CJC Open 5 (2023) 215–219

Original Article

Comparing the Effectiveness of 2 Cardiac Rehabilitation Exercise Therapy Programs

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ABSTRACT

Cardiovascular diseases are among the leading causes of morbidity and mortality in Canada, highlighting the critical role of disease prevention and risk reduction programs. Cardiac rehabilitation (CR) is a key component of comprehensive cardiovascular care. Currently, more than 200 CR programs are established across the country, varying in duration, number of in-person supervised exercise sessions, and recommendations for exercise frequency at-home. In an increasingly cost-conscious healthcare environment, the effectiveness of healthcare services must be consistently reevaluated. This study evaluates the impact of 2 CR programs implemented by the Northern Alberta Cardiac Rehabilitation Program, by comparing peak metabolic equivalents achieved by study participants in each program. We hypothesize that our "hybrid" CR program, which is structured as an 8-week program with weekly in-person exercise sessions and a prescribed home exercise program, has patient outcomes similar to those of our "traditional" CR program, which required biweekly in-person exercise sessions over the course of 5 weeks. The results of this study may have implications for evaluating how to minimize barriers to both rehabilitation participation and long-term effectiveness of CR programs. The results may help inform the structuring and funding of future rehabilitation programs.

RÉSUMÉ

Les maladies cardiovasculaires (MCV) sont parmi les premières causes de morbidité et de mortalité au Canada d'où l'importance des programmes de prévention des MCV et de réduction du risque cardiovasculaire. La réadaptation cardiaque est un élément clé du continuum de soins cardiovasculaires. À l'heure actuelle, il existe plus de 200 programmes de réadaptation cardiaque au pays, qui diffèrent tant par leur durée, par le nombre de séances d'exercice supervisées en personne que par leurs recommandations sur la fréquence des exercices à domicile. Dans un contexte où le coût des soins de santé est de plus en plus préoccupant, l'efficience des services de santé doit constamment être réévaluée. Cette étude évalue les effets de deux programmes de réadaptation cardiaque instaurés par le Cardiac Rehabilitation Program du nord de l'Alberta en comparant l'équivalent métabolique maximal obtenu par les participants à l'étude pour chaque programme. L'hypothèse de départ était que notre programme de réadaptation cardiaque « hybride », qui consiste d'une part en un programme de huit semaines de séances hebdomadaires d'exercices en personne et d'autre part en un programme d'exercices à domicile, donnerait des résultats semblables à ceux de notre programme « traditionnel » de réadaptation cardiaque. Celui-ci se compose de deux séances d'exercices en personne par semaine, pendant cinq semaines. Les résultats de cette étude pourraient nous aider à réduire les obstacles qui nuisent à la participation aux programmes de réadaptation et à l'efficience à long terme de ces programmes. Nous espérons apporter un éclairage sur la structure et le financement des futurs programmes de réadaptation.

Cardiovascular diseases continue to be among the leading causes of morbidity and mortality in Canada,[1,2] highlighting the critical role of disease prevention and risk reduction programs. Cardiac rehabilitation (CR) has long been recognized as a key component of comprehensive cardiovascular care.[3-7] Currently, more than 200 CR programs are established across the country.[1] These CR programs vary in duration, number of in-person supervised exercise sessions, and recommendations for exercise frequency at-home. A dearth of

Received for publication September 21, 2022. Accepted November 24, 2022.

Ethics Statement: This study was approved by the Health Research Ethics Board.

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See page 218 for disclosure information.

https://doi.org/10.1016/j.cjco.2022.11.022

research compares the effectiveness of these different CR exercise therapy programs.

Prior to the COVID-19 pandemic, multiple centres across Canada structured their CR programs as biweekly in-person exercise sessions, spanning anywhere from 5 weeks to 1 year in duration. The Northern Alberta Cardiac Rehabilitation Program (NACRP) also implemented this "traditional" CR program of biweekly exercise, over the course of 5 weeks. In 2013, with the combined goals of decreasing healthcare costs, increasing scheduling flexibility for participants, and promoting participant self-sufficiency, the NACRP restructured their CR program to focus on fewer in-person visits. This change led to the introduction of a "hybrid" CR program, which reduced the frequency of in-person sessions to once a week, supplemented by a home exercise program, over an 8-week period.

This study evaluates the impact of our hybrid CR program compared to that of the traditional CR program, by comparing peak metabolic equivalents (METs) achieved by study participants in each program. We hypothesized that patient outcomes in the hybrid CR program are not significantly different from patient outcomes in the traditional CR program.

Historical Beginnings

The first Canadian CR program was introduced in 1968 by Dr Terence Kavanagh at the Toronto Rehabilitation Institute. Prior to this, it was unclear whether aerobic exercise after myocardial infarction was safe, let alone beneficial. Dr Kavanagh's pioneering efforts not only established the safety of exercise therapy, but also demonstrated that aerobic exercise after acute coronary events led to better patient outcomes.[8] This finding led to a widespread movement towards secondary prevention of cardiovascular disease in Canada.

CR programs have existed in various forms over the years. In its infancy, the CR program at the Toronto Rehabilitation Institute focused on exercise therapy, namely aerobic exercises through progressive long-distance jogging or biking. Upon program enrollment, patients received exercise prescriptions, individualized based on their age and the presence of post-myocardial infarction complications. Progression through the program was measured by tracking heart rate and symptom response to each exercise session. This CR program lasted for a minimum of 2 years and required patients to complete 1 in-person and 4 at-home exercise sessions per week. In-person sessions consisted of 20 minutes of light warmup, an individualized jogging workout, and 10 minutes of cool-down. Home sessions required daily diary sheets tracking distance jogged, duration of activity, and measurement of pre-workout and post-workout pulse rates.

Recognizing that prevention is multifaceted, many CR programs have since expanded to include the "core components of cardiac rehabilitation." As outlined by the International Council of Cardiovascular Prevention and Rehabilitation, these core components include nutritional and psychosocial support, patient and family education, the delivery of cardiovascular risk-reduction strategies, and exercise training. The cornerstone of CR, however, remains the structured exercise therapy program, which significantly reduces the hazard of mortality and cardiovascular morbidity, as a recent meta-analysis has demonstrated.[9-16]

Table 1. Baseline characteristics of patients

Characteristic	Traditional (n = 326)	Hybrid (n = 151)	*P*
Reason for cardiac rehabilitation referral			< 0.001
Noninvasive management of CAD	31 (9.5)	62 (41.1)	—
PCI	182 (55.9)	37 (24.5)	—
CABG	64 (19.6)	35 (23.2)	—
Valve surgery	38 (11.6)	13 (8.6)	—
Heart failure	0 (0.0)	2 (1.3)	—
Male	265 (81.3)	126 (83.4)	0.569
Age at time of rehabilitation, y, mean ± standard deviation	62.9 ±11.4	60.6 ± 10.5	0.031
CAD and event (STEMI, NSTEMI, angina)	277 (85.0)	131 (86.8)	0.606
Valvular disease	38 (11.7)	13 (8.6)	0.317
Heart failure	0 (0.0)	3 (2.0)	0.011
History of myocardial infarction	31 (9.5)	58 (38.4)	< 0.001
Smoking history	197 (62.2)	71 (57.7)	0.394
Dyslipidemia	196 (61.1)	93 (73.8)	0.011
Hypertension	190 (58.6)	79 (64.2)	0.281
Family history of premature CAD	115 (43.4)	45 (52.3)	0.149
History of diabetes	76 (23.8)	28 (26.2)	0.614
Medications			
ASA	290 (89)	126 (91.3)	0.448
Beta-blocker	271 (83.1)	121 (87.7)	0.216
CCB	34 (10.4)	14 (10.1)	0.927
Diuretic	45 (13.8)	21 (15.2)	0.690
Anti-arrhythmic	12 (3.7)	2 (1.4)	0.199
ACE inhibitor	181 (55.5)	78 (56.5)	0.843
Antidepressant	19 (5.8)	7 (5.1)	0.746
Statin (n = 395)	274 (99.3)	119 (100)	0.352

Values are n (%), unless otherwise indicated.

ACE, angiotensin-converting enzyme; ASA, acetylsalicylic acid; CAD, coronary artery disease; CABG, coronary artery bypass grafting; CCB, calcium-channel blocker; PCI, percutaneous coronary intervention; NSTEMI, non-STEMI; STEMI, ST-elevation myocardial infarction.

Methods

Study design

This study was approved by the Alberta Health Services and University of Alberta Health Research Ethics Board. This study was a retrospective analysis of patients who participated in the NACRP from 2012 to 2014. Patients who successfully completed either the traditional or hybrid CR program were eligible for the study. Successful completion was defined as follows: (i) completion of a baseline pre-rehabilitation functional exercise assessment; (ii) attendance at all in-person exercise sessions, consisting of 30-40 minutes of moderate aerobic exercises (with moderate exercise defined as achieving 70%-85% of peak heart rate from baseline functional exercise assessment) and light resistance training; (iii) participation in a moderate-intensity home exercise routine, with a goal of more than 150 minutes/week, documented in a home exercise diary; (iv) completion of a post-rehabilitation functional exercise assessment at a 6-month follow-up session.

Functional exercise assessments were conducted with symptom-limited graded treadmill tests, using the Bruce or the modified Bruce protocol. Exercise capacity was determined using standard metabolic equations to calculate METs from pre-rehabilitation and post-rehabilitation functional exercise assessments.

Table 2. Traditional vs hybrid cardiac rehabilitation programs

METS achieved pre- vs post-rehabilitation			
	At baseline	At 6 mo	*P*
Type of CR program			
Traditional	8.8 ± 3.3	9.9 ± 3.7	< 0.001
Hybrid	9.4 ± 3.3	10.9 ± 3.5	< 0.001
Post-rehabilitation METs achieved			
	Traditional	Hybrid	
Changes in METS	1.2 ± 2.3	1.6 ± 2.2	0.068

Values are mean ± standard deviation, unless otherwise indicated.
METs, metabolic equivalents.

Data collection

Baseline characteristics of patients in each study arm were obtained from the Northern Alberta Cardiac Rehabilitation database. Major adverse cardiac events (MACE), defined as the composite of all-cause death, readmission for myocardial infarction, and readmission for stroke, were obtained from the Discharge Abstract Database and Provincial Death Registry via the SPOR Data Platform after patients completed their CR program.

Statistical analysis

Patient baseline characteristics (Table 1) were reported as mean ± standard deviation or frequency (percentage) and were controlled in the multivariable Cox model. The proportional hazard assumption was tested by adding an interaction term of grouping variable and time to the full model, for which a P value < 0.05 indicates violation of the assumption. No violations were found in any of the Cox regression models. Comparisons of baseline characteristics in each study arm were made with the χ^2 test or Fisher's exact test, as appropriate.

Comparisons of METs achieved pre- and post-rehabilitation (Table 2) were expressed as mean ± standard deviation, and comparisons were performed using paired *t*-tests.

Comparisons between study arms of the number of post-rehabilitation METs achieved (Table 2) were expressed as mean ± standard deviation and were made using independent *t*-tests.

MACE in each group (Table 3) was expressed as frequency (percentage). The Cox proportional hazard model was utilized to calculate the unadjusted and adjusted hazard ratios for MACE. Comparison between the 2 study arms was completed with the χ^2 test or Fisher's exact test, as appropriate.

Statistical analysis was performed using SAS 9.4 (SAS Institute, Cary, NC). A P value < 0.05 was considered statistically significant.

Results

A total of 477 patients were included in this study (traditional, n = 326; hybrid, n = 151; traditional, male-to-female ratio 265:61; hybrid, male-to-female ratio, 126:25; mean age, 62 ± 11 years). Baseline characteristics of patients in each study arm can be found in Table 1.

In both the traditional and hybrid groups, patients increased their METs on a repeat exercise stress test 6 months post-rehabilitation. A comparison of the 6-month post-rehabilitation METs between the traditional and hybrid study arms did not demonstrate a statistically significant difference (Table 2).

Comparison of MACE in the 2 study arms post-rehabilitation did not demonstrate a statistically significant difference, as demonstrated in Table 3.

Discussion

A well-established finding is that aerobic exercise reduces the risk of recurrent cardiac events, with an increase in peak METs achieved associated with an improvement in cardiac morbidity and mortality. Aerobic exercise capacity, quantified by peak METs, increased significantly in both our hybrid and traditional CR programs. Furthermore, a comparison of post-rehabilitation incidents of MACE between our study arms showed no difference in adverse events in the hybrid CR program, although notably, the absolute number of total adverse events was low. No evidence was found that the hybrid CR program, which has a reduced number of in-person visits but a longer duration of rehabilitation and concomitant supplementation of a home-exercise regimen, is significantly different from traditional CR programs that are widely employed at other rehabilitation sites.

The findings of this study may have implications for future CR program design. With the growing focus on disease prevention and risk reduction, enrollment in CR programs continues to trend upward across the country. With nationwide healthcare costs also growing at alarming rates, CR program directors and policy makers are searching for solutions to maintain program effectiveness and address barriers to care in an increasingly resource-strapped environment.

One well known barrier to effective CR is program access.[17-19] In-person visits result in higher healthcare expenditures, and with less in-person visits, the hybrid CR program is able to enroll a greater number of patients at any given time, compared with the traditional CR program.

Another barrier is program attrition, which is driven by both structural and personal barriers.[1,20-23] Structural barriers are due, in part, to the inconvenience of attending or inability to attend all in-person exercise sessions. Personal barriers include preference for solo training rather than group-based therapy or for training activities different from those offered in typical CR programs. The hybrid CR program may help address this barrier. With a reduced number of in-person visits, the inconvenience of traveling on-site or having to take time off work to attend CR is reduced for many patients. Furthermore, if patients are reluctant to participate in group-based therapy, fewer in-person visits may help with program compliance.

Another identified barrier is the variable poor long-term effectiveness of CR programs. CR, owing to the nature of the program duration and cost and resource limitations, has a greater focus on short-term fitness objectives. In our increasingly cost-conscious healthcare environment, programs and services are increasingly evaluated on their long-term outcomes. Prior studies have found that patients who participate in centre-based CR programs often find themselves unprepared to independently continue long-term exercise objectives once their CR program has concluded. The hybrid CR

Table 3. Major adverse cardiac events (MACE) comparing the hybrid group to the traditional group

Outcomes	Hybrid	Traditional	cOR (95% CI)	*P*	aOR (95% CI)	*P*
MACE at 1 y	2 (1.3)	6 (1.8)	0.72 (0.15−3.58)	0.689	0.77 (0.12− 4.80)	0.775
Readmission for nonfatal stroke	0	4 (1.2)	NA	0.594	NA	NA
Readmission for nonfatal myocardial infarction	2 (1.3)	2 (0.6)	2.17 (0.31−15.37)	0.313	1.82 (0.17− 19.75)	0.622
All-cause mortality	0	0	NA	NA	NA	NA

Values are n (%), unless otherwise indicated.

aOR, adjusted odds ratio; cOR, crude odds ratio; CI, confidence interval; MACE, major adverse cardiac events; NA, not applicable.

program may help address this barrier with the supplementary 8-week home exercise program. Not only have prior studies demonstrated that home-based CR is a safe and similarly effective alternative to centre-based CR,[24] home exercise programs may allow patients to develop the skills needed to independently manage and maintain their fitness.[20,25-28]

Study limitations

One of our study limitations was the overall small study sample size. The sample size of the hybrid arm was especially small. The small size was due to 2 consecutive changes that occurred in our facilities' electronic medical record system during the years when patients were enrolled in the hybrid program. These changes made patient data inaccessible for those who were enrolled after the changes and resulted in unmatched study arms. Furthermore, home-exercise regimens were unsupervised, so assessment of the exercise intensity of these sessions was not possible, although the hybrid CR participants still demonstrated an improvement in their peak METs post-rehabilitation. Additionally, CR personnel were not blinded to patients' pre-rehabilitation stress tests, leading to the possibility that patients were pushed harder to achieve higher METs in their post-rehabilitation stress test, although this also may have occurred during the traditional CR program.

Finally, measuring the amount of effort each patient used during their pre- and post-rehabilitation stress tests was not possible. This lack of measurement leaves open the possibility that patients placed greater effort into their post-rehabilitation exercise stress tests, resulting in a perceived improvement in peak METs, although this could also have occurred during the traditional CR program. Study participants were also all relatively fit, which may contribute to an underestimation of difference between the 2 study arms. Finally, our study was focused only on the difference in METs achieved pre- and-post-CR. We did not examine and compare other measures of effective CR programming, such as blood pressure management, lipid control, smoking cessation, and mood and psychosocial changes.

Conclusion

With the growing focus on prevention and risk reduction in an increasingly cost-conscious healthcare environment, the effectiveness of healthcare services must be consistently reevaluated. This study demonstrated that patient outcomes in a hybrid CR program, with a reduced number of in-person exercise visits and a longer supplemental home-exercise program, were not significantly different from those in traditional CR programs that are widely employed at other rehabilitation centres across the country. The results of this study may have implications for evaluating how to minimize barriers to participation and to long-term effectiveness of CR programs and may help inform the structuring and funding of future rehabilitation programs.

Funding Sources

The authors have no funding sources to declare.

Disclosures

The authors have no conflicts of interest to disclose.

Acknowledgements

The authors thank the Jim Pattison Foundation and the staff at the Northern Alberta Cardiac Rehabilitation Program for their support of this project.

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