Group-based Aerobic Interval Training in Patients With Chronic Heart Failure: Norwegian Ullevaal Model

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Background and Purpose

The purpose of this case report is to describe the responses of 4 patients with chronic heart failure (CHF) to a novel rehabilitation program: a group-based, high-intensity, interval-training program that includes aerobic, resistance, flexibility, and balance activities.

Case Descriptions

Four patients (55–71 years of age) with CHF (New York Heart Association class III) participated in the rehabilitation program twice per week for 16 weeks. Outcome measures included a 6-minute walk test (6MWT), a cycle ergometer test (aerobic capacity), and a quality-of-life questionnaire.

Outcomes

Patients 1, 2, and 3 increased their aerobic capacity (17%, 25%, and 52%, respectively). Patient 4 did not complete the cycle ergometer test because of limitations associated with his pacemaker. All patients increased their 6MWT distance (117, 66, 135, and 143 m for patients 1, 2, 3, and 4, respectively). No adverse events were reported.

Discussion

The Norwegian Ullevaal Model of cardiac rehabilitation is a novel high-intensity, interval-training program. The 4 patients with CHF in this case series who participated in this program experienced improvements in physical capacity and quality of life and had no adverse events. These results are consistent with recent evidence supporting the efficacy of high-intensity interval training in people with CHF. Randomized clinical trials are needed to evaluate the clinical efficacy of this group-based, high-intensity, aerobic interval-training program for patients with CHF.

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Chronic heart failure (CHF) has become one of the most common cardiovascular disorders in Western societies.[1] Five million people in the United States alone have CHF, with an incidence of 500,000 each year.[2] Despite major advances in the pharmacological treatment of CHF, many patients with CHF have dyspnea, fatigue, reduced exercise capacity, and poor quality of life.[3] Chronic heart failure is the most costly condition for Medicare, with 2 million hospitalizations and nearly 300,000 deaths each year.

Over the last 30 years, the effectiveness of cardiac rehabilitation for patients with coronary artery disease has been established.[4,5] The exercise interventions have been proven to be safe and to have a low rate of nonfatal cardiovascular events.[6] Van Camp and Peterson[6] calculated the incidence rates per million patient-hours of exercise to be 8.9 for cardiac arrest (1 per 111,996 patient-hours), 3.4 for myocardial infarction (1 per 293,990 patient-hours), and 1.3 for fatalities (1 per 783,972 patient-hours). In the last decade, several studies have been published on the effects of exercise interventions for patients with CHF.[7–12] Until now, exercise recommendations have been based on clinical experience, studies with a limited number of subjects, and studies with only individualized exercise models.[7] Three types of individualized exercise models have been assessed for patients with CHF: aerobic, strength (force-generating capacity), and respiratory muscle training.[13] No detailed reports of group-based aerobic interval-training programs for patients with CHF have been reported in the literature.

Studies of people who were healthy have demonstrated that more work can be performed before the onset of exhaustion by exercising with intervals than when the same total amount of work is performed continuously.[14,15] Because of the low exercise capacity in patients with CHF, aerobic exercise training with an interval model (with different combinations of work and recovery periods) has resulted in an increase in exercise capacity over that achieved with a continuous-exercise model.[11] Interval training is described as repeated bouts of high-intensity exercise (equal or superior to maximal lactic acid steady-state velocity) of variable length interspersed with recovery periods (light exercise or rest).[16] An interval-training model can enable patients with CHF to complete short periods of high-intensity exercise that would not be possible with a continuous-exercise model.

The American Heart Association Committee on Exercise, Rehabilitation, and Prevention[17] and the Working Group on Cardiac Rehabilitation, Exercise Physiology, and Heart Failure of the European Society of Cardiology[18] are not specific regarding the exercise model (ie, interval versus continuous exercise). There is no consensus on exercise prescription for patients with CHF because of variations in the studies included in these guidelines as well as the intensity used in those studies. The guidelines[17,18] state that patients with CHF should exercise at a moderate to high intensity (50%–80% of their exercise capacity). Exercise training at high intensity (90%–95% of peak heart rate) is in the upper range of current guidelines for humans. In a recently published article by Wisloff et al,[19] an interval model involving periods of training at 95% of peak heart rate improved aerobic capacity, quality of life, and left ventricular remodeling significantly compared with moderate-intensity continuous training (70% of peak heart rate) in patients with postinfarction heart failure.

A recent Cochrane Review identified 29 randomized controlled trials (RCTs) comparing exercise-based interventions with usual medical care for patients with CHF.[7] The exercise models described in the Cochrane Review varied considerably, and the exercise programs were generally incompletely described and not standardized. Stationary bicycle and treadmill walking were the most frequently used exercises.[8,9,20,21] Even though this review is the most comprehensive systematic review of the effectiveness of exercise training in patients with CHF, most of the trials included stable patients with CHF and samples comprising mostly men, and the trials were small and of relatively poor methodological quality. According to a coalition of national organizations led by the American College of Sports Medicine, an optimal training program for older adults should include endurance, strength, balance, and flexibility training to increase their physical capacity and improve their quality of life.[22]

The content of an exercise program, the optimal dose of exercise training, and the type of model (group based or individualized) are still topics to be explored. At Ullevaal University Hospital, we have extensive experience with group-based aerobic interval training for patients with coronary artery disease. Most of the patients with CHF in New York Heart Association (NYHA) classes II and III at Ullevaal University Hospital did not participate in these rehabilitation groups because of dyspnea with low-level exercise, the rapid beat of the music, and inadequate counseling. Therefore, our outpatient clinic now offers group-based aerobic interval training modified for patients with severe CHF; to date, more than 100 patients with CHF have participated in this program without any adverse events.

The purposes of this case report are to describe a group-based aerobic interval-training program for patients with CHF in NYHA class III and to explain how the program was implemented as an interdisciplinary treatment.

Case Descriptions

The 4 patients described in this case report were randomly selected male patients who were in NYHA class III and who were included in the exercise group in an ongoing RCT (n=80).[23,24] In that RCT, 47.5% of the patients randomly assigned to the exercise group were in NYHA class III. Written informed consent was obtained from all patients.

Measurements

All patients were referred from our outpatient heart failure clinic and were stabilized by medication for 4 weeks before testing and rehabilitation. Aerobic capacity was tested with a cycle ergometer test. Starting at 30 W, the patients maintained a constant pedaling speed of 60 revolutions per minute, with the workload increasing stepwise by 10 W every minute, to exhaustion.[25] Blood pressure and a 12-lead electrocardiogram (ECG) were monitored during the test. We used the rate-pressure product (RPP) as an index of myocardial oxygen consumption and defined it as the highest product of simultaneously measured heart rate (in beats per minute) and systolic blood pressure (in millimeters of mercury) during the exercise test.[26] In addition to the cycle ergometer test, a submaximal 6-minute walk test (6MWT)[27] was performed as a measure of functional capacity. The 6MWT has been shown to be valid for walking capacity and physical activity in patients with CHF[28] and closely mimics the daily submaximal energy expenditure required for functional activities.[28] The distance covered during the 6MWT has been shown to be closely related to exercise capacity indexes of bicycle work rate, stair-climbing time, and peak oxygen consumption.[29] The 6MWT is easy to administer, is well tolerated, reflects activities of daily living (ADL), and is safe for patients.[30] A 125-m course was marked in the hospital corridor, and patients were instructed to walk from end to end at their own pace with the objective of walking as far as possible within 6 minutes. Patient symptoms were recorded, and distance covered was expressed in meters.

Quality of life was assessed with the disease-specific Minnesota Living With Heart Failure (MLHF) Questionnaire.[31] The MLHF Questionnaire is one of the most frequently used disease-specific quality-of-life assessment instruments for patients with CHF.[32,33] The instrument is a 21-question self-assessment questionnaire focusing on patient perceptions of how CHF affects their lives (eg, symptoms of heart failure, social interactions, physical and sexual activities, and emotional dimension). The minimum score is 0, and the maximum score is 105, with higher scores indicating a lower quality of life. All measurements were obtained at baseline (prior to exercise training) and after participation in the program for 4 months. A cardiologist (AW) and a physical therapist (BBN) performed baseline patient testing. Two cardiologists and 2 physical therapist students who were unaware of baseline test results and whether patients participated in exercises or not performed postexercise testing.

Patients

Patient 1. Patient 1 was a retired 70-year-old man with CHF (NYHA class IIIB) attributable to hypertension and an ejection fraction (EF) of 15%. His ECG results at rest demonstrated atrial fibrillation. His resting heart rate was 97 bpm, and his blood pressure was 116/73 mm Hg. His comorbidities included type II diabetes, hyperlipidemia, chronic renal failure, chronic obstructive pulmonary disease (COPD), and sleep apnea. His daily medications included enalapril (20 mg, once per day), bumetanide (5 mg, twice), carvedilol (6.25 mg, twice), atorvastatin (20 mg, once), and warfarin to manage his CHF and hypertension and glibenclamide and metformin for his diabetes mellitus.

Baseline results included a peak workload of 50 W (210 seconds), a peak heart rate of 110 bpm, and a peak blood pressure of 125/65 mm Hg during cycle ergometer testing, which was stopped secondary to general fatigue. The patient's peak RPP was 13,500 mm Hg/min. The ECG at peak exercise revealed a left bundle branch block but no further arrhythmias or ECG changes. The patient walked 250 m in 5 minutes during the 6MWT but did not walk further because of marked dyspnea. His MLHF Questionnaire score was 65.

Patient 2. Patient 2 was a retired 71-year-old man with CHF (NYHA class III) attributable to dilated cardiomyopathy and an EF of 22%. The resting ECG revealed left bundle branch block. The patient's resting heart rate was 68 bpm, and his blood pressure was 105/64 mm Hg. Reported comorbidities included COPD. The patient's daily medications included enalapril (5 mg, twice per day), carvedilol (12.5 mg, twice), and furosemide (40 mg, twice) to manage his CHF and inhaled corticosteroids to manage his COPD.

Baseline results included a peak workload of 80 W (364 seconds), a peak heart rate of 129 bpm, and a peak blood pressure of 159/92 mm Hg during cycle ergometer testing, which was stopped secondary to dyspnea. The patient's peak RPP was 20,510 mm Hg/min. No arrhythmias or ECG changes were present at peak exercise. The patient walked a total of 433 m during the 6MWT, with dyspnea onset at 250 m. His MLHF Questionnaire score was 26.

Patient 3. Patient 3 was a retired 68-year-old man with CHF (NYHA class III) attributable to ischemic cardiomyopathy and an EF of 20%. The resting ECG revealed a normal sinus rhythm. The patient's resting seated heart rate was 63 bpm, and his blood pressure was 110/72 mm Hg. Reported comorbidities included ventricular dysrhythmia. The patient's daily medications included metoprolol (25 mg, twice per day), losartan (50 mg, once), furosemide (20 mg, twice), amiodarone (200 mg, once), simvastatin (40 mg, once), and warfarin to manage his CHF and ventricular dysrhythmia.

Baseline results included a peak workload of 50 W (209 seconds), a peak heart rate of 81 bpm, and a peak blood pressure of 122/75 mm Hg during cycle ergometer testing, which was stopped secondary to dyspnea. The patient's peak RPP was 9,880 mm Hg/min. He walked a total of 388 m during the 6MWT, with dyspnea noted upon the completion of testing. His MLHF Questionnaire score was 52.

Patient 4. Patient 4 was a 55-year-old male salesman (on sick leave) with CHF (NYHA class III) attributable to hypertension and ischemic heart disease and an EF of 26%. His resting heart rate was 60 bpm, and his blood pressure was 115/90 mm Hg. Comorbidities included ventricular dysrhythmia, atrial fibrillation/flutter, and anxiety. The patient's daily medications included metoprolol (100 mg, once per day), lisinopril (20 mg, once), furosemide (40 mg, once), spironolactone (25 mg, once), pravastatin (40 mg, once), warfarin to manage his CHF, and citalopram (20 mg, once) to manage his anxiety. His ventricular dysrhythmia and atrial fibrillation/flutter were treated with a rate response pacemaker/implantable cardioverter defibrillator.

Baseline testing was limited to the 6MWT and the MLHF Questionnaire because the pacemaker prevented a heart beat response during cycle ergometer testing (because of no activities with the upper extremities). The patient walked a total of 429 m during the 6MWT and reported dyspnea upon the completion of testing. A Holter ECG monitor worn during the 6MWT indicated that the peak heart rate was 106 bpm. The patient's MLHF Questionnaire score was 59. Peak blood pressure and RPP were not measured.

Intervention (Group-based Aerobic Interval Training)

The Norwegian Ullevaal Model for cardiac rehabilitation is based on the Swedish Friskis-Svettis model,[34] a Scandinavian fitness training program established by Johan Holmsater. This group-based aerobic interval-training program has been widely used in Scandinavian hospitals for patients with coronary artery disease. It is designed to improve physical capacity, body awareness, and emotional well-being; to promote a return to work and ADL; and to improve prognosis.

There are 3 intervals of high intensity and 2 intervals of moderate intensity, each one lasting for 5 to 10 minutes. Included in each is coordination. Exercises consist of simple aerobic dance movements and involve the use of both upper and lower extremities to challenge postural control.[35] To observe a patient throughout the program, the physical therapist teaches the exercises from the center of the exercise room. During walking exercises, the patient walks in a circle, and the physical therapist walks in the opposite direction within the circle.

The group-based aerobic interval-training program for patients with CHF is a modified cardiac rehabilitation program that has been used at Ullevaal University Hospital for 3 years. Between 8 and 12 patients constitute each CHF group. So far, more than 100 patients with CHF have executed the program with no adverse events.

Intensity

The model is designed to follow the intensity curve shown in the Figure. The Borg Scale[36] and beats per minute of the music pace are used to adjust exercise intensity. The Borg Scale is a patient self-report scale used to rate perceived exertion, with values ranging from 6 to 20. The scale is especially useful for determining intensity when beta-blockers, atrial fibrillation, pacemakers, chronotropic incompetence, or other conditions alter the natural response of the heart rate to exercise.[37,38] The majority of studies and experts support the use of moderate intensity (60%–80% of peak heart rate).[13,17,18] On the basis of experimental trials in rats with postinfarction heart failure,[39] patients with coronary artery disease,[40,41] patients with CHF,[19] and our own experience, we encouraged our patients to reach toward 90% to 95% of their measured maximum heart rate (15–18 on the Borg Scale) during the high-intensity exercise intervals of the program and 50% to 60% of their maximum heart rate (11–13 on the Borg Scale) during the moderate-intensity exercise intervals (Figure).

During the exercise sessions, the patients informed the physical therapist of their Borg Scale ratings. After the exercise was completed, a discussion and counseling session with the physical therapist was held to address their progression. With the exception of patient 4, patients in this case report wore a heart rate monitor (Polar S410*) to guide them to their optimal intensity levels. Pa-

* Polar Electro Oy, Professorintie 5, FIN-90440 Kempele, Finland.

tient 4 did not wear a heart rate monitor because of his pacemaker. Throughout the program, the choice of exercises and the pace of the music are factors influencing program intensity. The patients were guided to exercise at individual levels based on baseline exercise tests and health conditions (of the day), and some patients never reached more than 15 on the Borg Scale.

Music

The music is melodious, varied, and characterized by a strong rhythmic component.[42] The rhythmic component is important for pacing the intensity of the exercises. The music should have a steady rhythm and an "upbeat" feeling that encourages hard work in the high-intensity exercise intervals. Additionally, the instructor should like the music, in order to express joy. The music is designed to fit the age and exercise capacity of patients with CHF. Our clinical experience has indicated that the pace of the music should not exceed 124 beats per minute for rehabilitation groups including patients with CHF (in contrast to the pace for typical cardiac rehabilitation groups, for which the pace can be up to 172 beats per minute). This pace is fast enough for patients with severe CHF to reach 15 (hard) to 18 (very hard) on the Borg Scale without losing control of the movements or sacrificing exercise technique.

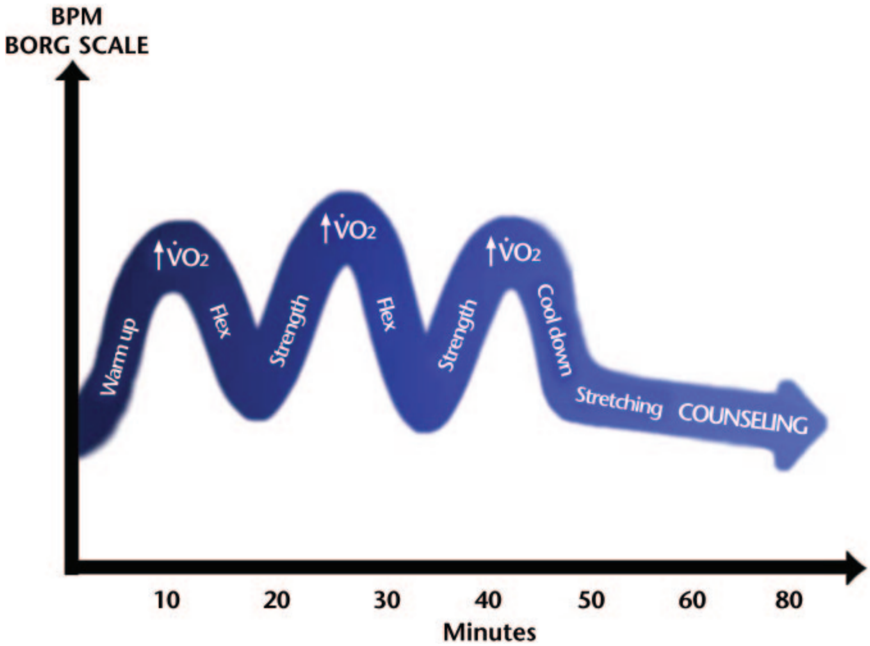

Figure.
Schematic illustration of the group-based aerobic interval-training program. The duration was 50 minutes of exercise plus 15 to 30 minutes of counseling. The intensity was adjusted with the Borg Scale and beats per minute of the music pace. Coordination exercises were included throughout the program. $\dot{V}O_2$=oxygen consumption, Flex=flexibility exercises.

Warm-up and Cool-down Periods

The program includes warm-up and cool-down periods conducted in accordance with American College of Sports Medicine guidelines.[11,43] Warm-up activities include large muscle movements and are a rehearsal of subsequent movements performed more forcefully and through a larger range of motion (Appendix 1). To prevent injuries, avoid myocardial ischemia, and prevent vascular spasm or redistribution of blood to an area at risk, the program is designed to gradually progress from warm-up exercises to the first high-intensity exercise interval (songs 3 and 4, Appendix 2). After the third and last interval of high-intensity exercise, there is a slow and progressive decrease in exercise intensity (eg, slow walking without arm reaches). This step is included to minimize the orthostatic response to the exercise and drug-induced dilated peripheral circulation and to eliminate lactic acid from working muscles.[11]

High-Intensity Intervals (Endurance/Peak Oxygen Uptake)

One of the goals of the model is to improve oxygen uptake during exercises. These exercises include extension, flexion, abduction and adduction, and rotations of the leg and foot, such as side stepping, fast walking, running, forward and backward stepping, leg lifts, heel touches, and different coordination exercises (Appendix 1). Intensity and heart rate should increase gradually during these intervals. Techniques to increase exercise intensity include performing the exercises to faster music or through a larger range of motion.

Moderate-Intensity Intervals (Flexibility and Strength)

Another goal of the model is to increase patients' range of motion (flexibility). Studies have demonstrated that flexibility decreases with age[44,45] and that a high level of flexibility is necessary to increase mobility, coordination, and performance of ADL.[45] Although flexibility exercises are part of the warm-up session, the majority of the exercises are performed during the 2 moderate-intensity intervals of the program[44] (Figure). During dynamic flexibility exercises, the muscles are moved through full joint range of motion.[22] Flexibility exercises for the upper extremity address the pectoralis, trapezius, and deltoid muscles. For the lower extremity, flexibility exercises for the gastrocnemius, hamstring, quadriceps, and hip adductor and flexor muscles are included (Appendix 1). The pace of the music during these exercises is between 48 and 68 beats per minute to promote a full range of motion.

Strength exercises are also a component of the 2 moderate-intensity intervals of the program (Figure). Goals of the strengthening exercises include increasing muscle strength in both the upper and the lower extremities and improving physical conditioning and performance of ADL tasks.[44,46] Muscle strength is required for many ADL tasks, such as climbing stairs.[44] The strength exercises are performed using patient body weight (calisthenics) and can be adapted individually according to the patient's preexercise fitness level. The strength exercises are performed by patients while lying down, sitting, or standing, and the pace of the music is between 52 and 96 beats per minute (Appendixes 1 and 3). Exercises for large muscle groups, including the abdominal, low back, and lower-extremity muscles, are included (Appendix 1).

Coordination

Coordination exercises are included throughout the program because they may be useful in the prevention of falls and for improved performance of ADL tasks.[47] Activities of daily living include balance and coordination tasks.[47,48]

Duration

Increments in physical performance with supervised exercise training programs performed 2 or 3 times weekly were previously reported.[4] Shepard and Balady[49] stated that the optimal frequency of exercise sessions for patients with heart disease is 3 times per week, whereas Bompa[48] recommended a minimum of 2 sessions per week. We elected to offer the training sessions twice per week and encouraged the patients to undertake additional moderate-intensity activities, such as brisk walking, once or twice per week. The duration of the training session was 50 minutes and included relaxation (with instrumental music) (Appendix 2). In contrast to ordinary aerobic dance classes, in which beat counting and choreographed movement patterns are essential, in the Norwegian Ullevaal Model the number of repetitions (of each exercise) depends on the skills of the patients. This model has been described as a freestyle model.[42] The benefit of a freestyle model is that the amounts of time required to teach (drill) exercises, to observe patients, and to adjust exercises are minimized. The disadvantage of a freestyle model is that the potential type and pace of the music are not used to full advantage.

Counseling Period

According to current guidelines,[4] cardiac rehabilitation should also include patient education or counseling. Counseling, either separate or as a component of a cardiac rehabilitation program, has been shown to improve psychological well-being and is recommended to complement the psychosocial benefits of exercise training.[4] How to cope with CHF and how to manage everyday social problems and events were discussed by group members during the counseling period in this program. A physical therapist, a nurse specializing in CHF, a cardiologist, or a dietician counseled patients on a variety of topics and encouraged group members to join in the discussions. Counseling topics were medicine, diet, and life-style, and patients were encouraged to continue the exercises after the rehabilitation period. Each counseling session in the program lasted 15 to 30 minutes. Patients with CHF were also offered individual counseling with a nurse specializing in CHF regarding special issues related to medicine, adherence, and psychological issues.

Group-based Model

A group-based exercise model benefits from the interactive and social processes described by Bandura's social learning theory.[50] Observational learning, imitation, and modeling are significant factors in interactive group processes. Furthermore, positive feedback, perception of success, and expectation of success are important. Groups consisting of people with something in common (eg, age and heart disease) yield positive social relationships in addition to increased motivation for physical activities and the development of a new network.[51] A patient's mental and physical condition on any given day should be monitored. Furthermore, it is important for physical therapists to observe patient behavior and how patients manage the dyspnea and fatigue attributable to their low exercise capacity. Patients with CHF need higher levels of motivation, positive feedback regarding progression, and individual counseling during exercise training.[52]

Safety and Specific Criteria for Patients With CHF

Three main factors need to be addressed to ensure patient safety during training sessions. First, a patient's exercise capacity must be tested prior to inclusion in the rehabilitation program. The ECG, exercise capacity, heart rate, and blood pressure responses are important parameters in patient selection.[53] At Ullevaal University Hospital, all tests are conducted until symptom limitation is reached, with testing on an electrically braced stationary bicycle performed under the supervision of a cardiologist. The workload is increased from 30 W stepwise by 10 W every minute,[25] as recommended by the European Working Group Report.[18] A minimum of 50 W should be reached for a patient to be

Table.
Scores and Percent Changes in Physical Capacity and Quality of Life at Baseline (Pre) and After 4 Months of the Exercise Program (Post)

Test[a]	Patient 1			Patient 2			Patient 3			Patient 4		
	Pre	Post	% Change	Pre	Post	% Change	Pre	Post	% Change	Pre	Post	% Change
Six-minute walk test (m)	250	367	32	433	499	13	388	523	25	429	572	25
Workload (s)	210	253	17	364	483	25	209	434	52			
Workload (W)	50	60	17	80	100	20	50	90	44			
MHLF Questionnaire score	65	23	65	26	18	31	52	34	35	59	6	90
Peak RPP (mm Hg/min)	13,500	17,820	24	20,510	27,750	26	9,880	20,618	52			

[a] Workload was measured during cycle ergometer testing. MLHF=Minnesota Living With Heart Failure (a high score indicates a lower quality of life; maximum score=105), RPP=rate-pressure product (systolic blood pressure × heart rate).

included in the exercise group. The 6MWT[28] is also performed to assess patient functional capacity, and a minimum of 250 m should be reached for a patient to qualify for the exercise group.

The exercise program is supervised by a specialized physical therapist who has training in exercise physiology, cardiology, counseling in group exercises, how to include music in aerobic classes, and first aid (cardiopulmonary resuscitation). A nurse specializing in CHF also joins the exercise classes as part of the interdisciplinary observation and to summon a rescue team if resuscitation is needed. All staff members are trained in cardiopulmonary resuscitation. A defibrillator and resuscitation equipment are not available in the exercise room but are located in the nearest hospital ward.

Finally, the physical therapist teaches the patients how to monitor their perceived exertion with the Borg Scale,[36] continuously stressing the importance of each patient monitoring his or her own physical capacity.[51,54] In patients with CHF, oxygen consumption during walking, reflecting exercise capacity, is 35% to 40% lower than that observed in age-matched healthy people.[55] Furthermore, patients with NYHA class III CHF usually reach 15 (hard) to 18 (very hard) on the Borg Scale within a few minutes of brisk walking or knee lift exercises.

Outcomes

All 4 patients in this case report showed improved physical capacity and quality of life after 32 hours of exercise (16 weeks) with the group-based aerobic interval training (Figure). The results of the treatment outcome measurements for these 4 patients are shown in the Table.

Patient 1 needed a few weeks before he was comfortable with the exercise model. He was advised to stop if he felt dizzy or had undue dyspnea, angina, or other significant pain. For the first 10 to 12 hours of exercise, he did not follow the strengthening exercises on the floor because of dyspnea, and he did not exercise hard (toward 15 on the Borg Scale). He came every week, and after 6 weeks he was able to reach a perceived exertion of 17 on the Borg Scale. His maximal measured heart rate during high-intensity exercise was 125 bpm. At postexercise testing, his peak heart rate was 134 bpm and his blood pressure was 133/77 mm Hg, with a peak RPP of 17,822 mm Hg/min during cycle ergometer testing. He occasionally had some beats with atrial fibrillation. His medications were not changed during the exercise period. He also reported that he had started to exercise (brisk walking) with his wife several times per week.

Patient 2 was a very positive man with a good sense of humor. He had some problems with coordination, but he was able to reach a perceived exertion of 18 on the Borg Scale after a few weeks. He missed only one session because of a cold. After 3 weeks he had some problems with dyspnea and edema and had to increase his dose of furosemide, with a good effect. His maximal heart rate during high-intensity exercise was 129 bpm. At postexercise testing, his peak heart rate was 134 bpm and his blood pressure was 133/77 mm Hg, with a peak RPP of 17,822 mm Hg/min during cycle ergometer testing. After the exercise model was completed, he reported that he continued a group-based exercise program organized by physical therapists in his home district.

Patient 3 also needed a few weeks to participate actively in the high-intensity exercise. He was extremely passive prior to inclusion in the exercise model but was able to reach a perceived exertion of 17 on the Borg Scale (without much activity). His main problem was bouts of perspiration, a side effect of the medication amiodarone. His medications were not changed during the exercise period. His maximum heart rate during high-intensity exercise was 96 bpm. At postexercise testing, his peak heart rate was 122 bpm and his blood pressure was 169/77 mm Hg, with a peak RPP of 20,618 mm Hg/min during cycle ergometer testing. After the exercise model was completed, he continued a group-based exercise program organized by the National Heart and Lung Association.

Patient 4 enjoyed the program and, after 4 weeks with exercise, returned to working part time. After completing the exercise model, he returned to full-time work. He missed 4 exercise sessions because of work; however, his main goal was to return to work. Six weeks into the program, his pacemaker was adjusted, and his maximal heart rate was 130 bpm during high-intensity exercise. His medications were not changed during the exercise period. Because of his pacemaker, he measured his heart rate only on the radial artery. He reached 18 on the Borg Scale during the first training session, but after 12 weeks his perceived exertion was 12 to 14 on the Borg Scale, probably because he had reached a higher exercise capacity. He needed extensive feedback and felt very safe about exercising in the group.

Discussion

The primary aim of this report was to describe a group-based aerobic interval-training program for patients with CHF, a model that was not previously reported in the literature. Group-based aerobic interval training gives patients with different exercise capacities continuous supervision during the important start-up months of rehabilitation. Patients learn how to monitor their own intensity level and, through group interactions, learn more about lifestyle behavior (coping) and how to improve their overall well-being.

All patients in the present case report had severe CHF. Two patients had atrial fibrillation (patients 1 and 3), and patient 4 had a pacemaker. Nevertheless, they responded positively to the group-based aerobic interval-training program, increasing their physical capacity, learning to monitor their intensity level, and improving their quality of life (MLHF Questionnaire). However, RCTs are needed to compare different models and the effects of high-intensity interval-exercise programs for patients with CHF.

Aerobic Interval Training

The high-intensity interval model was chosen because of extensive experience with this model for patients with coronary artery disease at Ullevaal University Hospital. In addition, Wisloff et al reported superior results for high-intensity interval models in animals[39] and patients with CHF.[19] The interval model is better suited to increasing aerobic capacity and is more effective in economizing cardiac function than models involving continuous exercise. Aerobic interval training[56–58] allows rest between exercise peaks with decreased total cardiac stress and, consequently, allows patients with compensated CHF to complete short exercise periods at a higher intensity than would be possible with a continuous-exercise model.[59] There is no gold standard for the optimal intensity for exercise training in patients with CHF, but Pina et al proposed a minimum of 13 to 15 out of 20 on the Borg Scale.[17] However, there is still a debate regarding the level of intensity and model of exercise that can provide optimal effects for patients with CHF.[60] The intensity in the Norwegian Ullevaal Model is similar to that in the high-intensity treadmill-walking model reported in studies by Wisloff et al[19] and Warburton et al.[41] In the model of Wisloff et al,[19] patients who exercised at 90% to 95% of their peak heart rate had a significantly higher peak maximal oxygen consumption value than did patients who exercised at moderate intensity (increased 46% versus 14%). This treadmill model was an individually tailored exercise program in which the number of treadmills available at the rehabilitation center restricted the number of patients training at the same time in a clinical setting. Other potential limitations of treadmill exercise are that treadmills are expensive to run and it is also probably rather boring to exercise on a treadmill for years. Other published exercise models have required attendance 3 to 6 times per week,[10,61,62] a goal that may not be possible outside of a research setting. Because the goal is for patients to continue with regular exercises, enjoyment, comfort, and safety during the exercises are important. Our model includes each of these aspects. Another aspect is that this kind of training is available in society and can be adjusted to fit patients with specific needs.

It is important to give patients time to participate actively in the high-intensity intervals and not push too hard in the beginning of the rehabilitation program. Many patients with CHF have not exercised for years, and they need to feel safe before they can reach an intensity level of 15 to 18 on the Borg Scale. Our exercise groups continue to include new patients as they are referred from a cardiologist or a physician. The "older" patients work as models for the new patients.[51]

Group-based Model

Ståhle[63] described the use of a model similar to the Norwegian Ullevaal Model for elderly patients discharged after an acute coronary syndrome. To our knowledge, the model of Ståhle[63] is not used for patients with CHF but rather for elderly people with coronary artery disease and with a higher baseline exercise capacity. In the model of Ståhle,[63] patients are encouraged to reach an exertion of 13 to 15 out of 20 on the Borg Scale. Furthermore, that exercise model is not an interdisciplinary approach and does not include counseling.

The most important factors in a group-based model are the skill and knowledge of the physical therapist as an instructor of the exercise session and the patient's motivation regarding adherence. Making exercise training safe, positive, and enjoyable requires a sensitive and committed individual.[64] Davidson and Maloney[37] described the power of example provided by the instructor as the most important feature in any cardiac recovery program. Five attributes are critical to successful leadership: physical appearance, educational background, behavioral attitude, emotional perspective, and personal resources.

Limitations

A potential limitation in the present case report is the absence of individual patient goals. Before participation in the exercise model, however, all patients participated in an individual consultation with a cardiologist and a physical therapist in which the aims of the intervention were presented.

The number of patients in this case report was small and precludes any inference about the safety of the high-intensity portion of the program. However, some studies have indicated more favorable results with high-intensity interval training (even in patients with CHF[19]), but only an RCT can produce experimental evidence for the efficacy of the treatment approach that we suggest.

Another limitation of the group-based exercise model is apparent from a comparison with an individualized training model. Patients with an exercise capacity higher than that of an average group of patients have to be motivated to walk faster or to do more exercises with their arms to reach 15 to 18 on the Borg Scale. It is important for physical therapists to be aware of the characteristics of individual patients to guide them to their optimal intensity levels.

Conclusion

In the present case report, 4 individuals with NYHA class III CHF achieved improvements in physical capacity and quality of life in response to participation in a group-based, high-intensity, interval-training program that included aerobic, resistance, flexibility, and balance activities. However, RCTs are needed to investigate the efficacy of group-based aerobic interval-training protocols in comparison with the efficacy of individualized programs as well as safety issues.

Ms Nilsson, Ms Hellesnes, and Dr Westheim provided concept/idea/project design. All authors provided writing. Ms Nilsson and Dr Westheim provided data collection. Ms Nilsson and Dr Risberg provided data analysis. Dr Westheim provided project management, patients, and institutional liaisons. Dr Westheim and Dr Risberg provided fund procurement. Ms Hellesnes and Dr Westheim provided consultation (including review of manuscript before submission).

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The treatment program was carried out according to the Helsinki Declaration and was approved by the regional medical research ethics committee.

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References

1 Aronow WS. Epidemiology, pathophysiology, prognosis, and treatment of systolic and diastolic heart failure. *Cardiol Rev.* 2006;14:108–124.

2 Hunt SA, Baker DW, Chin MH, et al. ACC/AHA guidelines for the evaluation and management of chronic heart failure in the adult: executive summary. *J Heart Lung Transplant.* 2002;21:189–203.

3 Guidelines for the evaluation and management of heart failure. Report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (Committee on Evaluation and Management of Heart Failure). *J Am Coll Cardiol.* 1995;26:1376–1398.

4 Wenger NK, Froelicher ES, Smith LK, et al. Cardiac rehabilitation as secondary prevention. Agency for Health Care Policy and Research and National Heart, Lung, and Blood Institute. *Clin Pract Guidel Quick Ref Guide Clin.* 1995; Oct:1–23.

5 Kavanagh T, Mertens DJ, Hamm LF, et al. Prediction of long-term prognosis in 12,169 men referred for cardiac rehabilitation. *Circulation.* 2002;106:666–671.

6 Van Camp SP, Peterson RA. Cardiovascular complications of outpatient cardiac rehabilitation programs. *JAMA.* 1986;256: 1160–1163.

7 Rees K, Taylor RS, Singh S, et al. Exercise-based rehabilitation for heart failure. *Cochrane Database Syst Rev.* 2004;(3): CD003331.

8 McKelvie RS, Teo KK, Roberts R, et al. Effects of exercise training in patients with heart failure: the Exercise Rehabilitation Trial (EXERT). *Am Heart J.* 2002;144:23–30.

9 Willenheimer R, Erhardt L, Cline C, et al. Exercise training in heart failure improves quality of life and exercise capacity. *Eur Heart J.* 1998;19:774–781.

10 Hambrecht R, Gielen S, Linke A, et al. Effects of exercise training on left ventricular function and peripheral resistance in patients with chronic heart failure: a randomized trial. *JAMA.* 2000;283:3095–3101.

11 Meyer K. Exercise training in heart failure: recommendations based on current research. *Med Sci Sports Exerc.* 2001;33:525–531.

12 Meyer K, Schwaibold M, Westbrook S, et al. Effects of short-term exercise training and activity restriction on functional capacity in patients with severe chronic congestive heart failure. *Am J Cardiol.* 1996;78:1017–1022.

13 Smart N, Fang ZY, Marwick TH. A practical guide to exercise training for heart failure patients. *J Card Fail.* 2003;9:49–58.

14 Astrand I, Astrand PO, Christensen EH, et al. Intermittent muscular work. *Acta Physiol Scand.* 1960;48:448–453.

15 Fox EL, Robinson S, Wiegman DL. Metabolic energy sources during continuous and interval running. *J Appl Physiol.* 1969; 27:174–178.

16 Billat LV. Interval training for performance: a scientific and empirical practice—special recommendations for middle- and long-distance running. Part I: aerobic interval training. *Sports Med.* 2001;31:13–31.

17 Pina IL, Apstein CS, Balady GJ, et al. Exercise and heart failure: a statement from the American Heart Association Committee on Exercise, Rehabilitation, and Prevention. *Circulation.* 2003;107:1210–1225.

18 Working Group Report. Recommendations for exercise training in chronic heart failure patients. *Eur Heart J.* 2001;22:125–135.

19 Wisloff U, Stoylen A, Loennechen JP, et al. Superior cardiovascular effect of aerobic interval training versus moderate continuous training in heart failure patients: a randomized study. *Circulation.* 2007; 115:3086–3094.

20 Gottlieb SS, Fisher ML, Freudenberger R, et al. Effects of exercise training on peak performance and quality of life in congestive heart failure patients. *J Card Fail.* 1999;5:188–194.

21 Wielenga RP, Huisveld IA, Bol E, et al. Safety and effects of physical training in chronic heart failure: results of the Chronic Heart Failure and Graded Exercise Study (CHANGE). *Eur Heart J.* 1999; 20:872–879.

22 Cress ME, Buchner DM, Prohaska T, et al. Best practices for physical activity programs and behavior counseling in older adult populations. *J Aging Phys Act.* 2005;13:61–74.

23 Nilsson BB. *Effekten av Trening Etter Ullevålsmodellen hos Pasienter med Kronisk Hjertesvikt* [master's thesis]. Oslo, Norway: Norges Idrettshøgskole; 2005.

24 Nilsson BB, Holst Hansen C, Simonsen H, et al. Increased exercise capacity and quality of life in patients with chronic heart failure participating in an organized training and special care program. In: Proceedings of the 2003 Congress of the European Society of Cardiology; August 30–September 3, 2003; Vienna, Austria.

25 Jonsson B, Aström H. Determination of work capacity in heart patients [in Swedish]. *Lakartidningen.* 1976;73:216–219.

26 Gobel FL, Norstrom LA, Nelson RR, et al. The rate-pressure product as an index of myocardial oxygen consumption during exercise in patients with angina pectoris. *Circulation.* 1978;57:549–556.

27 Guyatt GH, Sullivan MJ, Thompson PJ, et al. The 6-minute walk: a new measure of exercise capacity in patients with chronic heart failure. *Can Med Assoc J.* 1985;132:919–923.

28 Cahalin LP, Mathier MA, Semigran MJ, et al. The six-minute walk test predicts peak oxygen uptake and survival in patients with advanced heart failure. *Chest.* 1996;110:325–332.

29 Delahaye N, Cohen-Solal A, Faraggi M, et al. Comparison of left ventricular responses to the six-minute walk test, stair climbing, and maximal upright bicycle exercise in patients with congestive heart failure due to idiopathic dilated cardiomyopathy. *Am J Cardiol.* 1997;80:65–70.

30 Enright PL. The six-minute walk test. *Respir Care.* 2003;48:783–785.

31 Rector TS, Kubo, SH, Chon JN. Patients' self-assessment of their congestive heart failure, part 2: content, reliability and validity of a new measure, The Minnesota Living With Heart Failure Questionnaire. *Heart Failure.* 1987;Oct/Nov:198–209.

32 Franzén K, Saveman BI, Blomqvist K. Predictors for health-related quality of life in persons 65 years or older with chronic heart failure. *Eur J Cardiovasc Nurs.* 2007;6:112–120.

33 Guyatt GH. Measurement of health-related quality of life in heart failure. *J Am Coll Cardiol.* 1993;22(4 suppl A):185A–191A.

34 Johannesson I, Holmsater J, Johansson A, et al. *Friskis & Svettis Motionsbok*. Stockholm, Sweden: Bokforlaget Prisma; 1984.

35 Dault MC, Dugas C. Evaluation of a specific balance and coordination programme for individuals with a traumatic brain injury. *Brain Inj.* 2002;16:231–244.

36 Borg GA. Psychophysical bases of perceived exertion. *Med Sci Sports Exerc.* 1982;14:377–381.

37 Davidson DM, Maloney CA. Recovery after cardiac events. *Phys Ther.* 1985;65: 1820–1827.

38 Gibbons RJ, Balady GJ, Bricker JT, et al. ACC/AHA 2002 guideline update for exercise testing: summary article—a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (Committee to Update the 1997 Exercise Testing Guidelines). *Circulation.* 2002;106:1883–1892.

39 Wisloff U, Loennechen JP, Currie S, et al. Aerobic exercise reduces cardiomyocyte hypertrophy and increases contractility, Ca^{2+} sensitivity and SERCA-2 in rat after myocardial infarction. *Cardiovasc Res.* 2002;54:162–174.

40 Rognmo O, Hetland E, Helgerud J, et al. High-intensity aerobic interval exercise is superior to moderate-intensity exercise for increasing aerobic capacity in patients with coronary artery disease. *Eur J Cardiovasc Prev Rehabil.* 2004;11:216–222.

41 Warburton DE, McKenzie DC, Haykowsky MJ, et al. Effectiveness of high-intensity interval training for the rehabilitation of patients with coronary artery disease. *Am J Cardiol.* 2005;95:1080–1084.

42 Bø K, Kamhaug E-L. *Gymnastikk i Tiden. Det Beste fra Aerobics.* Oslo, Norway: Universitetsforlaget; 1989.

43 American College of Sports Medicine Position Stand. The recommended quantity and quality of exercise for developing and maintaining cardiorespiratory and muscular fitness, and flexibility in healthy adults. *Med Sci Sports Exerc.* 1998;30:975–991.

44 Fletcher GF, Balady G, Froelicher VF, et al. Exercise standards: a statement for healthcare professionals from the American Heart Association. Writing Group. *Circulation.* 1995;91:580–615.

45 Kell RT, Bell G, Quinney A. Musculoskeletal fitness, health outcomes and quality of life. *Sports Med.* 2001;31:863–873.

46 Pollock ML, Franklin BA, Balady GJ, et al. AHA Science Advisory. Resistance exercise in individuals with and without cardiovascular disease: benefits, rationale, safety, and prescription—an advisory from the Committee on Exercise, Rehabilitation, and Prevention, Council on Clinical Cardiology, American Heart Association; position paper endorsed by the American College of Sports Medicine. *Circulation.* 2000;101:828–833.

47 Wong AM, Lin YC, Chou SW, et al. Coordination exercise and postural stability in elderly people: effect of Tai Chi Chuan. *Arch Phys Med Rehabil.* 2001;82:608–612.

48 Bompa TO. *Periodization: Theory and Methodology of Training*. Champaign, Ill: Human Kinetics; 1999.

49 Shepard RJ, Balady GJ. Exercise as cardiovascular therapy. *Circulation.* 1999;99:963–972.

50 Bandura A. *Social Foundations of Thought and Action: A Social Cognitive Theory*. Englewood Cliffs, NJ: Prentice-Hall; 1986.

51 Mæland JG. *Helhetlig Hjerterehabilitering*. Oslo, Norway: Høyskoleforlaget; 1995.

52 McConnell TR. A review to develop an effective exercise training for heart failure patients. *Eura Medicophys.* 2005;41:49–56.

53 Erikssen G, Bodegard J, Erikssen J. Exercise ECG [in Norwegian]. *Tidsskr Nor Laegeforen.* 2004;124:339–341.

54 Hare DL, Fitzgerald H, Darcy F, et al. Cardiac rehabilitation based on group light exercise and discussion: an Australian hospital model. *J Cardiopulm Rehabil.* 1995;15:186–192.

55 Sullivan MJ, Knight JD, Higginbotham MB, et al. Relation between central and peripheral hemodynamics during exercise in patients with chronic heart failure: muscle blood flow is reduced with maintenance of arterial perfusion pressure. *Circulation.* 1989;80:769–781.

56 Maiorana A, O'Driscoll G, Cheetham C, et al. Combined aerobic and resistance exercise training improves functional capacity and strength in CHF. *J Appl Physiol.* 2000;88:1565–1570.

57 Meyer K, Gornandt L, Schwaibold M, et al. Predictors of response to exercise training in severe chronic congestive heart failure. *Am J Cardiol.* 1997;80:56–60.

58 Hedback B, Perk J. Can high-risk patients after myocardial infarction participate in comprehensive cardiac rehabilitation? *Scand J Rehabil Med.* 1990;22:15–20.

59 Smart N, Marwick TH. Exercise training for patients with heart failure: a systematic review of factors that improve mortality and morbidity. *Am J Med.* 2004;116:693–706.

60 Fletcher GF, Balady GJ, Amsterdam EA, et al. Exercise standards for testing and training: a statement for healthcare professionals from the American Heart Association. *Circulation.* 2001;104:1694–1740.

61 Meyer K, Samek L, Schwaibold M, et al. Interval training in patients with severe chronic heart failure: analysis and recommendations for exercise procedures. *Med Sci Sports Exerc.* 1997;29:306–312.

62 Coats AJ, Adamopoulos S, Radaelli A, et al. Controlled trial of physical training in chronic heart failure: exercise performance, hemodynamics, ventilation, and autonomic function. *Circulation.* 1992;85:2119–2131.

63 Ståhle A. *Physical Fitness and Quality of Life in Elderly Patients Recovering from an Acute Coronary Event: a Randomised Controlled Study on the Effects of Aerobic Group Training* [PhD thesis]. Stockholm, Sweden: Karolinska Institutet; 1999.

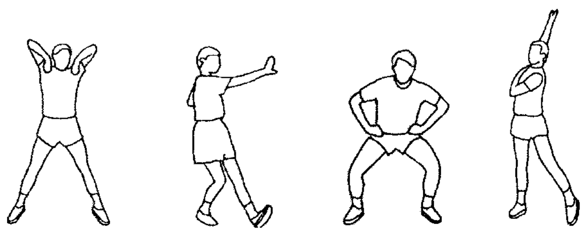
64 Oldridge N, Foster C, Schmidt DH. *Cardiac Rehabilitation and Clinical Exercise Programs: Theory and Practice*. Ithaca, NY: Movement Publications Inc; 1988.

Appendix 1.

Examples of Some Exercises in the Group-based Aerobic Interval-Training Program[a]

Exercises During Warm-up Period (Songs 1 and 2)

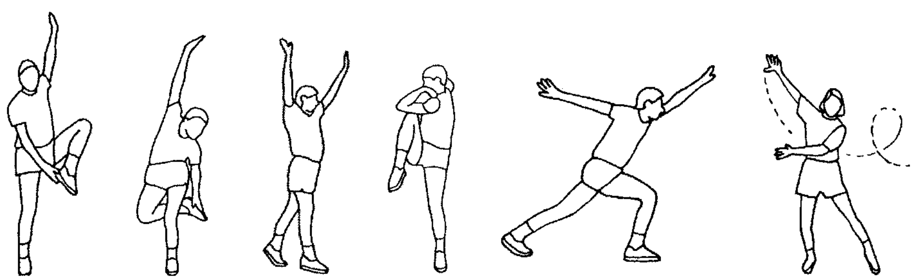
- Shoulder circle exercises (Fig. C1)
- Hip circle exercises
- Arm circle exercises
- Marching on the spot: progression including arm movements
- Arm swing exercises
- Stationary walking: alternate heel touches in front of the body (Fig. C2)
- Squats (Fig. C3)
- Thorax stretch exercises (Fig. C4)



C1 C2 C3 C4

Exercises During High-Intensity Periods

- Walking in a circle with different arm movements
- Twisting the body exercises
- Knee lift and clap exercises
- Heel touches, front and back (Figs. C5 and C6)
- Lateral walking
- Walking exercises with overhead arm reaches (Fig. C7)
- Knee lift with arms (Fig. C8)
- Alternating forward lunge with arms (Fig. C9)
- Swing and flex exercises including large arm movements (Fig. C10)



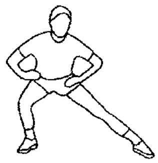
C5 C6 C7 C8 C9 C10

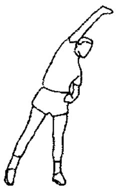
(Continued)

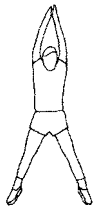
Appendix 1.
Continued

Exercises During Flexibility Periods

- Shoulder, hip, and arm circle exercises
- Lateral lunge (Fig. C11)
- Lateral trunk stretch (Fig. C12)
- Exercises using arm movements and including breathing (inhaling while raising arms, exhaling while lowering arms) (Fig. C13)

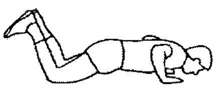

C11


C12

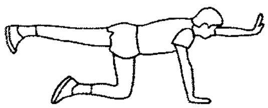

C13

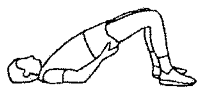
Exercises During Strength (Calisthenics) Periods

- Modified push-ups on flexed knees (Fig. C14)
- Curl-up exercises (Fig. C15)
- Side lying: leg lift exercises
- Quadruped exercises: diagonal arm and leg lifts (Fig. C16)
- Bridging (Fig. C17)
- Bicycle exercises (supine position)
- Prone latissimus dorsi muscle exercises (Figs. C18 and C19)


C14


C15


C16


C17


C18


C19

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Appendix 2.

Duration and Music Pace for Each Song in the Group-based Aerobic Interval-Training Model (Norwegian Ullevaal Model) for Patients With Chronic Heart Failure[a]

Song (min:s)	Exercises	Music Pace (Beats per Minute)
1 (3:30)	Warm-up and flexibility exercises	88–100
2 (4:00)	Stationary exercises of moderate intensity	96–100
3 (3:00)	Walking exercises	104
4 (2:30)	Stationary exercises of high intensity	120–124
5 (4:15)	Flexibility exercises	68
6 (5:00)	Strength exercises	52
7 (3:45)	Exercises done while sitting on the floor	104
8 (3:15)	Stationary exercises of high intensity	120
9 (2:45)	Swing and flex exercises	120
10 (2:50)	Flexibility exercises	68
11 (4:00)	Strength exercises	52
12 (3:40)	Stationary exercises of high intensity	116–120
13 (3:00)	Stationary exercises of high intensity and brisk walking	124
14 (4:00)	Slow walking and cool-down	96–100
15 (3:00)	Relaxation	

[a] For specific exercises, see Appendix 1. High intensity is 15 to 18 on the Borg Scale. Total duration of songs was 52.5 min.

Appendix 3.

Music Pace During Different Types of Exercises Included in the Group-based Aerobic Interval-Training Program[a]

Types of Exercises	Music Pace (Beats per Minute)
Flexibility exercises	48–68
Strength exercises	52–96
Stationary exercises of moderate intensity	92–124
Stationary exercises of high intensity	124–144
Running (not used in program for patients with chronic heart failure)	144–172
Walking exercises	96–108

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