International Journal of
Physical Medicine & Rehabilitation

Soares et al., Int J Phys Med Rehabil 2013, 1:7
http://dx.doi.org/10.4172/2329-9096.1000158

Research Article Open Access

Home-Based Programs and Application of New Technologies in Cardiac Rehabilitation

Diogo Soares, Sandra Magalhaes* and Sofia Viamonte

Physical Medicine and Rehabilitation Department, Hospital de Santo António / Centro Hospitalar do Porto, Porto, Portugal

Abstract

Introduction: Cardiac rehabilitation is a secondary prevention crucial component that has been developed and implemented in the past decades due to the scientific evidence of its multiple benefits. Despite the cost-effectiveness of the existing programs, the rates of participation and compliance are very low which demand the need of different types of interventions to overcome obstacles, such as distance or lack of time. The home-based programs and the integration of technologies of information and communication into models of telemedicine are potentially attractive solutions to increase the participation of eligible patients and the inclusion of groups of patients currently underrepresented.

Objectives: To describe the current scientific evidence on home-based cardiac rehabilitation programs, anticipate future challenges and new technologies applied in this specific field.

Materials and methods: A review of literature published between 2005 and 2012 in different scientific electronic databases was performed.

Conclusion: Home-based programs are as effective as traditional programs (hospital – based); therefore the provision of both modalities has the potential to increase adherence rates of patients by enabling patients' choice depending on their preference. Current technologies such as the internet enable the development of remote physical rehabilitation. The future of cardiac rehabilitation relies on the flexibility and personalization of care, since the cost-effectiveness of programs depends largely on the participation and compliance of eligible patients.

Keywords: Cardiac rehabilitation; Home-based programs; Telemedicine; Telerehabilitation; Technologies of information and communication

Introduction

Cardiac Rehabilitation Programs (CRP) have been recognized in recent decades as an essential component in the treatment of cardiovascular disease (CVD) and is currently recommended for all patients with a diagnosis of Acute Coronary Syndrome (ACS) [1,2], stable angina [3], heart failure [4], following Coronary Artery Bypass Graft (CABG) [5] or angioplasty (percutaneous cardiac intervention - PCI) [6] and cardiac transplantation [7].

The benefits of CRP in multiple variables are well recognized [8]: increased functional capacity [9]; control of blood glucose and lipid profile [10]; reduction of Body Mass Index (BMI), blood pressure and inflammatory parameters [10-15]; improvement of psychological factors and quality of life [16,17]; reduced number of re-hospitalizations [18], morbidity and mortality associated with heart disease [19-21], providing further economic benefits to the healthcare system. Despite the documentation of all these benefits, there is a worrying underutilization of these programs and it is estimated that in most European countries less than half of eligible patients attend to a CRP [22].

Classically CRP consist of three distinct, consecutive phases [23]: Phase 1-Inpatient program; Phase 2 -Outpatient/exercise program; Phase 3-Follow-up/maintenance. Phase II is, in most countries, a supervised outpatient program lasting six to twelve weeks. It consists of aggressive strategies to reduce risk factors and therapeutic exercise sessions (including aerobic, strength and flexibility training). However, there are some centers that enable the implementation of home (home-based) or community (community-based) programs. According to the literature, home-based programs exhibit clinical outcomes similar to those of center-based programs and that's the reason why they are a valid alternative to the latter [24].

Accessible intervention models as home-based programs and the use of Information and Communication Technologies (ICT) offer interesting perspectives for development and expansion of alternative programs, with potential to increase patients' participation and to improve the cost-benefit ratio of CRP.

The present study aims to describe the current scientific evidence on home-based cardiac rehabilitation programs and new technologies applied in this specific field, anticipating future challenges.

Materials and Methods

An initial search through the online databases (PubMed, Medscape, Endnote, PEDro and Google Scholar) was performed including the following keywords in Englishs: "cardiac rehabilitation", "home-based", "exercise-based rehabilitation", "telemedicine", "telehealth", "exergaming", "technology" and "telemonitoring".

Once obtained the list of articles, these were analyzed according to the inclusion criteria: publications in English; availability of the complete article online; published between January 2005 and December 2012.

In many studies the definition of home-based cardiac rehabilitation, community-based, center-based and hospital-based is not clear. For the purposes of this review, the home-based programs were considered synonymous with the community-based programs and defined as those provided in the patient's home or in a place other than the hospital. The hospital-based and center-based programs were defined as those

***Corresponding author:** Sandra Magalhaes, Physical Medicine and Rehabilitation Department, Hospital de Santo António / Centro Hospitalar do Porto, Porto, Portugal, E-mail: mag.sandra@gmail.com

Received August 26, 2013; **Accepted** September 21, 2013; **Published** September 25, 2013

Citation: Soares D, Magalhaes S, Viamonte S (2013) Home-Based Programs and Application of New Technologies in Cardiac Rehabilitation. Int J Phys Med Rehabil 1: 158. doi: 10.4172/2329-9096.1000158

performed at a hospital or equivalent infrastructure and are therefore considered synonyms. Thus, the main distinction between home-based and center-based programs is the absence or presence of a health professional supervising the exercise sessions. In this review we only use the terms home-based and center-based for the sake of simplification.

Home-Based Cardiac Rehabilitation

There isn't a universally recognisable definition of what constitutes a home-based program so there is a great heterogeneity in its constitution. A predominantly psychological, an exercise only or comprehensive approaches are different kinds of contents. However, all programs should respect the AHA and ESC guidelines [25,26] and provide the same core components of cardiac rehabilitation / secondary prevention (prescribed exercise; cardiac risk factor modification; education; and counselling, which includes diet instruction and disease management).

The main problems of centre-based CRP are the low participation, low adherence and high drop-out rate. Several barriers to the uptake include: geographical distance and transport issues, especially in rural and remote settings; work or domestic commitments; inconvenient schedules; difficulty parking and cost of fuel and parking [27,28].

In order to improve these problems home-based cardiac rehabilitation was suggested as long ago as 1980s. There are different home-based programmes that may include a combination of home visits, telephone or mail support, telemedicine or specifically developed self-education materials [29,30].

The Heart Manual was developed in Scotland in the late 1980s by a multidisciplinary team of cardiac rehabilitation [29]. This is a step-by-step guide of a comprehensive cardiac rehabilitation programme using a structured programme of exercise, stress management, and education. The key component is the facilitator, a rehabilitation professional who has had a brief training in the Heart Manual's behaviour change techniques. He or she works with the patient to determine their health needs and to arrive at a shared set of goals. It includes a walking programme, a relaxation and stress management component and attention to reducing the patients' coronary disease risk. The facilitator contacts the patient at set intervals, either face-to-face or by telephone, to check on progress and help the patient re-set the goals and add new ones. The behaviour change methods are cognitive-behavioural, such as motivational interviewing, goal setting and increasing confidence in small steps. The educational component is delivered through discussion with the facilitator, backed up by written and DVD-based materials. The physical activity program uses a daily walking program but also builds on and extends the patient's own favored physical activities or hobbies [29].

Since its implementation, many published studies have accumulated evidence on its effectiveness; this is currently the most widely investigated, validated and recommended for an increasing number of patients [29,31,32].

Trials comparing home based to centre based CRP have been published. The lack of standardisation of rehabilitation programs within hospital, community and home setting make direct comparisons difficult. These studies report similar improvements in exercise capacity and cardiovascular risk factors control at follow-up between both groups [31-34].

A systematic review and meta-analysis by Dalal et al. [24] showed no statistically significant difference between home based CRP and center based CRP for the following outcomes: mortality, cardiac events, exercise tolerance, modifiable risk factors (control blood pressure and total cholesterol) and quality of life related to health. These results support the studies of Cornwall Heart Attack Rehabilitation Management Study (CHARMS) [32], Birmingham Rehabilitation Uptake Maximization (BRUM) study [31] and Oerkild et al. [33] that compared home based CRP with usual care in elderly patients who rejected to participate in center based CRP. It is therefore consensus that both modalities are effective and that there are relatively small differences between them so the choice doesn't significantly affect clinical outcomes.

The risk of future cardiac events and mortality are probably related to the characteristics of the patients and the temporal distance in relation to the primary cardiac event, so the diversity of results between studies may be a reflection of the lack of standardized criteria for entry into the CRP in clinical studies [29].

According to the CHARMS [32] study the Heart Manual CRP has a lower dropout rate compared with center based CRP. On the other hand, anxiety about the exercise practice at home without the physical presence of the health professional and the lack of motivation are two major obstacles for non adherence to home based CRP mentioned by Jolly et al. [31].

Regarding the economic impact of the implementation of home based CRP the results are controversial and insufficient. It was estimated that the implementation of a home based CRP simultaneously with a center based CRP would cost less than the usual care [24,31]. The lower cost would be due to a readmission rate reduction associated with increased participation and compliance [24,31]. In fact, hospital readmission is an important result in terms of cost-effectiveness and arguably has major implications for the patient and the healthcare system. The current evidence suggests that home based CRP is effective in reducing hospital readmissions and those who are admitted to hospital have a shorter hospital stay [24,31]. According to Dalal et al. [24] there is no scientific evidence of difference in costs for the health care system among modalities center based and home based. The currency differences and the period in which the studies were conducted make it difficult to compare direct costs between studies. Wong et al. [35] published a systematic review of the economic evaluation of CR which concluded that there is evidence supporting the inclusion of center based CRP or home based CRP compared with the absence of CR in patients after heart attack, bypass surgery or percutaneous coronary interventions as well as those with chronic heart failure. Participation in CRP has been associated with shorter time to return to work, so the inclusion of these benefits would probably reduce the total cost to society for providing these programs.

Home-Based Versus Center-Based: Patient Choice

According to Dalal et al. [24] one of the important factors for CRP adherence and compliance is the patient preference. With the current consensus that home based CRP appear to be as safe and effective as center based CRP, the implementation of the first offers an alternative modality [35]. Studies were conducted about the preferences of patients when questioned in relation to home based CRP versus center based CRP and evidence suggests that patients and employees who feel they have a lack of time are more likely to prefer home based CRP [24]. The reasons why patients prefer home based or center based has been addressed in several qualitative studies. According Wingham et al. [36] fears and the consequent loss of trust inherent to cardiac events makes patients more motivated to make changes in lifestyle, reiterating the importance of this moment as a unique opportunity to begin the process of changing lifestyle habits. Some individuals prefer center based CRP for having medical supervision and group sessions during exercise [36]. The belief that the CRP should be adapted to the daily

routine (and not the reverse), the perception of greater self-discipline, preference for individual sessions, the desire to include the family and the difficulty in hospital-home transporting leads other patients to prefer home based CRP [36].

Tele-Cardiac Rehabilitation

Telerehabilitation is the provision of rehabilitation services at a distance using telecommunications and information technologies, potentially minimizing the barriers of distance, time and cost [37]. It is an emerging modality whose primary purpose is to provide equitable access to rehabilitation services and continuity of care outside the hospital. The low cost of ICT and its widespread use, make their integration in health services valuable because there is a growing need for monitoring patients with long-term conditions and the unsustainability of centralization of services in hospital physical infrastructure, from the point of view of human and economic resources.

Given that the main current challenges are access and participation in center-based CRP, telerehabilitation may be promising for alternative ways of providing the CRP outside the hospital, simultaneously ensuring the clinical assessment of the patient (especially during physical exercise) [38].

The safety of home-based CRP is closely related to the feasibility of remote monitoring, since the absence of direct supervision of the patient during physical exercise is a major problem. The use of ICT has been increasingly valued for its potential to enable control of the patient's clinical status and supervision during exercise by monitoring of symptoms (e.g. fatigue, dyspnea, chest pain) and physiological parameters (electrocardiogram - ECG), heart rate, blood pressure, body weight, oxygen saturation, drug therapy, etc.) [39].

Thus, current research is focusing on the development of sensitive and accurate instruments for detecting biological signals clinically relevant and useful for the continuous monitoring of the patient in their day-to-day activity. Other important issues are also related to the transmission, storage and access of the collected data. In recent years, ambulatory accelerometers, heart rate monitors and ECG instruments have been most widely studied for patient monitoring due to its low cost and its noninvasive nature.

The body accelerations can be measured through the use of accelerometers in one or more body segments (e.g. trunk, lower limb) or incorporating the accelerometer in a portable instrument like the mobile phone that comes with the individual in their day-to-day. Information obtained through the accelerometer may be useful in measuring the total daily duration of the walk; walking speed; the frequency of daily walking; postural transitions and metabolic consumption of the patient, among others [40].

Similarly, ambulatory heart rate and ECG monitors have been useful to evaluate cardiac function. We are witnessing today the innovation in this area with the creation of smart clothes: garments incorporated with noninvasive sensors that allow recording vital signs and high quality ECG, combined with the comfort of the patient [41,42]. Data collected during exercise (heart rate, ECG recording, acceleration, etc.) can be viewed online by health care professionals responsible for the CRP or analyzed retrospectively, since the signals are calibrated, captured and transmitted to a portable device where they are stored. These systems allow controlling the number and duration of weekly sessions performed by the patient, the compliance with the prescribed training intensity and analysis of heart rate achieved during exercise. It also allows evaluating the existence of electrocardiographic changes and respective correlation with anginal symptoms reported by the patient during exercise [42].

Finally, wearable sensors and smart homes with exosensors (sensors placed in spaces) are also solutions with the potential, for example, to monitor the patient's functional ability within home or for the prevention of falls in older people [41].

Recently, given the widespread and easy access to web services and telecommunications devices (mobile phones, smartphones, tablets, etc.), these have become useful tools in the context of primary and secondary prevention, leading to the new concept of Mobile Health (mHealth). As reported by Antypas and Wangberg [43], messaging services by phone or email can be presented as a convenient and cost-effective way to support self-management of the patient, for example, on compliance or motivation for the adoption of healthy lifestyle behaviors. According to recent state-of-art reviews about the use of email and phone for communication between patients/caregivers and healthcare professionals in the context of the management of chronic diseases such as heart failure, it is not recommended by the lack of scientific evidence [44,45]. Furthermore, there is lack of significant data concerning long-term effects, acceptance, costs, risks and limitations of such interventions [44,45].

The exergaming research (particularly with the Wii® platform) seems to be promising, and in 2011, the AHA has created a group of studies in this area to investigate how this modality can affect health [46]. This concept refers to the activities based on virtual reality which combine the use of video games and exercise; it involves interaction with the game by performing specific exercise movements that contribute to physical fitness [46]. The fact that it is a popular tool among young people can make video games attractive as facilitating the shift to a more active lifestyle. The evidence for the use of exergaming as a public health intervention is increasing; however it is difficult to make any recommendation in relation to its use in the present. The commercially available exergames can improve balance and muscle strength but are not designed for rehabilitation programs [46].

Only recently some models of Tele-Cardiac Rehabilitation were presented for investigation. To date, the models designed integrate the use of mobile phones and the internet in a home-based CRP [47-50]. The model presented by Walters et al. [48] was called Care Assessment Platform (CAP); it´s a comprehensive model of home care outpatient RC lasting six weeks and integrates the use of mobile phone and the internet to provide all the core components of a CRP. The mobile phone is used for monitoring exercise through an application to counting steps called Step Counter (SC); for the registration of self-observations related to their behavior related to health and communication with health professionals (e.g. reception of motivational messages or telephone consultations per week). All information is synchronized daily with the online portal called Wellness Diary Connected (WDC), a remote server. WDC allows records about other relevant health parameters such as body weight, physical activity, blood pressure, stress, sleep, diet, smoking and alcohol use. The supervisor accesses patient data via the Internet portal WDC before each weekly phone consultation to facilitate and customize feedback and set goals for the patient. In the end of the program, a consultation takes place, for planning the next six months follow-up period. During this period, the telephone contact between patient and health professionals' ceases and the patient is encouraged to use the phone and WDC portal tools for self-management [48].

Several other projects like HeartCycle (at European level and incorporating The Heart Manual CRP)[51], "The Whole System Demonstrator" [50] in UK, and "Telemedicine of the Heart" [51,52] in Germany are examples of research currently underway on the potential of telemedicine in the field of Cardiology.

A systematic review of clinical outcomes, utilization and costs associated with telerehabilitation made by Kairy et al. [53] concluded that despite the growing evidence on the efficacy and effectiveness of telerehabilitation there is still insufficient evidence regarding the impact on resource allocation and costs of this method. However, it is expected that remote monitoring services become increasingly important for patients (security, more control, convenience), health insurers (efficiency, cost reduction) and health system (care more effective) [54]. Future work will provide clinical evidence of the use of these technologies to support home-based CRP.

Conclusion

Cardiac Rehabilitation is considered a key element in the contemporary approach of individuals with CVD, with Class I recommendation in international guidelines. Home-based programs are a valid alternative to centre-based programs. New areas of research include the development of individualized programs, with increasing versatility. In an era where technology has so much presence in the daily routine of patients, the use of ICT has the potential to reverse the disappointing results concerning the involvement and participation of eligible patients to CRP. More research is needed on the technical feasibility of telerehabilitation systems, their applicability and clinical effectiveness, its cost and acceptability by users.

References

1. Anderson JL, Adams CD, Antman EM, Bridges CR, Califf RM, et al. (2011) 2011ACCF/AHA Focused Update Incorporated Into the ACC/AHA 2007 Guidelines for the Management of Patients With Unstable Angina/Non-ST-Elevation Myocardial Infarction: a report of the American College of Cardiology Foundation/American Heart Association Task Force on Practice Guidelines. Circulation 123: e426-579.

2. Krumholz HM, Anderson JL, Bachelder BL, Fesmire FM, Fihn SD, et al. (2008) 2008 ACC/AHA 2008 performance measures for adults with ST-elevation and non-ST-elevation myocardial infarction: a report of the American College of Cardiology/American Heart Association Task Force on Performance Measures (Writing Committee to develop performance measures for ST-elevation and non-ST-elevation myocardial infarction): developed in collaboration with the American Academy of Family Physicians and the American College of Emergency Physicians: endorsed by the American Association of Cardiovascular and Pulmonary Rehabilitation, Society for Cardiovascular Angiography and Interventions, and Society of Hospital Medicine. Circulation 118: 2596-2648.

3. Fraker TD Jr, Fihn SD, Gibbons RJ, Abrams J, Chatterjee K, et al. (2007) 2007 Chronic angina focused update of the ACC/AHA 2002 Guidelines for the management of patients with chronic stable angina: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines Writing Group to develop the focused update of the 2002 Guidelines for the management of patients with chronic stable angina. Circulation 116: 2762-2772.

4. Hunt SA, Abraham WT, Chin MH, Feldman AM, Francis GS, et al. (2009) 2009 Focused Update Incorporated into the ACC/AHA 2005 Guidelines for the Diagnosis and Management of Heart Failure in Adults: a report of the American College of Cardiology Foundation/American Heart Association Task Force on Practice Guidelines: developed in collaboration with the International Society for Heart and Lung Transplantation. Circulation 119: e391-479.

5. Hillis LD, Smith PK, Anderson JL, Bittl JA, Bridges CR, et al. (2011) 2011 ACCF/AHA Guideline for Coronary Artery Bypass Graft Surgery: a report of the American College of Cardiology Foundation/American Heart Association Task Force on Practice Guidelines. Circulation 124: e652-735.

6. Levine GN, Bates ER, Blankenship JC, Bailey SR, Bittl JA, et al. (2011) 2011 ACCF/AHA/SCAI Guideline for Percutaneous Coronary Intervention: a report of the American College of Cardiology Foundation/American Heart Association Task Force on Practice Guidelines and the Society for Cardiovascular Angiography and Interventions. Circulation 124: e574-651.

7. Writing Committee Members, Thomas RJ, King M, Lui K, Oldridge N, et al. (2010) AACVPR/ACCF/AHA 2010 update: performance measures on cardiac rehabilitation for referral to cardiac rehabilitation/secondary prevention services: a report of the American Association of Cardiovascular and Pulmonary Rehabilitation and the American College of Cardiology Foundation/American Heart Association Task Force on Performance Measures (Writing Committee to Develop Clinical Performance Measures for Cardiac Rehabilitation). Circulation 122: 1342-1350.

8. Lavie CJ, Thomas RJ, Squires RW, Allison TG, Milani RV (2009) Exercise training and cardiac rehabilitation in primary and secondary prevention of coronary heart disease. Mayo Clin Proc 84: 373-383.

9. Stewart KJ, Badenhop D, Brubaker PH, Keteyian SJ, King M (2003) Cardiac rehabilitation following percutaneous revascularization, heart transplant, heart valve surgery, and for chronic heart failure. Chest. 123: 2104-2111.

10. Pérez IP, Zapata MA, Cervantes CE, Jarabo RM, Grande C, et al. (2010) Cardiac rehabilitation programs improve metabolic parameters in patients with the metabolic syndrome and coronary heart disease. J Clin Hypertens (Greenwich) 12: 374-379.

11. Ades PA, Savage PD, Harvey-Berino J (2010) The treatment of obesity in cardiac rehabilitation. J Cardiopulm Rehabil Prev 30: 289-298.

12. Ades PA, Savage PD, Toth MJ, Harvey-Berino J, Schneider DJ, et al. (2009) High-calorie-expenditure exercise: a new approach to cardiac rehabilitation for overweight coronary patients. Circulation 119: 2671-2678.

13. Lavie CJ, Church TS, Milani RV, Earnest CP (2011) Impact of physical activity, cardiorespiratory fitness, and exercise training on markers of inflammation. J Cardiopulm Rehabil Prev 31: 137-145.

14. Milani RV, Lavie CJ, Mehra MR (2004) Reduction in C-reactive protein through cardiac rehabilitation and exercise training. J Am Coll Cardiol 43: 1056-1061.

15. Lavie CJ, Morshedi-Meibodi A, Milani RV (2008) Impact of cardiac rehabilitation on coronary risk factors, inflammation, and the metabolic syndrome in obese coronary patients. J Cardiometab Syndr 3: 136-140.

16. Milani RV, Lavie CJ, Cassidy MM (1996) Effects of cardiac rehabilitation and exercise training programs on depression in patients after major coronary events. Am Heart J 132: 726-732.

17. Milani RV, Lavie CJ (2007) Impact of cardiac rehabilitation on depression and its associated mortality. Am J Med 120: 799-806.

18. Ades PA (2001) Cardiac rehabilitation and secondary prevention of coronary heart disease. N Engl J Med 345: 892-902.

19. Heran BS, Chen JM, Ebrahim S, Moxham T, Oldridge N, et al. (2011) Exercise-based cardiac rehabilitation for coronary heart disease. Cochrane Database Syst Rev : CD001800.

20. Hammill BG, Curtis LH, Schulman KA, Whellan DJ (2010) Relationship between cardiac rehabilitation and long-term risks of death and myocardial infarction among elderly Medicare beneficiaries. Circulation 121: 63-70.

21. Lawler PR, Filion KB, Eisenberg MJ (2011) Efficacy of exercise-based cardiac rehabilitation post-myocardial infarction: a systematic review and meta-analysis of randomized controlled trials. Am Heart J 162: 571-584.

22. Bjarnason-Wehrens B, McGee H, Zwisler AD, Piepoli MF, Benzer W, et al. (2010) Cardiac rehabilitation in Europe: results from the European Cardiac Rehabilitation Inventory Survey. Eur J Cardiovasc Prev Rehabil 17: 410-418.

23. Graham I, Atar D, Borch-Johnsen K, Boysen G, Burell G, et al. (2007) European guidelines on cardiovascular disease prevention in clinical practice: executive summary: Fourth Joint Task Force of the European Society of Cardiology and Other Societies on Cardiovascular Disease Prevention in Clinical Practice (Constituted by representatives of nine societies and by invited experts). Eur J Cardiovasc Prev Rehabi 14: e1-40.

24. Dalal HM, Zawada A, Jolly K, Moxham T, Taylor RS (2010) Home based versus centre based cardiac rehabilitation: Cochrane systematic review and meta-analysis. BMJ 340: b5631.

25. Balady GJ, Ades PA, Bittner VA, Franklin BA, Gordon NF, et al. (2011) Referral, enrollment, and delivery of cardiac rehabilitation/secondary prevention programs at clinical centers and beyond: a presidential advisory from the American Heart Association. Circulation 124: 2951-2960.

26. Fifth Joint Task Force of the European Society of Cardiology, European Association of Echocardiography, European Association of Percutaneous Cardiovascular Interventions, European Heart Rhythm Association, Heart Failure Association, et al, (2012) European guidelines on cardiovascular disease prevention in clinical practice (version 2012): the fifth joint task force of the European society of cardiology and other societies on cardiovascular disease prevention in clinical practice (constituted by representatives of nine societies and by invited experts). Eur J Prev Cardiol 19: 585-667.

27. Mendes M (2011) Barriers to participation in cardiac rehabilitation programs. Rev Port Cardiol 30: 509-514.

28. Jones M, Jolly K, Raftery J, Lip GY, Greenfield S; BRUM Steering Committee (2007) 'DNA' may not mean 'did not participate': a qualitative study of reasons for non-adherence at home- and centre-based cardiac rehabilitation. Fam Pract 24: 343-357.

29. Clark M, Kelly T, Deighan C (2011) A systematic review of the Heart Manual literature. Eur J Cardiovasc Nurs 10: 3-13.

30. Ferrier S, Blanchard CM, Vallis M, Giacomantonio N (2011) Behavioural interventions to increase the physical activity of cardiac patients: a review. Eur J Cardiovasc Prev Rehabil 18: 15-32.

31. Jolly K, Lip GY, Taylor RS, Raftery J, Mant J, et al. (2009) The Birmingham Rehabilitation Uptake Maximisation study (BRUM): a randomised controlled trial comparing home-based with centre-based cardiac rehabilitation. Heart 95: 36-42.

32. Dalal HM, Evans PH, Campbell JL, Taylor RS, Watt A, et al. (2007) Home-based versus hospital-based rehabilitation after myocardial infarction: A randomized trial with preference arms--Cornwall Heart Attack Rehabilitation Management Study (CHARMS). Int J Cardiol 119: 202-211.

33. Oerkild B, Frederiksen M, Hansen JF, Prescott E (2012) Home-based cardiac rehabilitation is an attractive alternative to no cardiac rehabilitation for elderly patients with coronary heart disease: results from a randomized clinical trial. BMJ Open 2: e001820.

34. Valencia HE, Savage PD, Ades PA (2011) Cardiac rehabilitation participation in underserved populations. Minorities, low socioeconomic, and rural residents. J Cardiopulm Rehabil Prev 31: 203-210.

35. Wong WP, Feng J, Pwee KH, Lim J (2012) A systematic review of economic evaluations of cardiac rehabilitation. BMC Health Serv Res 12: 243.

36. Wingham J, Dalal HM, Sweeney KG, Evans PH (2006) Listening to patients: choice in cardiac rehabilitation. Eur J Cardiovasc Nurs 5: 289-294.

37. McCue M, Fairman A, Pramuka M (2010) Enhancing quality of life through telerehabilitation. Phys Med Rehabil Clin N Am 21: 195-205.

38. Neubeck L, Redfern J, Fernandez R, Briffa T, Bauman A, et al. (2009) Telehealth interventions for the secondary prevention of coronary heart disease: a systematic review. Eur J Cardiovasc Prev Rehabil 16: 281-289.

39. Piotrowicz E (2012) How to do: telerehabilitation in heart failure patients. Cardiol J 19: 243-248.

40. Corder K, Brage S, Ekelund U (2007) Accelerometers and pedometers: methodology and clinical application. Curr Opin Clin Nutr Metab Care 10: 597-603.

41. Axisa F, Schmitt PM, Gehin C, Delhomme G, McAdams E, et al. (2005) Flexible technologies and smart clothing for citizen medicine, home healthcare, and disease prevention. IEEE Trans Inf Technol Biomed 9: 325-336.

42. Lymberis A, Dittmar A (2007) Advanced wearable health systems and applications. IEEE Eng Med Biol Mag 26: 29-33.

43. Antypas K, Wangberg SC (2012) E-Rehabilitation - an Internet and mobile phone based tailored intervention to enhance self-management of cardiovascular disease: study protocol for a randomized controlled trial. BMC Cardiovasc Disord 12: 50.

44. Atherton H, Sawmynaden P, Sheikh A, Majeed A, Car J (2012) Email for clinical communication between patients/caregivers and healthcare professionals. Cochrane Database Syst Rev 11: CD007978.

45. Vodopivec-Jamsek V, de Jongh T, Gurol-Urganci I, Atun R, Car J (2012) Mobile phone messaging for preventive health care. Cochrane Database Syst Rev12: CD007457.

46. BHFNC (2012) Exergaming evidence briefing.

47. Varnfield M, Karunanithi MK, Särelä A, Garcia E, Fairfull A, et al. (2011) Uptake of a technology-assisted home-care cardiac rehabilitation program. Med J Aust 194: S15-19.

48. Walters DL, Sarela A, Fairfull A, Neighbour K, Cowen C, et al. (2010) A mobile phone-based care model for outpatient cardiac rehabilitation: the care assessment platform (CAP). BMC Cardiovasc Disord 10: 5.

49. Maddison R, Whittaker R, Stewart R, Kerr A, Jiang Y, et al. (2011) HEART: heart exercise and remote technologies: a randomized controlled trial study protocol. BMC Cardiovasc Disord 11: 26.

50. Sanders C, Rogers A, Bowen R, Bower P, Hirani S, et al. (2012) Exploring barriers to participation and adoption of telehealth and telecare within the Whole System Demonstrator trial: a qualitative study. BMC Health Serv Res 12: 220.

51. Maglaveras N, Reiter H (2011) Towards closed-loop personal health systems in cardiology: the HeartCycle approach. Conf Proc IEEE Eng Med Biol Soc 2011: 892-895.

52. Sohn S, Helms TM, Pelleter JT, Müller A, Kröttinger AI, et al. (2012) Costs and benefits of personalized healthcare for patients with chronic heart failure in the care and education program "Telemedicine for the Heart". Telemed J E Health 18: 198-204.

53. Kairy D, Lehoux P, Vincent C, Visintin M (2009) A systematic review of clinical outcomes, clinical process, healthcare utilization and costs associated with telerehabilitation. Disabil Rehabil 31: 427-447.

54. Hermens HJ, Vollenbroek-Hutten MM (2008) Towards remote monitoring and remotely supervised training. J Electromyogr Kinesiol 18: 908-919.

Citation: Soares D, Magalhaes S, Viamonte S (2013) Home-Based Programs and Application of New Technologies in Cardiac Rehabilitation. Int J Phys Med Rehabil 1: 158. doi: 10.4172/2329-9096.1000158