Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

ACRM
AMERICAN CONGRESS OF REHABILITATION MEDICINE

Archives of Physical Medicine and Rehabilitation

journal homepage: www.archives-pmr.org

Archives of Physical Medicine and Rehabilitation 2020;101:1835-8

SPECIAL COMMUNICATION

Cardiac Rehabilitation During Quarantine in COVID-19 Pandemic: Challenges for Center-Based Programs

Florent Besnier, PhD,[a,b] Mathieu Gayda, PhD,[a,b] Anil Nigam, MD,[a,b] Martin Juneau, MD,[a,b] Louis Bherer, PhD[a,b,c]

From the [a]Preventive Medicine and Physical Activity Centre and Research Center, Montreal Heart Institute, Université de Montréal, Montreal, QC; [b]Department of Medicine, Université de Montréal, Montreal, QC; and [c]Research Centre, Institut Universitaire de Gériatrie de Montréal, Montreal, QC, Canada.

Abstract

Because of the coronavirus disease 2019 (COVID-19) epidemic, many cardiac rehabilitation (CR) services and programs are stopped. Because CR is a class I level A recommendation with clinical benefits that are now well documented, the cessation of CR programs can lead to dramatic consequences in terms of public health. We propose here a viewpoint of significant interest about the sudden need to develop remote home-based CR programs both in clinical research and in clinical care routine. This last decade, the literature on remote home-based CR programs has been increasing, but to date only clinical research experiences have been implemented. Benefits are numerous and the relevance of this approach has obviously increased with the actual health emergency. The COVID-19 crisis, the important prevalence of smartphones, and high-speed Internet during confinement should be viewed as an opportunity to promote a major shift in CR programs with the use of telemedicine to advance the health of a larger number of individuals with cardiac disease.

Archives of Physical Medicine and Rehabilitation 2020;101:1835-8

Coronavirus disease 2019 (COVID-19) is a highly contagious respiratory disease caused by a new respiratory virus, the severe acute respiratory syndrome coronavirus 2. In mid-June 2020, the World Health Organization reported that more than 7.4 million cases of COVID-19 were confirmed worldwide with more than 418,000 deaths. Among infected patients, 15% develop a much more severe form of the disease,[1] including acute respiratory distress syndrome.

Elderly individuals and patients with cardiovascular diseases are particularly at risk of developing severe complications. The mortality rate increases sharply with age and reaches 3.6% in people aged 60 years, 8% in people aged 70 years, and 14.8% in people older than 80 years[1,2]; these data depend on the country and are constantly changing. High blood pressure, type 2 diabetes, or cardiovascular diseases are the most common comorbidities in people affected by COVID-19,[3] with mortality rates particularly high from 5.6%-10.5%.[1]

To date, there is no treatment and to slow the rapid spread of the virus, most epidemiologist experts and public health authorities recommend quarantine and frequent handwashing. Most governments have therefore imposed exceptionally drastic measures, such as social distancing, quarantine, and restricting movement for basic necessities, such as going to the grocery store and/or pharmacy. All hospitals and clinics have to reorganize to receive patients with COVID-19 while limiting contact between people. Ambulatory visits and nonessential services are closed. The closure of cardiovascular rehabilitation (CR) programs were among the first clinical services closed and would be the last to open.[4]

Center-based CR

Cardiovascular rehabilitation is a class I level A recommendation,[5,6] and it is generally provided in specialized centers. Programs involve multidomain therapeutic education (nutrition, lifestyle, stress management), individualized exercise training, cardiovascular risk factors management, pharmacologic treatment optimization, and return to home management.[5] More recently, cognitive training programs have also been proposed.[7] Individualized exercise

Funding: Mirella and Lino Saputo Research Chair in Cardiovascular Diseases and the Prevention of Cognitive Decline from Université de Montréal at the Montreal Heart Institute.

Disclosures: none.

0003-9993/20/$36 - see front matter © 2020 by the American Congress of Rehabilitation Medicine
https://doi.org/10.1016/j.apmr.2020.06.004

training is the cornerstone of these programs prescribed by a physician after a cardiopulmonary exercise test or a field test, such as 6-minute walk test. In general, CR services offer a length of stay ranging from 3 weeks to 3 months (depending on the country) with exercise training sessions that are done in groups or individually, 3-5 times per week under the supervision of a health professional (physiotherapist, exercise specialist, nurse).

Although the proportion of eligible cardiac patients participating in CR programs is generally low (range, 14%-55% in North America[8,9]), its effects on individual health outcomes and the benefits for the health care system are paramount. In fact, clinical benefits of CR programs are now well documented: CR reduces total and cardiovascular mortality (by 25%-30%) and the risk of rehospitalization in the 12 months following rehabilitation by 30% compared with the usual care treatment without CR.[10] These programs also have a beneficial effect on depressive symptoms, stress, and cognitive functions in cardiac patients.[11] The cessation of cardiovascular rehabilitation programs is therefore dramatic in terms of public health.

Need to maintain physical activity during confinement

Because of the COVID-19 epidemic, many CR services and programs have closed (eg, gyms for the general public) to limit contact between people, especially those most at risk (elderly persons with cardiovascular disease), and the issue of aerosolizing of secretions with exercise training. Isolation and quarantine are certainly the best solution to stem the pandemic. However, these exceptional measures also might have negative effects and create collateral damage to health, especially in frail people.[12] First, the psychological effects of quarantine have been discussed recently.[13] It seems that most of the negative effects (stress, confusion, anxiety) come from the imposition of a restriction of liberty, while voluntary confinement is associated with less distress and fewer long-term complications.[13] Confinement implies a radical change in our lifestyle, and in cardiac patients who already have a sedentary and/or inactive profile, these measures excessively increase the level of physical inactivity and sedentary lifestyle, which can increase the risk of acute events, depressive syndromes, and anxiety. Maintaining a minimum of physical activity during the COVID-19 crisis is essential[14] for cardiac patients with the advice of the medical team who can offer remote home-based supervised exercise training.

Remote home-based CR program

Recent developments in telemedicine with telecommunications (eg, virtual consultations, remote patient monitoring) and the multiple smartphone applications have led to the emergence of new strategies supplementing the conventional services offered in rehabilitation centers. There is an urgent need to validate these technological tools to personalize prevention care, help patients in their recovery, and prevent recurrent events.[15] The optimal program would include several modules dedicated to online coaching and learning, social interaction, and bilateral communication with the health care team. To date only clinical research experiences have been implemented, and no long-term follow-up is available. Virtual home-based CR could be an alternative to rehabilitation carried out in a specialized center, especially for low-risk patients.[15-17] These innovative virtual home-based CR programs are multiplying with remote monitoring trackers that can help cardiac patients to manage their heart disease and medication (therapeutic education) and promote healthy diet and increased physical activity. The use of trackers to quantify physical activity may lead patients to adopt an active lifestyle while ensuring safety. Moreover, patients should be able to contact the health care team at any time. The interface should be able to record and send variables (energy expenditure, body mass, glycemia, blood pressure, heart rate, electrocardiogram [ECG], etc) measured via sensors to a web platform accessible to the physician, cardiologist, exercise specialists, and nurses. Virtual home-based CR trials have been done in a number of countries. Some experiences described below (nonexhaustive) have shown convincing data both in terms of feasibility, safety, and improvement of cardiovascular risk factors. However, some challenges remain, such as the issues of privacy data and the ability to engage older patients. Real-time monitoring, such as ECG and blood pressure measurement during exercise, is also an issue. It may add some safety but is challenging in terms of technology resources as bandwidth.

In a randomized controlled trial (RCT), Frederix et al have evaluated the effects of telerehabilitation (after a period of conventional CR) compared with center-based CR.[18] The program involved semiautomatic e-mails or text messages, encouraging subjects to achieve their predefined physical activity goals. Results of the cost-effectiveness analysis and the readmission rate show a positive effect in favor of telerehabilitation.[19] In another RCT Reid et al have demonstrated the effectiveness of a strategy including an individual interview and 8 telephone contacts to increase the volume of physical activity over a period of 52 weeks in patients recovering from an acute coronary syndrome who did not plan to undergo standard CR.[20] Moreover, the European Study on Effectiveness and Sustainability of Current Cardiac Rehabilitation Programmes in the Elderly[21] is designed to evaluate the effectiveness of telerehabilitation via a mobile application in elderly cardiac patients who have refused to participate in a center-based CR. This study combines 2 clinical studies: the first is observational (n = 1760 patients) and plans to assess the cardiorespiratory fitness, measured as peak oxygen consumption (VO_2peak), at the beginning and the end of the center-based CR program and at 12 months of follow-up. The second study is prospective and plans to include 248 patients who refused to participate in a conventional CR program. They will be offered to participate in a telerehabilitation program (or in a control group without specific advice). The duration of follow-up (12mo) and the variables of interest are the same as the observational study ($\dot{V}O_2$peak, adhesion, cost, barriers, cardiovascular risk factors, acute events, rehospitalizations).

Home-based programs have also been used in patients with chronic heart failure. For instance, Piotrowicz et al[22] evaluated the effect of an 8-week Nordic walking program at home (5 sessions/wk at 40%-70% of maximum heart rate) in 78 patients (New York Heart Association II-III, left ventricular ejection fraction<40%); another 34 patients were part of a sedentary control group. Patients in the training group received a monitoring kit connected to a smartphone

List of abbreviations:

COVID-19	**coronavirus disease 2019**
CR	**cardiovascular rehabilitation**
ECG	**electrocardiogram**
RCT	**randomized controlled trial**
$\dot{V}O_2$peak	**peak oxygen consumption**

for remote data transmission (measuring heart rate, ECG, and blood pressure). Daily telephone coaching was set up by a nurse and an exercise specialist to ensure that the sessions were carried out correctly. Symptoms and adherence to treatments were also evaluated. At the end of the training period, the authors report an improvement in $\dot{V}O_2$peak and depression scores measured by Beck's questionnaire. The usual care group only reported an improvement in depression scores. Nevertheless, in a large RCT of 850 patients with chronic heart failure, the clinical benefits of a 9-week telerehabilitation program did not confirm the superiority of usual care vs telerehabilitation on mortality and rehospitalization rate over a follow-up period of 14-26 months without ongoing exercise.[23] This study showed that without encouragement, patients fail to continue exercise, and strategies are needed to maintain exercise adherence.

Exergames in CR

In patients with chronic heart failure, video games such as the Nintendo Wii Fit have also been proposed in CR.[24] These tools combining physical exercises and video games called exergames are promising, but more studies are needed. The HF-Wii study[25] evaluated the effectiveness of this new type of CR in a multicenter and international RCT of 605 patients with chronic heart failure (67±12y). At 1 year of follow-up the Wii intervention group reported mitigated results on the 6-minute walk test compared with the control group without intervention. However, the authors underlined that this type of program is feasible and safe.[25] In addition, because 36% of the patients report being inactive at baseline and this proportion did not change after the follow-up, the authors emphasize the importance of remote coaching and the necessity to study specifically remote motivational strategies.[25]

To summarize, compared with conventional center-based CR, recent studies and meta-analyses suggest that telerehabilitation could be (1) as effective on improving the $\dot{V}O_2$peak, (2) less costly, (3) safe, and (4) more effective in terms of maintenance of an active lifestyle in the medium-term.[19,26-31] Regarding mortality, cardiovascular risk factors, and physical activity volume, Dalal et al demonstrated in 1938 cardiac patients that there was no difference between home-based and center-based CR programs.[32] Studies with longer follow-up are still needed in the subpopulation of cardiac patients with heart failure.[23]

Physical activity at home during confinement

Currently, the US Department of Health and Human Services and the American College of Sports Medicine have published new recommendations of physical activity during the COVID-19 period.[33,34] In CR, teams can propose workouts at home without equipment material, such as gymnastic movements of muscular strengthening (squat, sit-to-stand, push-ups against a wall, 1-L water bottles for weights to exercise the upper body, etc), balance or stretching exercises, and online relaxation sessions. These exercises do not require any equipment and can be described and explained to the patient in live or online videos. Furthermore, the adapted movements could be described and illustrated in a physical activity notebook. Moreover, keeping an agenda can facilitate the practice of regular exercise during the few weeks or months of quarantine. Fifteen minutes per day, every day, may be enough[35] to fight against muscle deconditioning and limit the harmful effects of strict confinement. However, a precise individualized prescription (movement description, contraindications, duration of the exercises, number of repetitions, series, and recovery) for each patient is necessary to ensure safety aspects. Moreover, telephone coaching is seen as a good strategy to increase adherence and reduce isolation, which is known for having detrimental effects on psychological and physical health, even more so in the elderly population.[36]

eHealth, confinement, and perspective

The debate on connected health is taking an increasingly important place in our society. More than 3.4 billion people are currently confined to different degrees in an attempt to temper the pandemic. Social networks, online eHealth platforms, exercise training mobile applications, and home gym workouts videos have never been so popular.[37] The actual health emergency and the massive use of smartphones and internet during confinement could become an important tool of prevention methods in CR programs. Digital teleworking, trackers, and connected tools allow regular and individualized remote monitoring by exercise specialists, nurses, and cardiologists to promote healthy behavior. Within the framework of COVID-19, some countries use smartphones on a large scale to compel individuals to communicate their temperature, identify the movements of infected patients, identify their contacts, etc. The modernization of CR services with digital tools would allow better promotion of telerehabilitation programs. One challenge of these coming years will be to legislate and propose remote home-based CR for cardiac patients at low risk and clinically stable.[6,31,38] Older and disabled patients have less access and comfort with eHealth, devices, applications, and data collection devices, and these challenge need to be address.

In sum, evidence supports the use of home-based CR. Benefits are numerous and relevance is obviously suddenly increased with the COVID-19 crisis. This should be viewed as an opportunity to promote a major shift in CR programs for good and for the health of a larger number of individuals. Furthermore, the severe acute respiratory syndrome coronavirus 2 can lead to cardiac complications that could be addressed by CR. Nevertheless, while the Centers for Medicare and Medicaid Services recently agreed to cover additional types of telehealth services during the COVID-19 pandemic, home-based CR services were not among them.

Keywords

Cardiac rehabilitation; Coronavirus; Exercise; Rehabilitation

Corresponding author

Florent Besnier, PhD, Montreal Heart Institute, 5055 Rue St Zotique Est, Montréal, QC, H1T 1N6, Canada. *E-mail address:* florent.besnier@umontreal.ca.

References

1. Wu Z, McGoogan JM. Characteristics of and important lessons from the coronavirus disease 2019 (COVID-19) outbreak in China: summary of a report of 72314 cases from the Chinese Center for Disease Control and Prevention. JAMA 2020 Feb 20 [Epub ahead of print].

2. Wang LS, Wang YR, Ye DW, Liu QQ. Review of the 2019 novel coronavirus (SARS-CoV-2) based on current evidence. Int J Antimicrob Agents 2020;55:105948.
3. Yang J, Zheng Y, Gou X, et al. Prevalence of comorbidities and its effects in patients infected with SARS-CoV-2: a systematic review and meta-analysis. Int J Infect Dis 2020;94:91-5.
4. Vigorito C, Faggiano P, Mureddu GF. COVID-19 pandemic: what consequences for cardiac rehabilitation? Monaldi Arch Chest Dis 2020;90.
5. Piepoli MF, Hoes AW, Agewall S, et al. 2016 European Guidelines on cardiovascular disease prevention in clinical practice: the Sixth Joint Task Force of the European Society of Cardiology and Other Societies on Cardiovascular Disease Prevention in Clinical Practice (constituted by representatives of 10 societies and by invited experts) developed with the special contribution of the European Association for Cardiovascular Prevention & Rehabilitation (EACPR). Eur Heart J 2016;37:2315-81.
6. Balady GJ, Ades PA, Bittner VA, et al. Referral, enrollment, and delivery of cardiac rehabilitation/secondary prevention programs at clinical centers and beyond: a presidential advisory from the American Heart Association. Circulation 2011;124:2951-60.
7. de Tournay-Jette E, Dupuis G, Denault A, Cartier R, Bherer L. The benefits of cognitive training after a coronary artery bypass graft surgery. J Behav Med 2012;35:557-68.
8. Suaya JA, Shepard DS, Normand SL, Ades PA, Prottas J, Stason WB. Use of cardiac rehabilitation by Medicare beneficiaries after myocardial infarction or coronary bypass surgery. Circulation 2007;116:1653-62.
9. Grace SL, Bennett S, Ardern CI, Clark AM. Cardiac rehabilitation series: Canada. Prog Cardiovasc Dis 2014;56:530-5.
10. Anderson LJ, Taylor RS. Cardiac rehabilitation for people with heart disease: an overview of Cochrane systematic reviews. Int J Cardiol 2014;177:348-61.
11. Alagiakrishnan K, Mah D, Gyenes G. Cardiac rehabilitation and its effects on cognition in patients with coronary artery disease and heart failure. Expert Rev Cardiovasc Ther 2018;16:645-52.
12. Dempsey PC, Strain T, Khaw KT, Wareham NJ, Brage S, Wijndaele K. Prospective associations of accelerometer-measured physical activity and sedentary time with incident cardiovascular disease, cancer, and all-cause mortality. Circulation 2020;141:1113-5.
13. Brooks SK, Webster RK, Smith LE, et al. The psychological impact of quarantine and how to reduce it: rapid review of the evidence. Lancet 2020;395:912-20.
14. Chen P, Mao L, Nassis GP, Harmer P, Ainsworth BE, Li F. Coronavirus disease (COVID-19): the need to maintain regular physical activity while taking precautions. J Sport Health Sci 2020;9:103-4.
15. Frederix I, Vanhees L, Dendale P, Goetschalckx K. A review of telerehabilitation for cardiac patients. J Telemed Telecare 2015;21:45-53.
16. Hamilton SJ, Mills B, Birch EM, Thompson SC. Smartphones in the secondary prevention of cardiovascular disease: a systematic review. BMC Cardiovasc Disord 2018;18:25.
17. Jin K, Khonsari S, Gallagher R, et al. Telehealth interventions for the secondary prevention of coronary heart disease: a systematic review and meta-analysis. Eur J Cardiovasc Nurs 2019;18:260-71.
18. Frederix I, Hansen D, Coninx K, et al. Medium-term effectiveness of a comprehensive internet-based and patient-specific telerehabilitation program with text messaging support for cardiac patients: randomized controlled trial. J Med Internet Res 2015;17:e185.
19. Frederix I, Hansen D, Coninx K, et al. Effect of comprehensive cardiac telerehabilitation on one-year cardiovascular rehospitalization rate, medical costs and quality of life: a cost-effectiveness analysis. Eur J Prev Cardiol 2016;23:674-82.
20. Reid RD, Morrin LI, Higginson LA, et al. Motivational counselling for physical activity in patients with coronary artery disease not participating in cardiac rehabilitation. Eur J Prev Cardiol 2012;19:161-6.
21. Prescott E, Meindersma EP, van der Velde AE, et al. A EUropean study on effectiveness and sustainability of current Cardiac Rehabilitation programmes in the Elderly: design of the EU-CaRE randomised controlled trial. Eur J Prev Cardiol 2016;23:27-40.
22. Piotrowicz E, Piotrowski W, Piotrowicz R. Positive effects of the reversion of depression on the sympathovagal balance after telerehabilitation in heart failure patients. Ann Noninvasive Electrocardiol 2016;21:358-68.
23. Piotrowicz E, Pencina MJ, Opolski G, et al. Effects of a 9-week hybrid comprehensive telerehabilitation program on long-term outcomes in patients with heart failure: the Telerehabilitation in Heart Failure Patients (TELEREH-HF) randomized clinical trial. JAMA Cardiol 2019;5:300-8.
24. Verheijden Klompstra L, Jaarsma T, Stromberg A. Exergaming in older adults: a scoping review and implementation potential for patients with heart failure. Eur J Cardiovasc Nurs 2014;13:388-98.
25. Jaarsma T, Klompstra L, Ben Gal T, et al. Effects of exergaming on exercise capacity in patients with heart failure: results of an international multicentre randomized controlled trial. Eur J Heart Fail 2020 Mar 13 [Epub ahead of print].
26. Chan C, Yamabayashi C, Syed N, Kirkham A, Camp PG. Exercise telemonitoring and telerehabilitation compared with traditional cardiac and pulmonary rehabilitation: a systematic review and meta-analysis. Physiother Can 2016;68:242-51.
27. Piotrowicz E. The management of patients with chronic heart failure: the growing role of e-Health. Exp Rev Med Devices 2017;14:271-7.
28. Frederix I, Sankaran S, Coninx K, Dendale P. MobileHeart, a mobile smartphone-based application that supports and monitors coronary artery disease patients during rehabilitation. Conf Proc IEEE Eng Med Biol Soc 2016:513-6.
29. Frederix I, Vandenberk T, Janssen L, Geurden A, Vandervoort P, Dendale P. eEduHeart I: a multicenter, randomized, controlled trial investigating the effectiveness of a cardiac web-based elearning platform - rationale and study design. Cardiology 2017;136:157-63.
30. Kraal JJ, Van den Akker-Van Marle ME, Abu-Hanna A, Stut W, Peek N, Kemps HM. Clinical and cost-effectiveness of home-based cardiac rehabilitation compared to conventional, centre-based cardiac rehabilitation: results of the FIT@Home study. Eur J Prev Cardiol 2017;24:1260-73.
31. Thomas RJ, Beatty AL, Beckie TM, et al. Home-based cardiac rehabilitation: a scientific statement from the American Association of Cardiovascular and Pulmonary Rehabilitation, the American Heart Association, and the American College of Cardiology. Circulation 2019;140:e69-89.
32. Dalal HM, Zawada A, Jolly K, Moxham T, Taylor RS. Home based versus centre based cardiac rehabilitation: Cochrane systematic review and meta-analysis. BMJ 2010;340:b5631.
33. American College of Sports Medicine. Staying active during COVID-19. Available at: https://www.exerciseismedicine.org/support_page.php/staying-active-during-covid-191/. Accessed April 28, 2020.
34. US Department of Health and Human Services. Staying active while social distancing: questions and answers. Available at: https://health.gov/news/202004/staying-active-while-social-distancing-questions-and-answers?source=govdelivery&utm_medium=email&utm_source=govdelivery. Accessed April 28, 2020.
35. Wen CP, Wai JP, Tsai MK, et al. Minimum amount of physical activity for reduced mortality and extended life expectancy: a prospective cohort study. Lancet 2011;378:1244-53.
36. Poscia A, Stojanovic J, La Milia DI, et al. Interventions targeting loneliness and social isolation among the older people: an update systematic review. Exp Gerontol 2018;102:133-44.
37. Tate DF, Lyons EJ, Valle CG. High-tech tools for exercise motivation: use and role of technologies such as the internet, mobile applications, social media, and video games. Diabetes Spectr 2015;28:45-54.
38. Piotrowicz E, Piepoli MF, Jaarsma T, et al. Telerehabilitation in heart failure patients: the evidence and the pitfalls. Int J Cardiol 2016;220:408-13.