality of life on the elderly and women, and (d) provide practical guidelines for facilitation and monitoring of aerobic exercise.

Exercise and secondary prevention of coronary artery disease

Regular aerobic exercise training has been shown to prevent or delay future coronary deaths in patients with coronary disease (known as secondary prevention). A meta-analysis of 22 randomized trials of exercise-based rehabilitation after myocardial infarction in 4554 patients showed a 20% to 25% reduction both in overall mortality and in cardiovascular mortality.[11] Similarly, a meta-analysis of 10 trials in 4347 patients showed that comprehensive rehabilitation had a beneficial effect on mortality, but not on the rate of recurrent myocardial infarction.[12] Most of the trials incorporated other lifestyle changes, such as smoking cessation and dietary modification, along with exercise. When the trials of exercise alone were analyzed separately, the results were directionally similar but not statistically significant and this may be because of the small number of such trials.[13] However, the studies by Oldridge and O'Connor and their associates were conducted in the pre-thrombolytic era.[11, 12] Therefore it is not known whether current cardiac exercise rehabilitation programs will result in a similar relative decline in mortality beyond that associated with thrombolytic therapy.

A systematic review of electronic databases from the earliest date available to December 31, 1998 by Jolliffe and colleagues provided an expanded meta-analyses of 8440 patients.[14] They concluded that exercise-based rehabilitation is effective in reducing cardiac deaths. However, it is not clear from this review whether exercise only or comprehensive cardiac rehabilitation intervention is more beneficial.[14] Furthermore, the reviewers do not differentiate between the pre-thrombolytic and post-thrombolytic periods. Jolliffe and colleagues also reported that the population studied in their review was predominantly male, middle aged, and low risk.[14]

Beneficial effects of aerobic exercise training

Aerobic exercise is associated with an improvement in exercise tolerance. Exercise tolerance relates to exercise duration during a symptom-limited exercise test or more accurately as peak or maximal oxygen uptake (VO_2 peak).[15] The physiological adaptations, such as left ventricular remodeling, quality ventilatory (anaerobic) threshold, and peak aerobic power, should be increased as a result of exercise and enable patients with exertional angina to exercise to a higher intensity before reaching their thresholds for myocardial ischaemia.[15] Sustained training for longer than 1 year is associated with an improvement in left ventricular contractile function and cardiac output.[16,17] Although long-term aerobic exercise may be associated with an increase in left ventricular contractile function, the subjects cited in the study by Ehsani and colleagues were trained at an extremely high intensity (ie, 70-90% VO_2 max during a 6-month period) that may be unrealistic and impractical for most persons participating in cardiac (exercise) rehabilitation programs.[17] However, many patients show improvement in exercise tolerance without changes to left ventricular function,[18] which suggests that other factors are also responsible.[19] Noncardiac factors such as age, gender, Broca index, and forced vital capacity were shown to be better predictors of effort tolerance of patients with CAD than parameters of left ventricular function at entry to an exercise program or after 6 months of training.[18]

Aerobic exercise has been shown to contribute to modification of other coronary risk factors. After acute myocardial infarction, aerobic exercise promotes a decrease in percentage body fat,[20] reduces blood pressure,[20] decreases triglyceride levels, and increases HDL cholesterol.[21] Two studies have also shown that exercise training combined with modification of risk factors, especially a low fat diet, resulted in regression of atherosclerotic disease. Evidence of these changes to atherosclerosis were based on serial angiograms.[22,23]

Whereas the majority of the literature has focused on the physiological benefits of aerobic exercise, there is evidence to suggest that exercise may also be associated with enhanced quality of life.[24-28] Research suggested that persons' return to greater activity levels after a cardiac illness was associated with less depression and higher levels of self-esteem[24] and improved vocational status during a 5-year follow-up period.[28]

A cohort study of 83 women and 375 men referred to an outpatient phase-11 exercise program after a major ischaemic CAD event, showed statistically similar improvements in behavioral traits and quality of life scores.[26] Depression, hostility, and measures of mental health were not statistically reduced. Interestingly, at baseline, women scored lower than men with regard to validated measures of energy, function, and overall quality of life.[26] This suggests that the improvement in quality of life may be of greater clinical benefit to women than to men. Similar findings were reported in a study of 52 elderly women and 296 other patients. Behavioral characteristics and quality of life parameters were also assessed after exercise training.[25] Study findings showed significant improvements in anxiety, somatization, total quality of life, and all of its components.[25] However, these studies were retrospective, nonrandomized, and of relatively short duration.

Exercise training and the elderly: improvements in aerobic capacity. The demographic trends of an aging population suggest that patients admitted to the hospital with CAD are older and sicker and that this may continue to impact on the health care system.[1] Blair and colleagues reported that men $\geq$ 60 years of age who improved their physical activity level had a 50% lower risk of death compared with those who did not improve their exercise level.[29]

Diverse physiological changes occur in the oxygen transport system during the aging process. Physical performance and VO_2 max (an individual's maximum ability to consume oxygen) decline with age. This decrease is largely because of decreased cardiac output, which is a function of heart rate and stroke volume.[30] VO_2 max declines approximately 9% per decade; however, aerobic exercise can reduce this by as much as half. It is worth noting, however, that this research was undertaken with healthy adults.[31]

Maximum heart rate decreases with age because of a reduction in sympathetic activity and viscoelastic changes in the cardiac muscle resulting in resistance to movement. Stroke volume also decreases with age. Factors that decrease stroke volume include reduction in venous return; myocardial rigidity and reduction of pre-ejection filling; increased arterial pressure; reduction of mitochondrial enzyme activity; infiltration of muscle by collagen fibres; or loss of coordinated contractions.[30]

However, these changes may be attenuated with exercise training.[32] Observational studies have shown that exercise in the elderly can improve functional capacity in patients more than 65 years of age[33-35] and that the elderly show greater improvement in functional capacity than younger patients enrolled in similar programs of exercise.[35,36] Study findings from a nonrandomized comparative study (n = 283) showed that older coronary patients respond to aerobic conditioning with remarkable improvements in submaximal endurance capacity. Activities that were exhaustive before training became sustainable for extended periods of time at a lower perceived exertion, and ventilatory response to a given workload was lessened.[34]

Thus, whereas older patients after coronary events are substantially less fit than younger patients, they obtain a similar relative improvement of aerobic capacity with a graded conditioning program. However, older adults are enrolled in such programs at a lower rate than other age groups.[37] Reasons for this lower rate of enrolment are unclear from the literature. It has been suggested that a lack of awareness by physicians of the benefits of exercise for the elderly may have contributed to their underrepresentation in exercise programs.[37] Older patients are in greater need of these programs because they become deconditioned more easily as a result of cardiac disease and because they often have other chronic illness.[38]

Exercise training and women: improved aerobic capacity. Recent studies examining the benefits of exercise for women as compared with men showed that women show improvements similar to men in aerobic capacity in response to exercise training.[25,37,39] Despite these reported benefits, women were less likely than men to participate in exercise rehabilitation despite similar clinical profiles.[37, 40] This finding may be partly explained by a greater likelihood of primary physicians to strongly recommend cardiac rehabilitation to men.[10] In addition, programs may fail to take into account the needs of women.[41] A qualitative study incorporating in-depth interviews of 20 women showed that women frequently mentioned safety issues and financial problems as barriers both to attending cardiac rehabilitation programs and to maintaining lifestyle changes.[42] McSweeney (1996) suggested that negotiated plans of care may be a strategy to assist more women to pursue health-promoting activities after myocardial infarction.

There is limited data available related to the type of programs most suited to women. However, a study by Schuster and colleagues showed that women who participated in home programs, as compared with structured rehabilitation programs, did not fare as well as men. In general, females at home showed decreased exercise adherence, de-

creased ability to control stress, and no significant increase in knowledge about their medical condition.[43]

Since elderly women have considerably lower exercise capacity at baseline than the other patients, their relative clinical benefit after cardiac rehabilitation would be even greater.[25,44,45] Future research therefore needs to explore the reasons for low referral and unwillingness to participate among women—especially elderly women—and new strategies must be adopted to reach this population effectively.

Principles for exercise facilitation and monitoring

An aging population and advances in technology has meant that patients may present with chronic illness and multiple diagnoses. Trends in the increasing complexity of the cardiac patient point to the need for individualized programs. Generally, patients are prescribed a walking program, exercises, and activities of daily living to continue during phase 2 of rehabilitation.[46] Home activity programs are designed to allow gradual resumption of activities. In developing individualized exercise programs, nurses in consultation with the patient, patient's cardiologist, and other health professionals must consider the patient's age, comorbidity, and perception of their illness and level of social support. The primary goals of any exercise program should be to provide a level of fitness to promote self-care, to improve quality of life and self-confidence, and to reassure significant others.[5]

Principles of program development. According to the American College of Sports Medicine, general principles of exercise prescription include: 1) frequency; 2) intensity; 3) duration; 4) mode of training; and 5) rate of progression.[47,48] Most programs provide 3 sessions for 12 weeks. However, the intensity of programs varies. Recent studies suggest that low-intensity exercise may be as beneficial as high intensity and offers a safer alternative. In an Australian study, 308 men from a series of 479 men with transmural (Q wave) acute myocardial infarction were randomly allocated to 8 weeks of group aerobic exercise training (patients performed 30 minutes of continuous aerobic exercise at a level of energy expenditure that maintained their heart rate at 75% to 85% of maximum) or group light exercise (exercise interrupted by periods of rest where patients were allowed to increase their pulse rate intermittently to no greater than 20 beats per minute above the resting level).[46] Study findings showed that there were no significant intergroup differences at any stage in resting and maximal heart rate, resting and maximal systolic blood pressure, or rate-pressure product. Apart from a small temporarily greater physical working capacity, the physical benefits of aerobic exercise training were equally well achieved by group light exercise.[46] A lower level of exercise largely removes the hazards of cardiac arrest or skeletal injury and avoids the need for medical supervision.[49] This option may also be more attractive to patients as many persons dislike strenuous exercise.[50] This has the additional benefit of enabling persons to plan exercise programs around their lifestyle. Low-intensity exercise generally does not require high-technology monitoring systems, which means that community resources can also be used for exercise.

Minimal requirements set out by the National Heart Foundation for outpatient programs include:

- A light (equivalent to 3-5 METs) or moderate (5-7 METs) group exercise program for a minimum of 6 sessions, weekly or twice weekly. Each exercise session should last for about 45 minutes, including warm up and cool down periods, and be able to cater to the individual needs and capacities of each patient.
- Written guidelines for the scheduling and sequencing of the resumption of daily activities, including a home walking program aiming at an average minimum of 30 minutes continuous exercise each day of walking or other activity.
- Outpatient sessions must be supervised by a health professional trained in cardiopulmonary resuscitation.
- Individual review of walking program at discussion or exercise session.
- Referral to health professionals for individual intervention as required.[5]

Exercise facilitation. Nurses, often working with physiotherapists, occupational therapists, and other health professionals are involved in facilitating exercise programs. Although the Australian trend is toward low-intensity exercise programs, each hospital will vary in the structure of programs offered. Typically, exercises are based on graded, low-intensity exercises which include stretching and mobilization, walking up steps, stationary cycling, rowing, and weight work using pulleys and light weights.[46]

Key points related to facilitating patient exercise: Patients should be assessed and referred to the rehabilitation program by their physician. Generally, patients are classified as low, moderate, or high-risk

participants. The type and intensity of prescribed exercise is primarily determined by the participant's left ventricular function, severity of symptoms, severity of disease, and functional capacity.[46] Resuscitation equipment should always be readily available and a member of staff trained in Cardiopulmonary Resuscitation present. Exercise should start and progress slowly to prevent injury (approximately 5-10 minutes of stretching and light activity).[51] Incorrect warm up may increase the occurrence of ischaemic ST-segment depression, ventricular ectopy or abnormal left ventricular responses.[52] Five to 10 minutes of cool down is also recommended. Failure to cool down properly may result in an increase in postexercise hypotension and catecholamines resulting in fainting or arrhythmias.[53] Exercise should never be ceased abruptly. If it is necessary to cease exercise abruptly, the patient should lie down or elevate the legs to promote venous return.[30] Intermittent exercises and rests between exercises can help to minimize fatigue in elderly patients.[50,54]

If patients are instructed to monitor their carotid artery (ie, patients with peripheral vascular disorders), they must be instructed not to press so hard as to restrict blood flow and not to massage the artery, which may set off a vagal response.[30] Patients should be encouraged to increase caloric expenditure to 1000kcal per week (4,200kJ/wk).[51] This may be modified on the basis of exercise tolerance. Avoid activities that increase systolic blood pressure greater than 40 mm Hg above resting; decrease the systolic blood pressure greater than 40 mm Hg below resting; decrease diastolic blood pressure greater than 15 mm Hg below resting; and increase diastolic blood pressure greater than 110 mm Hg.[30] Target heart rates should only be used if results from a symptoms-limited exercise test are unavailable.[5] Avoid exercise in extreme temperatures (sweating is less efficient with age, therefore patients are unable to dissipate the heat; cutaneous vasoconstriction in extreme cold results in a rise in blood pressure).[55] Encourage patients to walk with cushioned sole shoes so as not to traumatize the bones and joints.[30] Encourage older patients not to hold their breath during exercise. A valsalva maneuver can occur by tightening the abdominal muscles while holding the breath (the elderly have decreased sensitivity of the baroreceptors and slowing of the autonomic nervous system; they are therefore more prone to fainting if they perform a valsalva maneuver).[55] Exercise should not occur for at least half an hour after eating a meal (decreased sensitivity of the baroreceptors with age contributes to orthostatic hypotension. It may also result in decreased blood pressure after eating, therefore leading to fainting or myocardial ischaemia).[56]

Monitoring exercise. Measures that have been used in both hospital and outpatient contexts to monitor exercise include: symptom frequency,[57] heart rate,[15,58-61] blood pressure[10,15,58,60-62] and ischaemic changes.[15,63] These measures provide nurses with cues related to the patient's ability to tolerate an exercise program on discharge. Patients must be observed for a level of fitness required for self care. Frequency of symptoms provides vital cues for this process. Symptoms which may indicate poor exercise tolerance include arrhythmias, light headedness, feeling dizzy, fatigue, shortness of breath, pain in the chest or arm, cool and clammy skin, leg pain, nausea, decreased coordination, confusion, and headache.

Heart rate provides an important indicator of aerobic fitness. However, in contrast to the young, in the elderly, physical fitness does not result in a decreased resting heart rate.[30] Symptom-limited exercise tests are often used to prescribe target heart rates for exercise. An alternative and less invasive approach has been suggested by Hare et al.[46] This approach included recording the heart rate at the wrist before exercising, immediately after completion of the exercise circuit, and after 2 minutes of rest. This approach provides feedback on abnormal resting rate and rhythm, response to exercise, and recovery postexercise.[46] Before exercising, the patient should have a resting pulse rate of between 60 and 100 beats per minute and the rhythm should be regular; if the resting systolic blood pressure is more than 150 mm Hg, exercise should proceed with caution (systolic blood pressure over 160 mmHg or diastolic blood pressure over 100 mmhg is considered hypertensive).[30]

For patients on beta blockers, smaller increments in heart rate are considered to be satisfactory.[46] Alternatively, patients may report their rate of perceived exertion. Rate of perceived exertion is a numerical scale ranging from 6 to 20 or 0 to 10 where patients describe their response to exercise in relation to the question "How much effort was the activity performed?" The Borg Scale correlates well with oxygen uptake and heart rate.[64]

Patients with a history of arrhythmias and heart failure may be advised to exercise using telemetry to enable closer monitoring of their response to exercise. Studies have shown that the incidence of cardiovascular complications, including arrhythmias and cardiac arrest, is low. It has been estimated that cardiac death occurrence is no greater

than 1 in 100 000 hours of exercise participation for both the general and the cardiac rehabilitation population.[65, 66]

In patients with heart failure, responses to exercise may be inconsistent because of atrial fibrillation, active ischaemia, salt overload, dehydration, or heat intolerance.[67] However, it has been shown that patients with left ventricular failure can exercise safely by gradually raising their heart rates above resting level.[68,69] Exercise programs must be carefully monitored to avoid unnecessary fatigue.[67,70] Data such as body weight, blood pressure, and rate response to exercise, measured routinely, are valuable in tracking the clinical status of these patients.[67]

Other systemic diseases such as diabetes, renal failure and pulmonary diseases may influence exercise response in patients with CAD. For these patients, exercise needs to be individualized and closely monitored. A supervised program for these patients possibly on a 1 to 1 basis may help patients to return to optimal levels of functioning, while at the same time providing reassurance for patients and their families.

Self-monitoring. Relatively little attention has been given in the literature to patient self-monitoring. The patient's self-monitoring of signs and symptoms, the ability to pace exercise and recognize adverse response to exercise, is essential to a confident return to the home setting. A program designed to encourage patients to take charge of their own long-term exercise rehabilitation, should include:

- Self monitoring of either radial or carotid pulse. If patients are unable to feel their pulse, a small 2-electrode monitoring device may be strapped to their chest before exercising.
- Recognition of symptoms indicative of myocardial ischaemia.
- Monitoring of exercise response.
- Details of various drugs and how they may influence activity levels.
- Guidelines for how and when to contact a designated health care professional with any change in response or cardiac symptoms.
- Guidelines for how to access support groups for exercise and social support.
- An exercise logbook detailing the duration, intensity and type of exercise response and any cardiac symptoms. This may be useful in future planning of activities and can be reviewed either through the mail or at the patient's next visit to their physician.

Compliance with exercise programs may be enhanced by self-monitoring strategies such as goal setting.[71] This strategy involves the health professional working with the patient in the identification of exercise goals. Each goal has an expected outcome and timeframe. Another self-monitoring strategy may be the use of computer assisted feedback systems that provide enhanced tracking, goal setting and feedback. Although this strategy is relatively new in the field of cardiac rehabilitation, initial research findings suggest that it may improve attendance and adherence to exercise rehabilitation.[72]

CONCLUSION

This article has examined only 1 aspect of cardiac rehabilitation, namely exercise. Clearly, there are numerous health benefits associated with regular exercise as opposed to leading a sedentary lifestyle after a cardiac event. This review of the literature pertaining to exercise training has shown that aerobic exercise in post myocardial infarction patients can contribute to modification of other coronary risk factors, improve exercise tolerance, reduce mortality, and enhance quality of life. However, referral and adherence rates to formal rehabilitation programs remain low. Women and the elderly are underrepresented in exercise programs despite evidence suggesting that they achieve similar and possibly better physiological outcomes than younger men.

It is therefore highly desirable that nurses have an understanding of the scientific basis for exercise in the elderly and are able to provide appropriate individualized instruction related to exercise. A patient-centered approach will have less emphasis on prescription of exercise and greater emphasis on cooperative planning. This program would take into consideration the patient's exercise tolerance, the nature of the illness, expectations about rehabilitation, and the social context of rehabilitation. Self-monitoring of exercise tolerance is an important aspect of this process. Further research into the efficacy of self-monitoring is warranted . Research is needed to determine how to increase rates of referral and adherence to exercise programs. In particular, research needs to address the reasons for nonparticipation among the elderly and women and reasons for their lower referral rates.

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