

Optimizing the Home-based Cardiac Rehabilitation Programme by Internet-based Interventions: A literature review

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Abstract—Cardiac rehabilitation program which includes exercise training, nutritional advice, psychosocial and risk factors counseling is traditionally applied for myocardial infarction survivor. However, the low participation rate [1] of cardiac rehabilitation has been reported globally. Recently home-based cardiac rehabilitation program is developed as an alternative approach [2][3][4] to overcome the challenges of low referral rate, inaccessibility of program site, and optimize the utilization of the program. Unfortunately, client may not be able to sustain the modified health behavior in their daily life after the completion of the cardiac rehabilitation programme. To date, the internet-based cardiac rehabilitation program has showed significant in improving the cardiovascular risk factors at the end of the cardiac rehabilitation program. [5][6][7][8] However, there are limited studies to review the significant of internet-based interventions of home-based cardiac rehabilitation in sustention of health behavior in long term. This review will fill the knowledge gap of how the internet-based interventions on home-based cardiac rehabilitation program modify the risk behavior for myocardial infarction survivor in the long run.

Keywords: cardiac rehabilitation, heart rehabilitation, internet-based intervention, mobile phone-based intervention

I. INTRODUCTION

According to the World Health Organization 1993 (WHO), cardiac rehabilitation program is defined as ‘activities that favorably affect the underlying cause of the disease and provision of the best possible, physical, mental, and social conditions, so that patients may, by their own efforts, resume as normal a place as possible in the community [9] On the other hand, American Heart Association [10] states that cardiac rehabilitation program is structured and supervised programs which help people recover from heart attacks, heart surgery and percutaneous coronary intervention. Whilst the European Society of Cardiology [11] declared that cardiac rehabilitation programme is a secondary preventive programme which includes comprehensive interventions like exercise, education programme, risk factors control in order to keep the healthy lifestyle for good. Despite diverse definitions of cardiac rehabilitation programme, they all focus on secondary prevention of recurrent of cardiovascular disease.

A. Components of cardiac rehabilitation

The core components of the cardiac rehabilitation programme include risk factor assessment and modification, exercise training, nutritional counseling, physical activities recommendation and psychosocial management. Traditionally, a cardiac rehabilitation programme is divided into four phases [12] Phase 1 is an in-patient hospital programme which is started after patient is stabilized from acute coronary syndrome or coronary bypass graft surgery. It aims at introducing risk factors of cardiovascular disease, life style modification, mobilization exercise and exercise training. Phase 2 is an out-patient hospital programme which target to discharge patient. This service is provided by the health care professionals to enhance development of exercise habit, re-evaluate the risks factor for cardiovascular disease and psychosocial counseling. Phase 3 is an out-patient community programme. It designed for secondary prevention, physical development and emphasize on normal daily activities. Phase 4 is a community – based programme which is also a life- long maintenance programme. It is focus on incorporation of physical activities and life style modification into life.

To date, the cardiac rehabilitation programme is eligible for clients diagnosed with myocardial infarction, received coronary angioplasty, valvular surgery, coronary artery bypass graft surgery and cardiac transplantation. Although there is various source of the patient, the utilization rate of the cardiac rehabilitation programme is still not optimized globally and locally. Researches [13][14][15] showed that low level of referral, inaccessibility of the cardiac rehabilitation center and poor adherence to risks factors modification are the barriers of the center-based cardiac rehabilitation program.

Other than the traditional factors identified by the studies, the fast-paced life style in Hong Kong may also hinder the client to engage to the cardiac rehabilitation program. These cases share the common point that is all the clients are asymptomatic after completing the post MI cardiac rehabilitation program. Unfortunately, they failed to manage their risk factors for coronary artery disease appropriately. As a result, these become a bomb that threatens the clients’ future health.

B. Modes of cardiac rehabilitation (limitations of the center based CR)

The classical cardiac rehabilitation is conducted in hospital and out-patient clinics.

The participants are mainly low-risk clients who had an insight of the cardiovascular disease. Clients visit the hospital or rehabilitation center 1 to 3 times a week up to 6 to 12 weeks. However, previous researches [1][13][14][15] showed that utilization of the classic cardiac rehabilitation is still not optimized. Factors like low referral, inaccessibility of the rehabilitation venue and non-adherence become the barriers of the rehabilitation. A home-based cardiac rehabilitation was developed by the 1990's in order to overcome these challenges. The home-based cardiac rehabilitation programme is a self-help programme which starts when client is discharge from the hospital. Recently, researches [2][3][16] showed that the home-based cardiac rehabilitation programme is a safe and cost effective alternative model to increase the access as well as the participation of the programme. A nursing case management model (MULTIFIT) [4] was the first home-based cardiac rehabilitation program which focused in exercise training, lifestyle modification, risk factors management and nutritional counseling. Some home -based cardiac rehabilitation programme may also include Heart Manual as a strategy to facilitate the application of home-based cardiac rehabilitation programme. The Birmingham rehabilitation Uptake Maximization study (BRUM) [2] and the Heart Attack rehabilitation Management study (CHARM) [3] were the studies in which the Heart Manual was applied and proved to be as significant as the traditional center- based cardiac rehabilitation program. In addition, the recent Cochrane review [17] has demonstrated a full meta-analysis on available studies on home based versus hospital-based researches. The review showed that the provision of home-based cardiac rehabilitation provides a viable and alternative option for participants who have constraints on traditional hospital-based cardiac rehabilitation.

C. Challenge and barriers of home-based cardiac rehabilitation

Unlike traditional cardiac rehabilitation programme, the home-based cardiac rehabilitation allows the client to have a tailored content according to their stage of changes and physical condition. However, questions like "How to monitor the progress of the client?" and "How could the modified health behavior be sustained?" are raised when home-based cardiac rehabilitation is widely adopted. The application of telerehabilitation may answer part of the question.

II. TELEREHABILITATION

Telerehabilitation is defined a form of telehealth in which the telecommunication technologies is applied for rehabilitation. [18] It includes a wide range of health care service and health care promotion activities. Cardiac telerehabilitation through internet -based intervention is an innovative model to deliver and monitor the cardiac care like diet counseling, cardiac risk factors education, stress management, exercise training by interactive telecommunication technology. It increases the feasibility and

accessibility of the cardiac rehabilitation. From the studies [19][20], the core components of the cardiac telerehabilitation include ECG monitoring, physical exercise training, phone counseling about exercise, nutrition, smoking, stress management and psychosocial problem. Telecommunication technologies such as step counter and well diary installed mobile, telephone, transtelephonic ECG and voice transmitter are applied.

Research indicated that the internet-based cardiac telerehabilitation is cost effective [21] [5], significant to reduce the cardiac risk factors, [5][6][7][8] improve quality of life [6][22] and most importantly optimize the cardiac rehabilitation.

III. CASE STUDY

Case 1. A 49-year-old male marketing executive was brought to the AED 30 minutes after unsolved central chest pain. The ECG revealed 3 mm ST segment depression in the anterior leads. Client then developed sustained wide complex ventricular tachycardia. Amiodarone 150mg in 100 ml D5 infusion Q1H was given. PCI revealed re-stenosis of LAD. Client stated that he had completed the cardiac rehabilitation program 2 years ago after the first episode of AMI. However, he admitted that he had been smoking more heavily in recent years because of the stressful working environment, and was otherwise asymptomatic.

Case 2. A 59-year-old retired government servant was brought to the AED following a sudden collapse in MTR station. The ECG revealed 2mm ST segment elevation in the inferior leads. The biomarker Troponin T and CK showed positive results. Thrombolytic therapy was given. Client's wife indicated that the client had been gaining weight and maintaining sedative lifestyle after cardiac rehabilitation commenced a few years ago.

Case 3. A 31-year-old male truck driver presented to AED with a sudden onset of chest pain. The ECG revealed T wave inversion in the lateral leads. The biomarker Troponin T and CK showed negative result. The client was diagnosed as acute coronary syndrome and was treated by medical therapy. Past medical history indicated that client had hypertension, hyperlipidemia. The client had completed the cardiac rehabilitation program after AMI a year ago.

All the cases had recognized the risk factors and management of cardiovascular disease through the cardiac rehabilitation programme. However, why are they still suffering from recurrent heart attack? Is there any issue left behind the cardiac rehabilitation programme?

In the cases (Case1, Case2 and Case3 were readmitted cases through AED to Cardiac and Intensive Care Unit in Ruttonjee Hospital in 2008-2009), all the post myocardial infarction survivors were terrified by the first life threatening event. They recognized the importance of life style modification, compliance of the treatment and the accomplishment of cardiac rehabilitation. However, they all failed to strength the desired health behavior. According to the researches [23][24], the impact of risk factors modification is vital to secondary prevention of cardiovascular disease. Internet-based Cardiac rehabilitation could service as a useful

adjunct to monitor and modify the personal cardiovascular risk factors like smoking, obesity, stressful and sedentary life style during the rehabilitation period. Mobile phone and internet computer may be used as an effective external reinforcement and prompter to encourage a new health behavior development.

IV. THE REVIEW

The aim of the review was to include studies that exam the impact of telecommunication technology in health behavior adherence after the home-based cardiac rehabilitation. Therefore, the objective assessments of the modifiable coronary risk factors like physical activity, blood pressure, smoking, cholesterol level, alcohol were included in the review. In addition, quality of life was also included.

Primary outcomes

The primary outcome was the sustention of modified health behavior at six and twelve months after completion of home-based cardiac rehabilitation.

Secondary outcomes

The secondary outcome was the modification of coronary risks factors and health- related quality of life.

Methods

Types of studies

Studies included randomized controlled trials

Types of participants

The study population included adults who were the participants of cardiac rehabilitation programme. They previously experienced cardiac events like myocardial infarction, coronary heart disease, congestive heart disease, and coronary artery bypass grafting and percutaneous coronary intervention.

Types of interventions

The review includes:

Studies which examine any forms of telecommunications technology for patient with home- based cardiac rehabilitation.

The review excludes:

Studies which only use the telecommunication technology as a reminder of the follow- up appointment.

Type of outcomes measures

Outcomes measures included excise capacity, modifiable cardiovascular risk factors (blood pressure, smoking, BP, total cholesterol, HDL, LDL, BMI), Quality of life and depression.

Electronic searches

The electronic databases will be searched included Cochrane Central Register of Controlled Trials (CENTRAL) on the Cochrane Library, MEDLINE (OVID), EMBASE (OVID), PsycINFO (OVID), CINAHL on EBSCOhost and SCOPUS.

The key words used were 'cardiac rehabilitation', 'heart rehabilitation', internet-based intervention' and 'mobile phone-

based intervention'. And the review period was restricted to 2003 to 2013 to ensure the continuing currency of the studies included. After the initial search strategy, seven studies were identified. (Table 1 illustrate the studies detail). However, three out of seven were extracted for the review as three studies (Walters et al.2010 [25], Leemrijse et al.2012 [26] and Antypas et al.2012 [27] were on-going studies which included unpublished results.

V. RESULT

The studies have showed that the use of internet-based interventions of home based cardiac rehabilitation benefits the sustention of modified health behavior at six and twelve months after the completion of home-based cardiac rehabilitation. The review included 733 participants from U.S., Northern Germany, Spain and Australia. The ongoing studies, Walters et al.2010 [25], Leemrijse et al.2012 [26] and Antypas et al.2012 [27] are likely to fulfill the inclusion criteria and may affect the findings in the future. Southard et al have firstly examined the effectiveness of internet-based case management intervention for the secondary prevention of coronary heart disease in U.S. Mittag et al [7] demonstrated the expanded size of randomized control trial of internet-based home- based cardiac rehabilitation in Germany whereas Blasco et al [8] and Redfern et al [6] have published the studies, the telephone-delivered lifestyle intervention for home-based cardiac rehabilitation in Spain and Australia respectively.

Impact of internet-based intervention in improving cardiovascular risk factors

In the review, four studies were similar in design, intervention and primary outcomes. All four intervention arms of the included studies showed sustained effect on health behavior modification for six to twelve months after internet-based intervention of home-based cardiac rehabilitation. The interventions, telephone or mobile phone delivered behavior coaching and counseling, were initiated by trained registered nurse or case manager. The duration of the telephone intervention ranged from ten to thirty minutes. Although the effectiveness of individual outcomes varied, they all indicated that the interventions benefited by improving the modifiable cardiovascular risk factors.

The Southard 2003 study [5] did show the significant difference ($p = .003$) of body weight and BMI six months after the home-based cardiac rehabilitation, although other risk factors like blood pressure and lipid values were statistically insignificant. Similarly, the Blasco study [8] confirmed the long term benefit of reductions of BMI and body weight ($p=.003$). However, there is no significant difference in smoking cession 12 months after the rehabilitation. Whereas, the Mittag 2006 study [7] depicted the Framingham scores, the assessment tool for risk of coronary heart disease, significantly declined ($P=0.038$) twelve months after the intervention. Redfern 2009 trial [6] also revealed the improvement of multiple risk factor levels for twelve months after the rehabilitation.

Impact of internet-based intervention in improving quality of life

Interestingly, the studies of Southard 2003 [5], Mittag 2006 [7] and Blasco 2012 [8] suggested no significant difference between the experimental and control groups on quality of life. Only Redfern 2009 [19] reported that there was significant difference ($p < .01$) in physical functioning domain of quality of life (SF-36).

Impact of internet-based intervention in reducing cost of follow-up programme

Three randomized controlled trials were based on telephone or mobile phone as a basic component of the internet-based intervention of the home-based cardiac rehabilitation. Southard (2003) [5] study analyzed the cost which was estimated to be \$453 per participant over the course of 6 months whereas the cost of the internet-based interventions was not an outcome measured in Mittag (2006) [7], Redfern (2009) [6] and Blasco (2012) [21] studies. However, based on another research [22], it is likely that internet-based cardiac rehabilitation is more cost effective than the traditional center-based one.

VI. DISCUSSION

Cardiac rehabilitation programme is well established for decades to reduce the mortality of clients suffering from heart disease. Clients benefited from this programme include those with acute myocardial infarction, angina, post CABG, Post PCI, heart failure, post heart transplant, post heart valve surgery and post device implantation. The structured cardiac rehabilitation programme was initiated in 1980s and it has expanded its roles and modes of delivery for decades.

Although the cases showed different presentations of heart disease, they shared the common health behavior which was non-adherent to cardiovascular risk factors modification. In these cases, failure of the clients to modify their risk factors, smoking (case 1), obesity (case 2) and hyperlipidemia (case3) attributed to another cardiac event even though they had completed the cardiac rehabilitation programme. The review proved that internet-based intervention like telephone or mobile phone could assist clients in fostering their new health behavior. The most important application of internet-based intervention is weight control after the accomplishment of the rehabilitation. The Southard (2003) [5], Mittag (2006) [7], Redfern (2009) [6] and Blasco (2012) [8] studies all supported the significant reduction in BMI in the long run (6 to 12 months) after the internet-based intervention. Since there is a well established relationship between obesity and other cardiovascular risk factors like hypertension, diabetic mellitus and hyperlipidemia [28], the reduction of BMI demonstrates efficacious in secondary prevention of cardiovascular disease.

It is easier to start a new health behavior than to maintain it. The crucial point is how to keep this health behavior. It is not surprising that some 'successful' participants of cardiac rehabilitation may share their experience of relapse of coronary heart disease after the rehabilitation. They successfully participated and acknowledged throughout the cardiac rehabilitation. However, they failed to maintain and integrate the adjusted health behavior in the long run. Concerning the situation in Hong Kong, a fast-paced living environment, sedentary life style and high fat and caloric diet are the most common precipitating factors which trigger the disease.

Sustentation of healthy attitudes and behavior needs motivation. Internet-based intervention (telephone or mobile) may also be applicable in Hong Kong as it provides the basis for problem-solving, feedback and reinforcement. If internet-based intervention is feasible, then how can we optimize it in home-based cardiac rehabilitation? Motivational interviewing may be an answer. Motivational interviewing through internet-based intervention may act as an internal motivator to encourage the development of the healthy behavior. Motivational interviewing has been defined as a "directive, client-centered method for enhancing intrinsic motivation to change by exploring and resolving ambivalence" [29]. Four principles illustrated in motivational interviewing include expression of empathy, developing discrepancy and avoiding argument, rolling with resistance and supporting self-efficacy. Researchers [30][31][32] have shown that motivational interviewing is effective to facilitate a health behavior change. Internet-based intervention plays an important role in future development of cardiac rehabilitation. It could be enriched by an innovative approach like motivational interviewing. The training of the specialized nurses or case managers is also the prerequisite for the success of an effective internet-based cardiac rehabilitation.

VII. CONCLUSIONS

Internet-based interventions have been shown to sustain the modified health behavior after the completion of home-based cardiac rehabilitation. The main component of the internet-based intervention is telephone delivered behavior coaching and counseling. Since telephones are extremely common household items nowadays, they may serve as an alternative to in-person visit. Surprisingly, internet-based intervention has also an effect on eliciting the intrinsic motivation to sustain the modified health behavior. For the above reasons, an internet-based intervention is likely to be used to optimize the benefit of the home-based cardiac rehabilitation.

The review showed that randomized controlled trials of internet-based intervention of home based cardiac rehabilitation are feasible and significant in sustaining the modified health behavior. The diversity of the components of the internet-based intervention depends on the computer literacy of the participant. More research is required on the impact of computer literacy on internet-based home cardiac rehabilitation. Besides, researches on integration of motivational interview into the internet-based intervention would be worthwhile as an intrinsic motivation is vital for the persistence of a newly acquired health behavior.

Successful secondary prevention of cardiovascular disease depends on sustentation of cardiovascular risk factors and health behavior modification. The use of telephone and motivational interviewing in current home-based cardiac rehabilitation can facilitate the maintenance of health behavior in the long term. The concept of completion of cardiac rehabilitation is not enough to prevent the recurrence of cardiovascular disease. The awareness on the risk factor modifications should be the key to secondary prevention of the cardiovascular disease.

Appendix 1

Table 1 Characteristics of Studies

Author (year)	Study design (sample size)	Study population	Duration and applied technologies	Outcomes and variables reported	Country
Southard et al. (2003)	RCT intervention n=53 control n=51	Congestive heart disease and coronary heart disease	Duration: 10 months Technology: Telephone and e-mail	HR, BP ,body weight, total cholesterol, HDL, LDL, Quality of life, depression	USA
Mittag et al. (2006)	RCT Intervention n=154 Control n=143	Previously had cardiac event like myocardial infarction, coronary artery bypass grafting, percutaneous coronary intervention	Duration: 12 months Technology: Monthly nurse-initiated telephone counseling about sports, physical exercise, nutrition, nonsmoking, stress management, psychosocial and cardiac problems	Total cholesterol, HDL, BP, smoking, DM, anxiety SCL-90(SD) and depression CES-D(SD)	Germany
Redfern et al. (2009)	RTC Intervention n=67 control n=69	ACS survivors	Duration: 12 months Technology: Telephone consultation and follow-up	BP, smoking, total cholesterol, HDL, LDL, BMI, Physical activity, Quality of life and depression	Australia
Walters et al. (2010)	RCT IT group n=100 Control n=100	Post STEMI or NSTEMI and referred for phase 2 rehabilitation	Duration: 6 months Technology: Mobile phone which installed step Counter and Wellness Diary	6minutes walk test, BMI, BP, smoking, alcohol intake, FBC, lipids HbA1c, Hb, Kessler 10, diet Habits Questionnaire, Health Outcome Questionnaire, the Seattle angina questionnaire, Unplanned re-admission and mortality, client self-report and staff time report	Australia
Leemrijse et al. (2012)	Randomised parallel group study n=200 control n=200	Hospitalized less than 8 weeks with heart disease like STEMI, NSTEMI, IAP, CABG and PCI	Duration: 6 months Technology: phone contact by MI trained nurse in every four to six weeks for life style modification	BMI, waist circumference, physical activity scale, BP, Total cholesterol, HDL, LDL, Diet Questionnaire(Maastricht Voedingsvragenlijst), Blood glucose, HbA1c.smoking, adapted Morisky scale, HRQL questionnaire, Hospital Anxiety and depression scale	Netherlands
Antypas et al. (2012)	RCT Intervention n=120 Control n=120	Participants of the cardiac rehabilitation programme with cardiovascular disease	Duration: 12 months Technology: Internet- based intervention include discussion to stage of change, regulatory focus, self-efficacy and behavioral monitoring	Physical activity, smoking, alcohol use, quality of life, depression	North Norway
Blasco et al. (2012)	Single-blind randomized controlled trial Intervention N=98 Control N=98	Acute coronary syndrome survivor	Duration:12 months Technology: Mobile phone	BP, BMI, smoking, total cholesterol, HDL, LDL, HbA1C, Quality of life(SF36) and Mental health scale	Spain

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