Exercise Prescription Techniques in Cardiac Rehabilitation Centers in Midwest States

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ABSTRACT

Introduction: Cardiac rehabilitation (CR) is a primary prescribed treatment for a variety of cardiovascular disease states, including: coronary artery disease, percutaneous coronary intervention (PCI), coronary artery bypass graft (CABG), myocardial infarction (MI), and heart failure. For this reason, exercise prescription guidelines for cardiac patients have been established. However, it is unclear how these guidelines are being administered at cardiac rehabilitation centers. The purpose of this study is to assess current exercise prescription techniques at cardiac rehabilitation clinics across several Midwest states in the United States.

Methods: Fifty-eight CR programs from Michigan, Indiana, Illinois, Minnesota, Wisconsin, and Ohio were administered a questionnaire assessing clinic characteristics, aerobic and resistance exercise prescription techniques.

Results: Most reported patient types were PCI, CABG, and MI. Clinical exercise physiologists were the primary exercise prescription writers (81%). Only 32% of the clinics required a clinical certification. Baseline stress tests prior to CR were performed in 33% of programs. Rating of Perceived Exertion (RPE) was the most commonly used indicator of exercise intensity, followed by heart rate reserve (HRR), and METs. Resistance exercise was practiced in 89% of CR programs. The most common intensity indicator was trial and error, and RPE.

Conclusion: Results demonstrate exercise prescription variability among CR programs. This emphasizes the complexity and expertise among clinical exercise physiologists. These results also highlight the importance that academic programs place on training students across all prescription techniques, and utilization of research-based prescription guidelines published by professional organizations. *Journal of Clinical Exercise Physiology*. 2018;7(1):8–14.

Keywords: cardiovascular disease, aerobic exercise, resistance exercise

INTRODUCTION

Since the 1950s, cardiac rehabilitation (CR) programs have been developed and offer a comprehensive cardiovascular disease (CVD) intervention process that integrates risk factor management, pharmacological prescription adherence strategies, psychosocial support, stress management, functional capacity testing, exercise counseling, and prescriptions. These strategies facilitate the restoration, progression, and maintenance of patient functionality, sociability, psychological well-being, and health-related quality of life. A recent meta-analysis indicated that 36 sessions of cardiac rehabilitation reduces hospital readmissions and improves health-related quality of life in patients with stable heart failure and coronary heart disease (1). Furthermore, at 12 months or more follow-up from rehabilitation, there is a reduction in mortality among patients with coronary heart disease (1) and continued improvement in functional capacity among those with heart failure (2).

Leading organizations such as the American Association of Cardiovascular and Pulmonary Rehabilitation (AACVPR), the American College of Sports Medicine

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(ACSM), and the American Heart Association (AHA) have developed recommendations and guidelines for cardiac rehabilitation programs to treat the diverse CVD patient groups. However, the extent to which such guidelines and recommendations are being followed by cardiac rehabilitation clinics has not been fully evaluated. Many recommendations and guidelines developed by such scientific organizations are taught to higher education students who aim to work in cardiac rehabilitation facilities postgraduation (e.g., clinical exercise physiologists). It is important to understand common practices occurring within CR programs and match the knowledge, skills, and abilities to those being taught to our students. The practices identified in the current study include exercise intensity settings (e.g., percent heart rate reserve [%HRR], rating of perceived exertion [RPE], oxygen uptake reserve [VO_2R]), initial target exercise intensity, functional capacity goals, modes of exercise, certification requirements, interval exercise, and resistance training practices. Overall, there is lack of data regarding practices common to all programs in CR. Therefore, the purposes of this observational study were to determine if current exercise prescription guidelines are being followed and to provide better training/education for clinical students.

METHODS

A questionnaire was modified based upon a similar research study conducted among Dutch CR programs (3). Cardiac rehabilitation clinicians from 58 phase II facilities across the states of Illinois, Indiana, Michigan, Minnesota, Ohio, and Wisconsin completed the questionnaire over the phone. The cardiac rehabilitation sites were identified based on whether they provided educational internships to undergraduate and graduate university students and whether or not they were certified by AACVPR. The clinicians from each site held supervisory level positions or were responsible for writing the exercise prescriptions within the CR programs at the respective organizations. The questionnaire is provided in Table 1.

TABLE 1. Clinical exercise questionnaire.

Clinical Characteristics
1. Please describe your patient population.
2. Are heart failure patients currently being admitted into your program?
3. How many training sessions are scheduled for each patient prior to the start of their cardiac rehabilitation program?
4. What is the graduation rate at your facility?
5. What is the functional capacity goal at the end of the rehabilitation program?
6. Are baseline stress tests performed before the exercise prescription is written?
7. Who is writing the exercise prescription for the cardiac rehabilitation patients?
8. Do you require that your clinicians have a certification?
Aerobic Exercise Prescription
1. How often is aerobic exercise performed each week for each patient?
2. How is the intensity for aerobic training prescribed (select all that apply)?
3. How is intensity prescribed in the absence of a baseline exercise test?
4. How long does each aerobic training session last (minutes)?
5. What types of training modes are used for aerobic exercise (check all that apply)?
6. Which type of training is used for aerobic exercise?
7. How are patients progressed throughout their program?
Resistance Exercise Prescription
1. Is strength training being performed at your facility?
2. How many strength-training sessions are performed each week?
3. How is training intensity determined?
4. On average, how many sets are performed for each strength exercise?
5. On average, how many strength exercises are performed each session?
6. What type of resistance training is used?

Statistical Analysis

The questionnaire data were analyzed using descriptive statistics (frequency, counts, percentages, means, and ranges). Comparison statistics were not performed. The data presented is for descriptive purposes only.

RESULTS

In some analyses, combined percentages exceed 100% if clinics had multiple responses to questions.

Clinical Characteristics

Patients who had received a percutaneous coronary intervention (PCI) were described as being the most common patient population to utilize cardiac rehabilitation, followed by those who had suffered a myocardial infarction (MI), then by those with coronary artery bypass graft (CABG) (see Table 2 for clinical characteristics data). Very few clinics reported patients with valve disease. All CR programs admitted patients with heart failure into their programs. The number of exercise training sessions scheduled prior to the start of the CR programs ranged from 9 to 36 sessions, with the full 36 sessions coverage by Medicare occurring in 57% of CR programs.

Table 2 lists CR program characteristics. Almost 75% of enrolled patients graduated from phase II CR programs. Forty-four percent of CR programs set specific patient functional capacity (FC) goals upon graduation. Exercise prescriptions were written by clinical exercise physiologists (81%) in the majority of surveyed clinics. Other healthcare professionals writing prescriptions included nurses (56%), respiratory therapists (12%), and other clinicians (18%). The "other clinicians" category included cardiologists, physical therapists, and those described as exercise therapists or exercise technicians. Further, 68% of CR programs did not require their clinicians to have a certification from an established clinical agency (i.e., ACSM, AACVPR). Performing baseline stress tests before writing an exercise prescription

TABLE 2. Cardiac rehabilitation program characteristics.

Characteristic	Results
Most reported patient group (ranked order)	1) PCI, 2) MI, 3) CABG, 4) Valve
Enrolling heart failure patients (percentage of clinics)	100% of clinics
Exercise training sessions (number) (average from all clinics)	36 sessions (n = 33, 57%), range 9–36 sessions
Graduation rate (completing all sessions) (average from all clinics)	73%, range 15%–95%
Graduation functional capacity goals	Other (n = 16, 28%), 3 METs (n = 4, 8%), 4 METs (n = 3, 4%), 2 MET improvement (n = 3, 4%), no defined goal (n = 32, 56%)
	Other included: 3–6 MET overall, 5 MET total, 1 MET
Performing baseline GXT prior to beginning rehabilitation (percentage of clinics)	Yes (n = 19), No (n = 39)
	Reason for not: physician's choice, cost, not helpful, or not common practice
Writing exercise prescriptions (percentage of clinics)	Clinical exercise physiologists (n = 47), nurses (n = 32), respiratory therapists (n = 7), other clinicians (n = 10)
	Note: percentages exceed 100% due to clinics having multiple clinicians prescribing exercise
Certification requirement (percentage of clinics)	Yes (n = 18), No (n = 40)

PCI = percutaneous coronary intervention; MI = myocardial infarction; CABG = coronary artery bypass graft; METs = metabolic equivalent of task; GXT = graded exercise test.

TABLE 3. Aerobic exercise prescription principles.

Prescription Principle	Techniques Reported in Percentage of Clinics
Frequency	*3 days per week (n = 56, 98%), 2 days per week (n = 11, 15%), 4–5 days per week (n = 3, 6%)
Intensity measure	*RPE (n = 49, 84%), HRR (n = 20, 34%), METs (n = 16, 27%), HRmax (n = 16, 27%), VO_2R (n = 2, 3%), combinations (n = 39, 67%)
	Combinations is more than one technique
Target intensity w/o stress	*11–14 RPE (n = 37, 64%), 20 b·min^{-1} above rest (n = 20, 34%), BP (n = 6, 10%), combinations (n = 29, 48%), other (n = 20, 34%)
	Other category included: 20–40 b·min^{-1} above rest, 85% HRmax, common sense, trial and error.
	Combinations is more than one intensity method (e.g., RPE + 20 b·min^{-1} above rest)
Duration	40 minutes (n = 24, 41%), 30 minutes (n = 17, 29%), 35–50 minutes (n = 13, 22%), 60 minutes (n = 4, 8%)
Mode	*Treadmill (n = 58, 100%), arm ergometer (n = 49, 85%), Nustep (n = 53, 91%), recumbent bike (n = 46, 79%), elliptical (n = 37, 67%), bike ergometer (n = 35, 61%), rower (n = 24, 42%), arch trainer (n = 12, 20%), stair stepper (n = 7, 12%).
Type	*Continuous (n = 57, 98%), Interval training (n = 40, 69%)
Progression	*Intensity (n = 54, 94%), duration (n = 49, 84%), Frequency (n = 5, 8%), progress into intervals (n = 14, 24%)

RPE = rating of perceived exertion; METs = metabolic equivalent of task; HRR = heart rate reserve; HRmax = percentage of maximal heart rate; BP = blood pressure; VO_2R = oxygen consumption reserve.
*Totals exceed 100% due to clinics reporting more than one response.

occurred in 33% of CR programs. Reasons for not performing baseline stress tests included doctor's choice, cost, and the test considered not helpful or not a common practice. Several clinics reported using the 6-minute walk test to evaluate fitness.

Aerobic Exercise Training

Table 3 presents information on aerobic training. Aerobic exercise training was prescribed 3 days per week in most CR programs, with some treating patients 2 days per week. The most frequently reported measure for aerobic exercise prescription was RPE; however, 67% of CR programs used more than one measurement to prescribe intensity. Other measures included %HRR, METs, and heart rate max. Target intensity ranges for first aerobic session were: 11–15 on the RPE scale (Borg scale); and 30%–80% for %HRR; 50%–85% for HRmax. When prescribing initial exercise intensity without performing a baseline stress test, the most common variable used was RPE (11–14). Other intensity markers used were 20 b·min^{-1} above resting HR, blood pressure, and many used combination prescription techniques. Thirty-four percent of clinics used other intensity measures, including 20–40 b·min^{-1}, 85% HRmax, common sense, and trial and error.

The reported durations of the aerobic training session, from most often to least often used, were 40 min, 30 min, between 30–50 min, and 60 min. All CR programs used treadmills with their patients along with other modes (see Table 3). Most programs used continuous aerobic training, and almost 70% utilized interval training. All CR programs progressed patients using a combination of intensity and duration. Only a few programs set calorie expenditure goals for their patients (not reported in Table 3).

Strength Exercise Training

Strength training (see Table 4) was used in most programs, with sessions performed 1 to 3 days per week. The majority of clinics used a trial-and-error approach for determining intensity with additional reported methods of RPE, and %1RM**.** Among the clinics that used RPE, intensity range was 11–15 (6–20 Borg scale; data not in Table 4). The range was 50%–80% for 1 RM (data not in Table 4). All CR programs monitored HR during strength-training exercise as well as blood pressure (BP) checked before and after exercise sessions. Few programs monitored BP during the session, citing monitoring only occurred if a BP reading was high during the earlier aerobic session or if the patient had hypertension. The most reported number of sets of resistance exercise was 1. All clinics reported a range between 6–12 exercises per session for their respective patients. Clinics used a variety of exercise equipment, which included free weights, elastic bands, resistance machines, and bodyweight exercises. All CR programs progressed patients by the amount of resistance being used in combination with RPE.

TABLE 4. Resistance exercise prescription principles.

Prescription Principle	Techniques Reported (Percentage of Clinics)
Prescribing resistance exercise	Yes (n = 52, 89%), No (n = 6, 11%)
Frequency	3 d/wk (n = 36, 58%), 2 d/wk (n = 20, 34%), 1 d/wk (n = 2, 3%)
Intensity methods	*Trial and error (56%), RPE (48%), % 1RM (3%)
Sets	One (n = 21, 36%), Two (n = 17, 29%), Three (n = 7, 13%), Other (n = 5, 8%) Other includes: set range 1–2 or no set requirement
Number of exercises	6–12 (n = 58, 100%)
Mode	*Free weights (n = 41, 71%), elastic bands (n = 27, 46%), resistance machines (n = 20, 34%), body weight (n = 2, 4%)

RPE = rating of perceived exertion; 1-RM = one-repetition maximum
*Totals exceed 100% due to clinics reporting more than one technique.

DISCUSSION

The extent to which guidelines and recommendations from professional organizations are being followed by exercise-based cardiac rehabilitation facilities has not been fully evaluated. The results of the current study demonstrate variability among exercise prescription methodology with the most reported marker for intensity of both aerobic and resistance exercise being RPE; however, most clinics used multiple intensity gauges. This highlights the importance of professional organizations setting guidelines using multiple techniques, and the reminder that undergraduate and graduate teaching programs should place emphasis on teaching exercise prescription in a variety of formats.

Clinical Characteristics

The Centers for Medicare and Medicaid Services (CMS) have recently expanded coverage for cardiac rehabilitation services to include those with stable chronic heart failure (4). Prior to this expansion, the CMS permitted coverage to beneficiaries who experienced one or more of the following: acute MI within the preceding 12 months, CABG, current stable angina pectoris, heart valve repair or replacement, PCI or coronary stenting, or a heart or heart-lung transplant (4). Studies show that utilization rates of cardiac rehabilitation programs are low for covered diagnoses such as MI or CABG (5) and for recent coverage expansion of stable chronic heart failure (6). Yet more studies that assess utilization rates of all currently covered diagnoses are needed. From our findings, post-PCI patients were described as the most common patient population at CR sites, followed by those who had suffered an MI, and then CABG patients. Encouragingly, all CR programs were treating patients with heart failure. Many factors have been identified as barriers to participating in CR, including logistics, age, gender, race, socioeconomic status, education level, and the presence of comorbidities (5). While these factors were not assessed in the current analysis, we found that the average graduation rate for the 58 CR programs was 73%, but the range was 15%–95%, further substantiating a lack of patient adherence to cardiac rehabilitation. Recently, Ades and colleagues (7) created a valuable roadmap outlining specific strategies for increasing cardiac rehabilitation participation to 70%, which would save an estimated 25,000 lives and prevent 180,000 hospitalizations. The framework for achieving this goal was centered on patient referral, enrollment, and adherence. Several adherence strategies were presented, such as incentives, text messaging, and gender-tailored programming. While the graduation rates reported in the current analysis reflect adherence, types of strategies employed to maintain patient attendance were not collected. In addition, both referrals and enrollment are unknown in the surveyed clinics.

Various healthcare professionals are involved in exercise-based cardiac rehabilitation. Our findings showed that clinical exercise physiologists are primarily involved with writing exercise prescriptions. Interestingly, 32% of the facilities require that their exercise staff obtain clinical certification from highly respected organizations such as ACSM or AACVPR. A large effort has been made by these organizations to establish set criteria and examinations to substantiate the positions of clinical exercise physiologists. In the United States, Louisiana is the only state that licenses clinical exercise physiologists as a means of governing the practices and define the scope of services provided to the public by clinical exercise physiologists (8). In the remaining 49 states, anyone can claim to be an exercise physiologist (8). In addition, ACSM has established undergraduate and

graduate educational program accreditation similar to that in other fields of study (e.g., physical therapy, physician assistant). An important indication for program success is students sitting for and passing certification exams. Based on this current study, additional efforts are needed to raise the level of training and certifying of clinical exercise personnel.

Graded exercise tests—often referred to as *stress tests*—may be used for diagnostic, prognostic, and therapeutic purposes (9). The importance of the stress test for cardiac rehabilitation is to accurately prescribe exercise intensity. We found that 67% of the CR facilities surveyed did not conduct a baseline stress test before writing an exercise prescription. Reasons for not performing baseline stress tests included physician's choice, cost, and that it was considered not helpful or not a common practice. Failure of being reimbursed may also be reason for not performing baseline stress tests. Those eligible for CR programs are often at high-risk, so it was surprising to find so many CR facilities not performing baseline stress tests. Disparities among facilities could be due to the influence of organizational internal factors. Ideally, to accurately assess the safety and effectiveness of an exercise prescription, a test-retest methodology is needed.

Subsequently, if a baseline stress test is not conducted prior to developing an exercise prescription, other measurements could potentially be used to establish exercise workload. Among the clinics surveyed, RPE (most commonly used), 20 $b \cdot min^{-1}$ above resting HR, ≥85% of age predicted maximal heart rate, blood pressure, common sense, and trial and error were being used. Variability exists due to multitude of patient types (e.g., CABG, MI, PCI), characteristics (e.g., age, health history), and condition (e.g., exercise tolerance, exercise history). Therefore, it is essential to train exercise clinicians in a variety of prescription techniques in the absence of a baseline stress test.

Aerobic Exercise Training

Various strategies are used to monitor exercise training prescriptions, often based on frequency, intensity, duration (time), type, volume, and progression—also known as *FITT-VP principle* (9). We found that all CR facilities used standard thresholds specified within FITT-VP guidelines. All CR programs prescribed exercise sessions 3 times per week. Sessions typically lasted 40 minutes, and a range of aerobic exercise training equipment was utilized at each facility.

Common strategies in aerobic exercise training to measure relative exercise intensity includes using heart rate max (HRmax), heart rate reserve (HRR), metabolic equivalents (METs), oxygen uptake reserve (VO_2R), and the Borg rating of perceived exertion scale (RPE). With numerous ways to measure relative exercise intensity for patients, the preferred methodologies remain unanswered. We found that the majority of CR programs use more than one measurement to prescribe intensity; the most frequently used measurement is RPE. High use of this variable as a measurement tool could be due to its ease of use with patients. RPE is a standardized subjective measurement of effort that matches verbalized statements and visual cues with an individual's perception of how hard they feel they are working. RPE can be a relative intensity monitoring tool for both aerobic and resistance exercise training, and it has been validated against several physiological markers (10,11). The reliability of the use of RPE is dependent on the individual's understanding of the description and explanation of RPE offered by the health care professional. In addition, it is imperative that standard language is used to explain the RPE scale. Patients should receive consistent descriptors for exercise exertion. Additional educational efforts should be made to ensure future clinical exercise physiologists can clearly explain the RPE scale.

Aerobic exercise training sessions are often structured with the patient performing a continuous exercise bout. We found that all CR programs applied continuous aerobic exercise training sessions with their patients. Many cardio-protective benefits and positive adaptations to aerobic training are further emphasized in cardiac patients who have engaged in a high intensity interval training program as compared to moderate intensity continuous training (12–17). High-intensity interval training has also been associated with greater patient satisfaction (18). That said, using higher intensity exercise prescriptions carry a potential risk for the occurrence of cardiac events in high-risk cardiac patients (19). Thus, it remains unclear if cardiac rehabilitation facilities prescribe high-intensity interval exercise prescriptions to their patients. We found that interval training was applied in 69% of CR programs. However, whether these interval training sessions were specifically regarded as high-intensity interval training was not assessed and should be investigated further.

Typically, aerobic capacity is diminished following a cardiac event or development of symptoms of CVD, making daily living and leisure activities much harder for the patient to accomplish, which often leads to further sedentary behavior. A 1 MET increase in cardiorespiratory fitness corresponds to a 15% reduction in CVD events (20). An exercise program should be designed to maximize an individual's increase in functional capacity; therefore, functional capacity goals should be set to assess the effectiveness of the exercise prescription. Our questionnaire found that only 44% of the programs set functional capacity goals for their patients with no clear, consistent benchmark. A commonly described endpoint for CR programs that did not set functional capacity goals was cited as "just improvement." However, the methodology on how "improvement" was assessed was never definitively elucidated, instead suggesting that functional capacity was a benchmark. Established markers for clinical improvement in CR would be beneficial.

According to ACSM (9), progression through an exercise program may consist of increasing any of the components of the FITT principle. From our findings, patients progressed through their aerobic programs in a variety of ways; 85% of the centers surveyed their patients' progress through their exercise programs by using a combination of

the components of the FITT principle. The most frequent combination used to progress patients through their aerobic exercise programs was an intensity/duration combination. With a cap on duration due to fixed session lengths, intensity may be the best progression variable.

Resistance Exercise Training

The application of resistance exercise training has been shown to be safe for patients with cardiac conditions. We note that 89% of the programs conducted resistance exercise training sessions with their patients. The most commonly reported frequency of resistance training sessions per week was 3 days per week, falling into the prescribed 2–3 days per week recommended by the ACSM (9). Various types of equipment were utilized during resistance exercise sessions, with free weights being the most commonly used.

Often, the intensity of resistance exercise training sessions is based on using a resistance equivalent to a certain percentage of a patient's 1RM or upon repetitions of a certain weight until voluntary fatigue. RPE can also be used as an effective intensity-monitoring tool for resistance exercise sessions. Of the centers that performed resistance training, the most cited techniques for intensity was trial and error, followed by RPE. The RPE range of 11–14 equates to a subjective effort interpretation of "light" to "somewhat hard," falling within ACSM recommendations. The frequent use of trial and error emphasizes the concept of individual exercise prescriptions within CR programs.

Monitoring of hemodynamic responses from resistance exercises may be especially important for patients with CVD as postural changes, resistant hypertension, irregular breathing patterns (Valsalva maneuver), and poor exercise techniques can contribute to elevated hypertensive or hypotensive responses. Among the centers that conducted resistance exercise sessions with patients, we found that they all monitored HR during sessions. Blood pressure was monitored by all the centers both before and after sessions, but only 20% measured BP during sessions. Some reasons BP was monitored during exercise included if BP was high during aerobic exercise and if the patient was hypertensive.

ACSM recommends that 8–10 exercises of the major muscle groups be performed during each exercise session (9). We found that all the CR centers fell slightly below this recommendation, with the majority of centers prescribing 6 exercises per session. CVD patients are deconditioned when beginning CR programs, so it may be wise for the exercise prescription to train major muscle groups initially with one set and progressing to multiple sets as tolerated by the patient. We note that 66% of the CR programs follow this guideline. Initial loads should allow a patient to be able to comfortably complete 10–15 repetitions (9). We also found that all the CR centers prescribed repetitions within this range, and the most frequently reported was 10 repetitions.

As patients adapt to the resistance exercise sessions, they will increase in both muscular strength and muscular endurance. The ACSM recommends that patients progress by increasing the resistance being performed, increasing the number of repetitions performed, or by setting decreased rest periods between performed sets. Despite the difficulty for clinicians to manipulate resistance exercise among this population, we found that all CR programs progressed their patients by increasing resistance and by RPE.

CONCLUSION

The current observational study highlights the variability and complexity of prescribing exercise to CVD patients. While the sample size in the current study is small (58 clinics), all facilities surveyed provided educational internship opportunities to exercise science/physiology university students or were AACVPR accredited. We might assume that students are learning different techniques than their colleagues performing internships at other clinics; however, the procedures taught may be different but not incorrect. This emphasizes the importance that academic programs place on training students across all prescription techniques. In addition, this study demonstrates the application of research-based exercise prescription among disease patients as outlined by professional organizations such as ACSM and AACVPR.

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